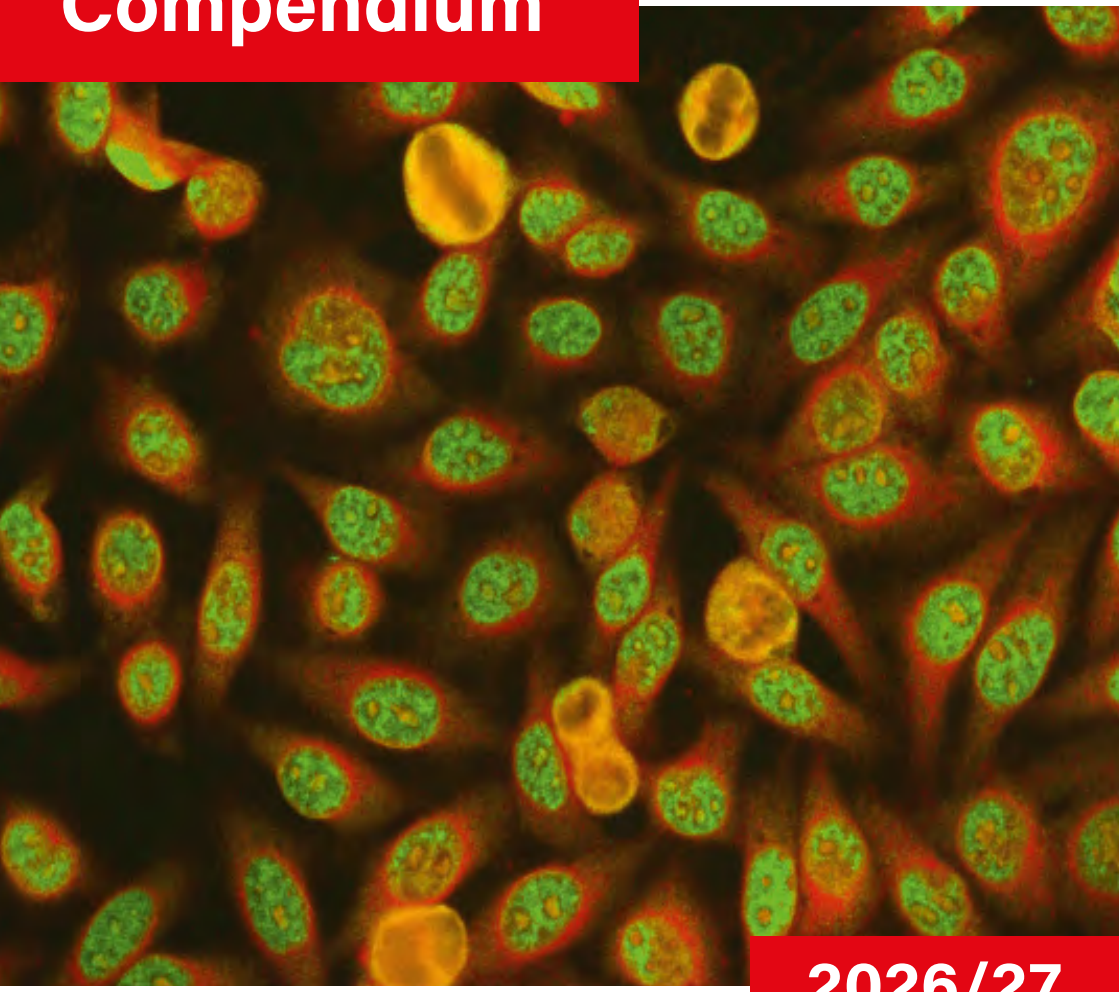
LABOKLIN
LABORATORY FOR CLINICAL DIAGNOSTICS

Compendium



2026/27

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Images:
Laboklin (including cover),
BD (blood culture bottles),
Laboklin & Sarstedt (2024): *Tipps & Tricks in der Präanalytik: Band 1 Blutuntersuchungen bei Kleintieren* [Broschüre].
Dr Annemarie Baur-Kaufhold, Dr Maria Brockmann, Ida Dolle.

As of: January 2026

Dear colleagues,

Laboratory tests – how do I choose the right one? The Laboklin Compendium answers this as well as many other questions. After all, we do not just perform tests – we also offer advice and support. What sample material is required and how should it be prepared? What are the advantages and limitations of laboratory findings? The Compendium provides the answers!

How much does the laboratory test cost and how quickly will I receive the results? To answer these questions, we have compiled the Catalogue of Prices and Services, which is published annually. The present Compendium, however, is intended as a compact reference guide designed to remain valid over a longer period of time. Regular new editions are intended to take into account that new tests are constantly replacing old ones, because perfect is the enemy of good. And there are always new additions, too!

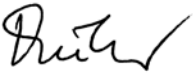
And how do the practice and the laboratory work together? Laboklin offers a genuine all-round service: from telephone consultation in advance to sample collection, rapid processing of samples and electronic reporting of results to expert advice afterwards – always reliable.
Courier: Registration via "MyLab" or, more traditionally, by telephone (depending on the country).
Submission form: via the practice management software, via "MyLab" or by paper – we are happy to accommodate your preferences.
Reporting of results: in "MyLab", in the practice programmes or by e-mail, whichever you prefer – and it is also possible to send an automatic copy to the animal owner.
Monthly billing: with a turnover-based discount, upon request already visible in "MyLab" in numerous countries, everything is completely transparent. And you remain free to entrust your samples to whoever you think suits best.

How about communicating with the animal owner? We offer numerous resources for the practice, ranging from Help & Advice folders to Fact Sheets on travel sickness to the vbd.laboklin.com website and the 4Paws app, thus providing answers to many questions.

Our unique qualities – going the extra mile: The *Laboklin Academy* offers a wide range of training opportunities. Our team of experts not only continuously evaluates ways to improve lab work, but also love to communicate with you, discuss cases, assist with the interpretation of lab results etc. In addition, we provide helpful flow charts and posters with cell images to support in-house microscopy.

All this is the result of our constant efforts to provide you with the best possible service. Our efforts have already been recognised for the fourth time by an external jury: We continue to be one of the **100 most innovative companies in Germany** and have already been awarded the title of **Bavaria's Best 50** twice. In our capacity as a Chamber of Industry and Commerce (CCI) training centre, we take our responsibilities seriously, as well as in our role as a training centre for various veterinary specialties, the European College of Veterinary Clinical Pathology (ECVCP) and the European College of Veterinary Microbiology (ECVM). Our mission: Times are changing – and so are the demands that practices place on laboratories. What stays the same: A good laboratory is able to help the practice. We will continue to stand by your side.

With best regards from the laboratory



Dr. Elisabeth Müller

LABOKLIN at a Glance

LABOKLIN GmbH & Co. KG is accredited according to DIN EN ISO/IEC 17025:2018

An overview of LABOKLINs range of services

Profiles and screenings
- Small animals
- Small mammals
- Birds
- Reptiles
- Horse
- Ruminants
- South American camelids
- Pig
- Amphibians
- Fish

Blood examinations
- Allergy
- Endocrinology
- Function tests
- Haematology
- Immune status
- Clinical chemical parameters
- Serology/Infectious diseases
- Diagnosis of leukaemia/lymphoma
- Tumour markers

Hereditary diseases
- Dog
- Cat
- Horse
- Cattle
- Pig
- etc.

Microbiology and parasitology
- Bacteriology
- Mycology
- Virology
- Parasitology
- Maldigestion/Malabsorption
- Dysbiosis/Microbiome analysis
- Autovaccines etc.

Pathology
- Histopathology
- Immunohistology
- Cytology
- Exsudate/Transudate
- Cerebrospinal fluid
- Synovia
- Other aspirates
- Tumour genetic tests

PCR detection
- Dog
- Cat
- Small mammals
- Birds
- Reptiles
- Horse
- Ruminants
- South American camelids
- Pig
- Amphibians
- Fish
- etc.

Other genetic examinations
- Dog leukocyte antigen (DLA) typing
- Sex determination (mammals/birds/snakes)
- Breed analysis
- Identity and parentage
- DNA profile
- Species differentiation
- Coat colour/Coat structure

Water Tests
- Water of aquarium/ponds

Hygiene
- Hygiene examinations
- Profiles

Contents

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Abbreviations/Additional Information Concerning the Test Descriptions

Sample quantities

The indicated sample quantities are minimum quantities. Please note that larger minimum quantities may be required, depending on the type of test tube used (see Chapter 1.1.4, p. 20).

Sample material/Further information

Below you will find a list of our abbreviations. You will also find these abbreviations on our submission forms. The required materials for the individual tests are indicated in this compendium but may (for lack of space) not (all) be listed on the submission forms.

, (comma)	Information connected with comma: You can choose which sample material you want to submit (see p. 27).
+	Information connected with "+": You must submit all of these sample materials.
!	refrigeration required (see Ch. 1.10.2, p. 33)
A	swab without medium
AM	abortion material
AP	contact plates
AS	ascites
B	bees
BAL	bronchoalveolar lavage
BI-D	bioindicator steam steriliser
BI-H	bioindicator dry heat steriliser
BL	bee larvae
BS	blood smear
CB	citrate blood
CP	citrate plasma
CSF	cerebrospinal fluid
E	Egg
EB	EDTA blood
EP	EDTA plasma
F	feather
FA	faeces
FG	liquid
FGW	formalin-fixed tissue
FL	fleas
FNA	fine-needle aspirate
GW	tissue
H	urine
HA	hairs
HB	heparin blood
HP	heparin plasma
HS	urolith
HSD	urinary sediment
HT	skin
K	scab
KM	bone marrow
KW	aqueous humour
L	liver
Ln	lymph node
LnA	lymph node aspirat
LQ	CSF
LSP	pulmonary lavage
M	spleen
MH	morning urine
Mi	milk
MSP	gastric lavage
N	kidney
NaFB	sodium fluoride blood
NSP	nasal lavage
OT	specimen slide
PSP	preputial lavage
S	serum
Sp	sperm
SV	synovia

TaM	tank milk
TBS	tracheobronchial secretion
TM	swab with medium
TSP	tracheal lavage
V	vomit
W	water
Z	tick

Test methods

AAS	atom absorption spectrometry
CEDIA	cloned enzyme donor immunoassay
cELISA	competitive ELISA
CLIA	chemiluminescence assay
CFT	complement fixation test
ddPCR	droplet digital PCR
EIA	corresponds to ELISA
ELISA	enzyme linked immunosorbent assay
FAVN	fluorescent antibody virus neutralisation
FLP	fragment length polymorphism
FTIR	Fourier transform infrared spectrometry
GCMS	gas chromatography-mass spectrometry
HAH	haemagglutination inhibition assay
HPLC	high performance liquid chromatography
ICA	immunochromatography assay
ICP-MS	inductively coupled plasma mass spectrometry
IFAT	immunofluorescence antibody technique
IRMA	Immunoradiometric assay
ISE	ion-selective electrodes
LA	Slow agglutination
LCMS	liquid chromatography-mass spectrometry
MALDI-TOF	matrix-assisted laser desorption/ionisation – coupled time of flight mass spectrometry
MAT	microscopic agglutination test
NIRS	near-infrared spectroscopy
PARR	polymerase chain reaction for antigen receptor rearrangements
PCR	polymerase chain reaction
RBT	Rose-Bengal test
RIA	radioimmunoassay
SAFC	sodium acetate-acetic acid-formalin concentration
STRs	short tandem repeats (microsatellite analysis)
VNT	virus neutralisation test

Other abbreviations

AB	antibodies
AG	antigen
bdw	body weight
rpm	revolutions per minute

Numbers in the test descriptions

(1)	Specifications apply to testing with method (1)
(2)	Specifications apply to testing with method (2)
(3)	Specifications apply to testing with method (3)

Duration The specified standard testing times in working days (Mon–Fri) apply from the date of arrival of the samples at Laboklin Bad Kissingen and may vary for other laboratories – please refer to the country-specific Catalogue of Services and Prices.
The specified test durations are supplied without liability.

Species

Camelids
South American camelids (SAC), camels;
as polygastric animals, they may appear under the heading “ruminants” in this compendium.

Camels
Bactrian camel, dromedary

Equidae
Horses, donkeys, mules

Farm animals
Ruminants and pigs

Large animals
Horses, farm animals, camelids

New World camelids
see South American camelids

Old World camels
see camels

Small mammals
Rabbit, guinea pig, ferret, chinchilla, rat, mouse, hamster and other small mammals which are kept as pets.
In individual cases, tests for small mammals may also be applicable for small wild mammals (e.g. hedgehogs).

Small animals
Dogs and cats

South American camelids (SAC)
Llama, alpaca, vicuña, guanaco;
(also known as New World camelids)

Further notes

Following the harmonisation of the **requirements for reporting diseases** across Europe under the European Union Animal Health Law (AHL), corresponding notes for the relevant pathogens are provided in Chapter 14 on infectious diseases (as of December 2025).

> greater than
< less than

1 Pre-analytics

1.1 Samples of Blood, Plasma, Serum, Bone Marrow, Urine

The first step in the process of examining a sample is the pre-analysis. Pre-analysis includes all steps from patient preparation, specimen collection and transport of the sample to the lab to the preparation of the sample for analysis.

1.1.1 Preparing Patients for Blood Collection

Before taking a blood sample, adult **dogs** and **cats** should generally not have eaten for 10–12 hours. Puppies should fast for 4 to 6 hours maximum. Otherwise, faulty results are to be expected, especially for cholesterol, glucose and TLI. In addition, parameters such as α-amylase, ALT, AST, bilirubin, total protein, triglycerides, serum bile acids, urea, leukocytes and calcium can be affected.
In **horses, donkeys, ruminants, camelids** and **small mammals,** prolonged periods of fasting are not recommended and fasting blood samples are not common. For special tests (e.g. insulin and glucose for the diagnosis of Equine or Asinine Metabolic Syndrome), horses and donkeys should not be given any concentrated feed, oats or access to pasture 4–6 hours before the blood sample is taken but may continue to eat hay. Ferrets should fast for a maximum of 2 to 4 hours prior to insulinoma diagnosis.
It is advisable to inform the owner about the influence of physical activity or stress on the results of a blood examination. Particularly muscular enzymes such as CK, LDH and AST can show increased levels in serum after physical exertion. Additionally, glucose and lactate can also show elevated serum concentrations.

Sampling time and drug administration

Pre-analysis is particularly important when drugs are administered at the same time, as numerous medications can influence the measured results of biochemical and haematological parameters. Depending on the active ingredient, dose and time of administration, changes in enzyme activity, metabolite concentration, protein binding or antibody concentration/activity may occur. If possible, blood should therefore be collected before the next dose of medication is administered in order to avoid acute pharmacological effects. It is also important to accurately document all drugs administered, including dosage and time of administration, in order to be able to interpret the laboratory findings correctly. In some cases, it may be necessary to coordinate the sampling time between the animal owner and the treating veterinarian, especially for drugs with a narrow therapeutic range or those known to interfere with laboratory diagnostics.

Before doing any **allergy tests**, including feedstuff tests, any administration of corticosteroids and JAK inhibitors (Janus kinase inhibitors) should be discontinued, since they can significantly affect serological allergy tests by suppressing antibody production and immune response. To do so, the following withdrawal times are recommended:

- local/topical corticosteroids: 2–4 weeks
- oral corticosteroids (e.g. Prednisolone): up to 8 weeks
- depot cortisone preparations (e.g. Voren®): up to 3 months

If these times cannot be observed, false negative results are possible. If there is a positive result, the reaction class must be assessed taking into account the previous administration of cortisone.
Please note that other itch-suppressing medication may also have a negative impact on the allergy test. Our allergy team will be pleased to advise you.
Allergy tests should be performed during the season or at the end of the season and not earlier than one month after the onset of the clinical signs, as the test may be false negative if performed out of season.

1.1.2 Whole Blood, Plasma or Serum – When to use Which Material

Details on the recommended material (blood, serum, plasma) for the requested test can be taken from our test descriptions or the submission form or the Catalogue of Prices and Services.
For labelling the sample, it is also necessary to indicate the sample type (see Chapters 1.8, p. 27 and 1.9, p. 30).

Whole blood samples

EDTA blood (EB)

- For doing a blood count, EDTA blood is the most suitable material in mammals (however, for birds and reptiles it is heparin blood, see below).
- For the serological examination of the blood type, EDTA whole blood is needed as well.
- As the cells in the sample are not stable, EDTA samples for haematological tests should not be older than 48 hours or the relevant information provided on the submission forms regarding the services should be observed.
- For most PCR analyses and genetic tests, EDTA blood is required.
- To determine certain parameters such as ACTH, CPSE (prostate), normetanephrine/metanephrine, parathyroid hormone-related protein, taurine or pro-BNP, only EDTA plasma which was immediately centrifuged and cooled (or frozen EDTA plasma – see test description) can be used to obtain reliable results.

Heparin blood (HB)

- To collect heparin samples, lithium heparin (LiHep) tubes are available.
- For doing a blood count in reptiles and birds, lithium heparin blood should generally be used.

- Since the amount of blood is often very low in small mammals, reptiles and birds, lithium heparin tubes are particularly suitable, as heparin whole blood can be used to do the blood count and heparin plasma to determine clinical chemistry parameters as well as T4.
- For the PCR, lithium heparin whole blood should only be used under exceptional circumstances, as lithium heparin can inhibit the PCR and might thus lead to false negative results.

Citrate blood (CB)
- To determine the coagulation parameters, only the appropriate citrate tubes should be used. For getting a correct evaluation, their shelf life may not be exceeded. It is also necessary to have an exact mix ratio of 1:10 (1 part citrate + 9 parts blood).
- For correctly performing platelet function tests, citrate whole blood is required.

Sodium fluoride blood (NaFB)
- Sodium fluoride inhibits enzyme activities which lead to a reduction of some parameters. It should be used for the correct determination of glucose and lactate.
- Make sure to observe the fill level when using sodium flouride tubes. Because of the smaller sample volume that is expected in small mammals, it is also possible to submit either serum which was centrifuged and separated shortly after coagulation (after 30 minutes at room temperature) or plasma (immediately) for determining the glucose concentration.

Plasma

- Samples are drawn into tubes **with** anticoagulants (heparin, EDTA, citrate).
- Fill volume: Fill the sample tubes exactly up to the mark to ensure the correct ratio between blood and anticoagulant. If the quantity is too small or too large, results may be incorrect. The size of the tube that is used should match the required sample volume.
- Can be centrifuged immediately after collection (10 min, 2000 g).
- Remove the supernatant by pipette and transfer it into an uncoated test tube. Make sure that plasma is **not** pipetted into significantly larger tubes after centrifugation. In large vessels, the material may adhere more to the vessel walls or become less stable due to an unfavourable surface-to-volume ratio. The test tube should then be labelled with the sample material or suitable bar code labels should be used (see Chapter 1.9, p. 30).
- Please note: The additives limit the number of analyses!
- Heparin plasma (HP) is needed for many clinical-chemical examinations. HP cannot be used for agglutination tests.
- The collection of EDTA plasma (EP) for clinical-chemical and/or serological parameters should only take place in exceptional cases, as EDTA disturbs through various mechanisms the measurement of individual parameters such as calcium, magnesium and AP. Likewise, potassium cannot be determined when using EDTA plasma, since EDTA is added as K-EDTA.
- Some coagulation parameters can only be analysed using citrate plasma (CP). Performing platelet function tests using centrifuged citrate plasma is not possible.

Serum

- Samples are drawn into tubes **without** anticoagulants, using a coagulation activator if applicable.
- Select a tube size that matches the required sample volume to ensure the correct ratio of blood to coagulation activator.
- Allow to stand for 30–60 min.
- Centrifuge for 10 min at 2000 g.
- Remove the supernatant by pipette and transfer it into an uncoated test tube that is not too large (see Plasma). Label the test tube with the sample material or use a suitable bar code label (see Chapter 1.9, p. 30).
- For the correct determination of individual parameters, only serum should be used (see detailed descriptions provided for the individual parameters).
- Sending non-centrifuged samples should only be done exceptionally (e.g. in case of a very low sample quantity), as the transport might result in cell damage and thus lead to haemolytic serum.

An overview of the different tubes can be found in Chapter 1.8, p. 27.

1.1.3 Factors Interfering with the Analysis of Blood Samples

Serum samples with varying degrees of haemolysis (Laboklin & Sarstedt (2024))

Haemolysis

Haemolysis is caused by leakage of intracellular components of the erythrocytes such as phosphate, iron, potassium and especially haemoglobin due to damage to the cell membrane. Haemoglobin causes a red colouration of serum/plasma which primarily interferes with the photometric testing done in clinical chemistry.

Lipaemia

Lipaemia refers to the milky/turbid discolouration of serum/plasma due to triglycerides. It is often caused by diet- or stress-related factors. Lipaemia also occurs as a result of endocrinological diseases like Cushing's syndrome or hypothyroidism. Lipaemic samples often complicate the measurement of certain clinical parameters, e.g. bilirubin.

Icterus

Icterus is a yellowish discolouration of serum/plasma. Excess amounts of bilirubin, which is the reason for the yellow colouring, are normally caused by a medical condition and cannot be influenced. Very severe icterus may sporadically affect certain parameters. The yellow colouration is physiological in horses.

Interfering factor	Parameter	Level
Haemolysis	LDH, HBDH, CK, AST, bilirubin, creatinine, PO4, K, Fe, fructosamines	↑
Haemolysis	Ca, glucose, Mg	↓
Lipaemia	ALT, AST, GLDH, γ-GT, AP, bilirubin, creatinine, haemoglobin	↑
Lipaemia	amylase, Na, Cl, K	↓

Medicine	Parameter	Level
Penicillin G	K	↑
Tetracyclines	PO4	↑
Tetracyclines	K	↓
Salicylates	CK, AP, glucose, Na, protein	↑
Salicylates	K, Ca	↓
Corticosteroids	CK, AP, glucose, Na, protein	↑
Corticosteroids	K, Ca	↓
Phenylbutazone	Ca, Na	↑
Barbiturates	CK	↑
Halothane anaesthesia	CK, PO4	↑
Glucose infusion	glucose	↑
Glucose infusion	PO4	↓

1.1.4 Special Sample Requirements in Clinical Chemistry, Haematology and Haemostaseology

Sample material

- **Sample quantity:** In addition to the required sample type, the **minimum sample quantity** is specified in the Compendium as well as in the Catalogue of Prices and Services and on the submission forms. You are welcome to send us **more material**, as higher volumes speed up processing times in the laboratory for clinical chemistry and haematological analysis and increase the likelihood of obtaining a diagnostically

conclusive result. Submitting larger volumes than specified is beneficial, particularly when it comes to birds, reptiles and small mammals. When you request profiles/ screenings and you were only able to collect a small amount of material, you can specify the order of the parameters according to their priority on the submission form. This ensures that the most important parameters will be analysed even if the sample quantity is insufficient.

- **Two samples of the same type of material** are needed if special pre-analytical conditions (e. g. freezing or exclusion of air) are required for a requested service.
  Example 1: Two serum samples must be submitted to determine serotonin and other serum parameters. One sample is used to analyse the additional parameters, while an unopened, refrigerated sample is required to determine serotonin. This is necessary because serotonin is unstable when not refrigerated.
  Example 2: To determine ionised calcium (requires exclusion of air) and other serum parameters, two serum samples must be sent in so that the other tests can be performed at the same time without affecting the "air exclusion" status.

<u>Blood counts</u>

- EDTA or lithium heparin blood
- When collecting the sample, discard the first 0.5 ml of blood, if possible, as they contain an increased amount of coagulation factors, or first obtain a serum sample.
- Let the blood run down slowly on the side of the sample tube.
- Pay attention to the fill volume! Preferably fill up to the mark, since an insufficient volume can result in changes in cell morphology. Do not overfill the tube in any case, as the sample might clot.
- After drawing the sample, tilt the test tube carefully several times. Do not shake it.
- When requesting haematological analysis, a blood smear should always be supplied in addition to whole blood.
- Do **not** store blood smears **in the refrigerator** and not close to formalin.
- Pack the samples **frost-proof** in winter; possibly cool them in summer.
- Reliable results can only be obtained from samples not older than 48 hours.

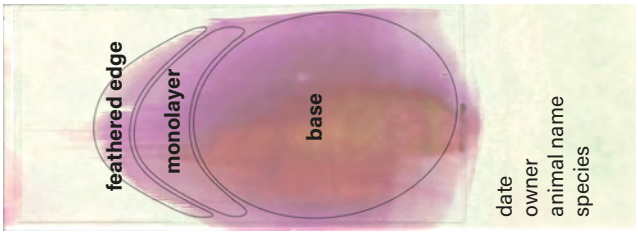


Image of a blood smear showing the base, monolayer and feathered edge as well as the labelling, stained with Diff-Quik.

Clinical chemistry of serum or heparin plasma

– Prompt centrifugation of the samples will lead to better test results, as it reduces the risk of haemolysis caused by transportation.
- For plasma, immediate centrifugation after collection is recommended, but serum should be allowed to stand for a minimum of 30 min at room temperature to ensure a complete clotting of the sample.
- Serum samples can also be shipped frozen. However, repeated freezing/thawing should absolutely be avoided.

Determination of glucose and lactate

- Determination is only possible from sodium fluoride blood or sodium oxalate blood or serum (glucose only) which was centrifuged and separated shortly after coagulation.
- **Fill volume:** Fill the sample tubes exactly **up to the mark**, selecting the appropriate size of the test tube. If the quantity is too small or too large, results may be incorrect.

Coagulation parameters

- Determination is carried out using sodium citrate plasma which is obtained from citrate blood with the mix ratio being 1:10 (1 part citrate + 9 parts blood). Centrifugation should take place promptly (< 1 hour) at the practice. When testing for the von Willebrand antigen, it is imperative to do this immediately after collection. For further information, see also Chapter 1.1.2, p. 15.
- If commercial citrate-treated tubes are used, the expiry date needs to be checked before collecting the sample. Expired tubes may no longer be used, as skewed results are to be expected. When drawing the sample, special attention must be paid to the **exact fill level** (marking on the tube) to ensure the correct ratio of blood to anti-coagulant. The test tube should therefore be selected according to the required sample volume.
- If no commercial tubes are available, sodium citrate 3.13% can be drawn into a syringe.
- No heparinised needles or catheters may be used.
- Sample material intended for the determination of coagulation factors should arrive at the laboratory frozen, as temperatures in the critical range of 2–6 °C trigger cryoactivation. Please note the instructions for pre-analytical handling, which must be followed when transporting frozen samples in order to maintain the frozen state (see Chapter 1.10.2.1, p. 33).

Sample collection for bone marrow cytology

- Sample material from the first aspirate should be used to prepare the smears for cytological examination (avoid contamination with peripheral blood).
- The syringe used for aspiration should be preloaded with an anticoagulant. The aspirate should be placed into an EDTA, lithium heparin or citrate tube immediately after the puncture and then inverted well to avoid clots.
- To prepare a smear, the aspirate is put in a Petri dish and gently inverted in order to find the bone marrow spicules.
- The spicules are each placed on a slide and carefully spread to form a monolayer.
- The remaining aspirate is then put back into the tube (wetted with the same anticoagulant) and sent in as well.

- In addition, peripheral blood is collected in a tube, a blood smear is prepared and both are also sent to the laboratory together with the clinical history (clinical presentation, any previous treatment, diagnostic issue).

1.1.5 Urine Samples

- When **collecting urine**, a distinction must be made between sterile urine (cystocentesis urine, catheter urine) and spontaneous urine (free-catch urine).
- For microbiological testing (bacterial and mycological culture), sterile urine should be used (see also requirements for microbiological testing, Chapter 1.2, below).
- For all other tests (including PCR, see Chapter 1.6, p. 25), spontaneous urine is acceptable. Please also note the information on the individual tests, which may include additional requirements such as early morning urine.
- The urine sample should be **stored** in sterile, tightly sealable disposable tubes. Please label the sample containers with the relevant patient data. For photometric, chemical or microscopic examinations (as well as for culture tests, see Chapter 1.2, p. 22), please indicate the time of collection and the type of urine sample on the submission form.
- Samples for photometric, chemical or microscopic examination should generally be stored protected from light at 2–8 °C in a refrigerator. Please note the special storage requirements for microbiological tests (see Chapter 1.2, p. 22) and for PCR tests (see Chapter 1.6, p. 25). It may even be necessary to freeze the urine after collection.
- Please also refer to the respective test descriptions for specific information on **storage** and **transport** as well as **sample quantity** and **sample preparation**.
- Samples should be shipped promptly (see the additional information in Chapter 1.10 Packaging and Transport, p. 32).

1.2 Microbiology and Parasitology

- It is important to collect samples as sterile as possible to avoid contamination with physiological flora.
- **Swabs** for bacterial examination (aerobic and anaerobic microbes) and for mycological examination should be sent with a transport medium ("swab with medium" = TM) to protect the microbes during shipment.
- For swabs without transport medium for molecular biological pathogen detection, see Chapter 1.6 PCR, p. 25.
- If both a culture and a PCR test should be done, it is necessary to send in 2 swabs (one swab with and one without transport medium). Alternatively, if using an eSwab® sampling and transport system, one swab can be sent in.
- For all swabs for bacteriology, the **sampling site** and the **animal species** must be indicated on the submission form. This is, for example, necessary for the evaluation of antibiograms according to CLSI, but also if respiratory pathogens such as Bordetella bronchiseptica and Histophilus somni are suspected, as special culture media are required!

- **Urine** should ideally be collected as cystocentesis or catheter urine and submitted using a swab with transport medium or using Uricult, always in combination with the urine sample. If cystocentesis urine is sent in, please make sure to remove the needle. Urine samples must be stored in a cool place; after transferring them to a transport medium (e.g. swab, Uricult), they can be stored at room temperature. Please indicate on the submission form what type of urine it is (cystocentesis, catheter or spontaneous urine) and on which day the sample was taken.
- **Hairs and/or skin scrapings** (without the scalpel!) for the diagnosis of dermatophytes are best sent in a sterile container, a paper bag or in aluminium foil.
- For sending **faeces/excrement**, special transport tubes should be used, no bags or gloves tied with a knot or glass containers.
- For both PCR (see Chapter 1.6, p. 25) and parasitological faecal examinations, it is recommended to submit pooled faecal samples (from 3 days) to increase the chances of detection, as pathogens/worm eggs are excreted intermittently.
- For **puncture fluids from primarily sterile body cavities**, the use of the Peds Plus™ blood culture bottle is recommended; the sample material should not be refrigerated.
- **Blood culture bottles can be ordered with prior written notice (subject to a charge).** Information on the different blood culture bottles available can be found in Chapter 15.1, p. 291 under the service Blood Culture.

1.3 Hygiene

The **test materials** and the instructions will be sent to you after we have received your submission form. Samples can be collected up to the expiration date of the test kit, or up to a maximum of 3 days for test sets designed for devices for cleaning and disinfecting surgical instruments as long as the kit is stored according to the specifications in the accompanying documents.

For monitoring **surfaces** (surface contamination or surface disinfection efficacy), you will be provided with contact plates. According to the manufacturer, these can be stored at 2–25 °C prior to sampling. Monitoring the surface contamination is done without prior disinfection. To check surface disinfection effiency, the surfaces to be sampled have to be cleaned and disinfected and must be well dried before sampling. After sampling, the contact plates must be labelled on the bottom, stored in a cool place and returned to the laboratory within 24 hours together with the filled-in accompanying form.

The bioindicators necessary for evaluating the proper functioning of the **sterilisers** can be applied right in the device together with the regular sterilisation material. After testing, these bioindicators and the positive control need to be stored at room temperature and sent promptly to the laboratory together with the filled-in accompanying form.

For testing the disinfection of **endoscopes**, two swabs with medium, two rinse samples and a water sample from the endoscopy water bottle are required for each endoscope. After sampling, the samples must be cooled until they are transported back. The samples must be sent within 24 hours together with the accompanying form.

For testing **devices for cleaning and disinfecting surgical instruments**, the test set components (bioindicators and transport controls) must be requested from the laboratory and can be stored at 7 °C to 10 °C for a maximum of 3 days before use. Once the hygiene tests have been completed, the components need to be stored at room temperature and sent to the laboratory within 24 hours together with the filled-in accompanying form.

If you participate regularly (2x a year) in these hygiene tests, you will receive a free **certificate** for the corresponding year confirming the successful monitoring of your device (steriliser, endoscope, device for cleaning and disinfecting surgical instruments) or the surface disinfection test.

1.4 Water Examination

To take water samples from **aquariums/ponds** for testing **chemical water parameters**, you need a glass or a plastic container (e.g. a 500 ml bottle which previously contained water).
To obtain a representative sample without any air included, collect the sample approximately in the middle of the **aquarium** and close the container under water.
Samples from **ponds** should be taken in an area of the pond with little water flow, not close to the filter and not directly underneath the surface. If possible, avoid larger pieces of dirt in the sample.
When shipping the samples, cooling is recommended. Please indicate on the submission form whether it is a freshwater or a saltwater sample.

1.5 Histology and Cytology

1.5.1 Histology and Immunohistochemistry

When submitting tissue samples for histopathological and immunohistochemical examinations, the following points must be observed:
- artefact-free extraction of a typical lesion sufficient in size (diameter > 0.5 cm)
- immediate fixation (4% neutral buffered formaldehyde ≙ 10% formalin)
- preparation of an anamnesis including diagnostic task and clinical picture
- shipment in a suitable container (available from us free of charge)
- Immunohistochemistry can always be done after histopathology with the material supplied.

Detailed explanations:
As a sample, a representative piece of tissue free of preparation artefacts (e.g. disruption, squashing, electrocoagulation) should be taken. The diameter of the sample should not be less than 0.6 cm. An exception to this are samples which, for technical reasons, cannot be obtained otherwise (such as endoscopically taken stomach biopsies). Furthermore, it should be borne in mind that samples which are too small only provide little information,

whereas samples that are too large cannot be fixed properly. Pieces of tissue with an edge length of 1 cm are recommended. However, this might vary depending on the lesion to be examined, the sampling site and the diagnostic task.
Small lesions should be placed centrally so they are not overlooked and thus truncated during preparation. If in doubt, several samples should be collected.

1.5.2 Skin Punches

As skin samples, punch biopsies of all dermal layers with a diameter ≥ 0.6 cm are to be submitted. Primary lesions from several locations should be selected. The biopsied area should not be pre-treated by scraping or shaving. The anamnesis should contain all relevant data which might be important for the diagnosis. It is recommended to use our submission form Pathology, which especially focuses on skin and tumour diagnostics, but also leaves room for any other type of anamnesis.

1.5.3 Cytology

Samples can primarily be taken by **puncture** (with or without aspiration) or by **wipe test**. **Fine needle aspiration** is the most common technique. A thin hollow needle (G22–G27) is used with or without (needle-alone) being attached to a syringe. With the syringe attached, a vacuum is created and, if possible, the tissue should be punctured several times in different directions. Before detaching the needle, the vacuum must be released to avoid the material receding into the syringe. The material obtained is then pressed out of the needle onto the side of a glass slide. A second slide is placed flat at a right angle on top of the first one and is then carefully pulled away across the slide.
If the sample is more liquid, a steeper angle (45°) – like in a blood smear (see Chapter 3.1, p. 39) – should be applied.
For the cytological examination of **aspirates**, **excretions** or **secretions**, the fluids obtained are centrifuged at 2500–3000 rpm for three to five minutes. The supernatant is decanted and the sediment is carefully spread like a blood smear and shipped air-dried. Please indicate on the submission form whether it is a sediment smear or a fresh specimen. If the aspirates are sent directly, uncoated and EDTA tubes should be used as test vessels.
For **bronchial**, **conjunctival** and **vaginal cytology**, the swab obtained (cytobrush) should be rolled onto a glass slide, not smeared.

All **smears** should generally be sent in air-dried, but unfixed. If desired, the smears can already be stained at the practice (please note: do not use a cover glass). The most important point is to create a thin smear consisting of only one layer (monolayer). The most common reason for getting a limited quality up to not being able to assess at all are smears that are too thick.

For pre-analytical information on bone marrow cytology, see Chapter 1.1.4, p. 20.

1.6 Polymerase Chain Reaction (PCR)

PCR is a very sensitive and specific method for the **direct detection** of infectious agents. Via PCR, gene sequences characteristic for the respective pathogen are reproduced and detected – if necessary, even of pathogens which are no longer viable. The sample material that must be supplied for the PCR highly depends on the pathogen to be detected and the present signs or the diagnostic task. Depending on how the pathogen has spread in the body and its excretion, different sample materials are suitable.

At this stage of infection, pathogens causing viraemia, parasitaemia or bacteraemia can be detected directly in an **EDTA blood sample** (EB). Lithium heparin is less suitable as an anticoagulant, as it can inhibit the PCR. **For blood samples and other liquid samples, an amount of at least 0.2 ml is required, unless otherwise specified.**

In contrast to bacterial culture/mycological examinations, for PCR tests it is recommended to use sterile **swabs without transport medium** ("swab without medium" = A, "dry swab"). If the concentration of the pathogen is low, swabs in a medium can lead to false negative results. There are a few exceptions for which a special transport medium is required. For collecting the sample, the swabs can be moistened with physiological saline solution. For PCR tests, so-called cytobrushes (brush swabs) are also suitable, which can be shipped in an uncoated sterile tube.

For the detection of pathogens in faeces, a sample of approximately the size of a hazelnut is needed. For some agents (e.g. coronavirus, Tritrichomonas foetus) we recommend collecting faecal samples for 3 days, since these pathogens are excreted intermittently in the faeces.
Further sample materials, e.g. skin biopsies, organ material, urine, synovial fluid, CSF, bone marrow aspirates and lymph node aspirates, for PCR tests are best sent in sterile, uncoated test vessels. Fixation solutions such as formalin or the like can lead to DNA degradation, PCR inhibition and thus to false negative results.
Samples do not normally need to be sent cooled. Until it is dispatched, the sample material can be stored in the refrigerator at 2–8 °C. Repeated freezing/thawing should absolutely be avoided.

Please note: Creating an **antibiogram** is **not possible** after doing a PCR test.

The **test duration** is generally specified in working days (Mon–Fri), even if some of the PCR tests are also carried out and evaluated on Saturdays. However, the test duration not only depends on the method but also on the test material supplied, and may therefore vary even for a single pathogen. Thus, for the sake of clarity, no further differentiation is made regarding the duration of the test.

1.7 Genetic Testing

As sample material for the molecular genetic detection of hereditary diseases, for parentage analysis as well as for the genetic determination of coat colours and blood groups, **EDTA whole blood samples (approx. 1 ml)** are suitable. Alternatively, in dogs and cats, swabs from the oral mucosa, known as **buccal swabs**, can be used (except for certain tests where it is specified that only EB is possible – Lafora Disease and Squamous Cell Carcinoma of the Toe). Here, either dry swabs (without transport medium) or special swabs are suitable. For sampling, see the section on buccal swabs or special swabs (see below). To create DNA profiles and parentage reports in dogs and cats, we recommend to always send in a **blood sample**.

For LABOGenetics XXL, only blood samples or **special swabs** are suitable (swabs without medium are not possible). Special swabs can also be used for the Premium SNP DNA Profile, DLA typing as well as the Symptom Complex Combinations and can be requested from us free of charge for the recommended tests.

For all genetic testing in horses, it is sufficient to supply about **20 hair roots** from mane or tail for DNA isolation. For some tests in horses only mane or tail hair is suitable.

EDTA blood is the most suitable sample material. It is absolutely essential to use EDTA as anticoagulant. Lithium heparin or citrate are unsuitable as anticoagulants, as they may inhibit the subsequent PCR. In very rare cases, haemolysis induced by transport or extreme stress during sample collection might lead to the situation that no result can be obtained. However, the percentage of blood samples which cannot be evaluated is extremely low, being < 1%.

Buccal swabs, often incorrectly called saliva samples, are very suitable sample materials for genetic testing in dogs and cats, as long as the sampling procedure is performed correctly observing the following rules:

1. The animal should not have eaten anything for about 1–2 hours prior to the sample collection. It should be ensured that puppies and kittens have not been nursed for a minimum of 2 hours, as otherwise maternal cells might skew the results.
   It is also recommended to keep the animal separate from conspecifics and other animals during this time.
   2 buccal swabs (dry swabs) or **1** buccal swab (special swab) should be taken per animal. When taking the sample, it should be scrubbed strongly at the inside of the cheek to make sure that enough cells of the oral mucosa and thus genetic material is attached to the swab. Genetic testing can only be conducted if enough genetic material adheres to the swab. Generally, saliva alone is not sufficient. However, there should not be any blood on the swabs!
2. **Dry swabs:** Place each swab in the corresponding tube, but do not close the lid completely for 1–2 hours (the swabs should dry to prevent the growth of bacteria and mould).

Special swabs: Hold the tube upright and unscrew the cap. Avoid any contact with the liquid. Should there be any contact with the skin, rinse immediately with plenty of water. After collecting the sample, insert the swab into the tube. Break it off at the predetermined breaking point, replace the cap, close the tube tightly and place it in the outer packaging provided by Laboklin.

3. The tubes with the swabs should be labelled with the supplied bar codes alongside the tube and additionally marked with clear information (e.g. name of the animal). The bar code must also be affixed to the sample accompanying form next to the corresponding animal. Any remaining bar codes can be discarded.
4. Send the sample material and the sample accompanying form to us as soon as possible. Please use plastic or padded envelopes.

As there is considerably less cell material available from mucosal swabs compared to blood samples, it is not always possible to isolate enough DNA from buccal swabs for a genetic test. This applies to about 5% of the submitted buccal swabs. In this case, we recommend sending in a new sample of EDTA blood.

For horses, **hair roots** can be used to perform genetic examinations. To do so, about 20 pulled mane or tail hairs are needed. If samples are taken from various animals, hands must be cleaned thoroughly after each sampling – even a single hair of a different animal can skew the result.
For each animal separately, hairs can, for instance, be shipped in a little plastic bag or in an envelope – do not forget to label it! It is absolutely necessary to make sure that the hairs are put in a closed envelope, separate from the sample accompanying sheet, when sent in.

There should not be any blood samples sent in for cattle from multiple births because of a possible blood chimerism, but if the test allows it, hair roots, sperm or tissue samples can be used. One exception to this is the freemartin test, for which a blood sample is mandatory.

If you wish to supply sample materials different from those listed above for performing genetic tests, please contact us before sending the samples.

1.8 Sample Material/Shipping Material

Note regarding the sample materials listed in the test descriptions from Chapter 3 onwards:

If the abbreviations are separated by a comma, you can choose the material which is easiest for you to collect from the given list. When collecting sample material for the detection of a pathogen using PCR, you should preferably collect that material from the listed alternatives which is likely to have the highest concentration of pathogens.
If the specifications are connected by one or more "+", both or all the materials joined with "+" need to be provided for determining all the parameters of the selected testing block.
The materials required for the individual tests are also indicated on the submission forms, however, for lack of space, not always completely.

The **following sample** and **shipping containers** are available for the collection and transport of the samples. They are **consecutively numbered**. These are not order numbers; you will find the order numbers under "MyLab", on the submission forms or on the special order form for shipping materials.

(1) EDTA tube#

EB = EDTA blood: It can be shipped in this tube (+ No. 8).
EP = EDTA plasma: EDTA blood has to be centrifuged and the supernatant needs to be transferred into a neutral tube (e.g. Eppendorf tube with screw cap). It must then be marked accordingly as EP or labelled with the appropriate bar code.

(2) Heparin tube#

HB = Heparin blood: It can be shipped in this tube (+ No. 8).
HP = Heparin plasma: Heparin blood has to be centrifuged and the supernatant needs to be transferred into a neutral tube (e.g. Eppendorf tube with screw cap). It must then be marked accordingly as HP.

(3) NaFB = Sodium fluoride blood

With NaFB samples, too, please pay attention to the labelling.

(4) S = Serum#

To collect serum, the coagulated blood should be centrifuged at 2000 g 30 minutes after being collected. The supernatant should then be transferred into a neutral tube or another serum tube (remove beads before!) and marked accordingly as serum or labelled with the appropriate bar code.

(5) Citrate tube#

CB = Citrate blood: It can be shipped in this tube (+ No. 8).
CP = Citrate plasma: The sample should be centrifuged and the supernatant needs to be transferred into a neutral tube (e.g. Eppendorf tube with screw cap). It must then be marked accordingly as CP.

(6) Salivette®

for collecting saliva samples

(7) Blood smear

Blood smears should always be sent in air-dried, unfixed and unstained. For transportation, the depicted transport covers (shipping containers) are suitable. Before transport, store at room temperature (may not be cooled).

(8) Shipping containers for blood tubes or urine tubes

(9) TM = Swab with transport medium

(**orange:** thin swab, Amies medium clear; **black:** thick swab, Amies with charcoal)

(10) A = Swab without transport medium, (dry swab)

(11) Shipping container for swabs with/without medium

(12) Urine tube (suitable shipping container see No. 8)

(13) Container for histology (formalin tube with shipping container)

(14) Faeces tube with shipping container

(15) Set of blood culture bottles (aerobic and anaerobic)

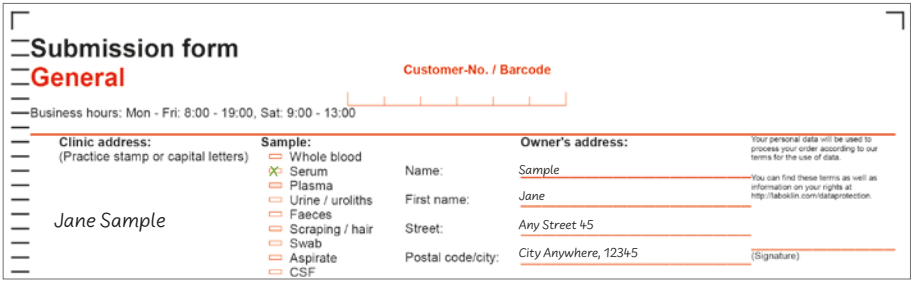
(16) Blood culture bottle Peds Plus™

On special request, **small test tubes** (see each of the tubes shown on the left) are provided for collecting small amounts of EDTA blood, EDTA plasma, heparin blood, heparin plasma, citrate blood, citrate plasma and serum, e.g. from small mammals. If required, please **order** these **small test tubes** by **e-mail** or **telephone only.**

For the examination of blood samples at Laboklin, we can also provide you with vacuum tubes. You can find them in "MyLab" and on the special order form for shipping materials.

1.9 Labelling

- The name of the animal or the owner and, for farm animals, the ear tag number(s) should be clearly marked on the submission form and the sample. Alternatively, bar code labels can be used to unmistakably identify the sample and the form – they will automatically be sent along when submission forms are ordered. For farm animals, there are special sample lists for the submission of several samples, even from different animals in a livestock.
- For function tests, it is essential to also indicate the respective time of sampling.



Submission form
General

Customer-No. / Barcode

Business hours: Mon - Fri: 8:00 - 19:00, Sat: 9:00 - 13:00

Clinic address:
(Practice stamp or capital letters)

Jane Sample

Sample:
- Whole blood
- Serum
- Plasma
- Urine / uroliths
- Faeces
- Scraping / hair
- Swab
- Aspirate
- CSF

Owner's address:
Name: *Sample*
First name: *Jane*
Street: *Any Street 45*
Postal code/city: *City Anywhere, 12345*

Your personal data will be used to process your order according to our terms for the use of data.
You can find these terms as well as information on your rights at http://laboklin.com/dataprotection.
(Signature)

Jane Sample Veterinarian
Any Street 45
City Anywhere, 12345

05000

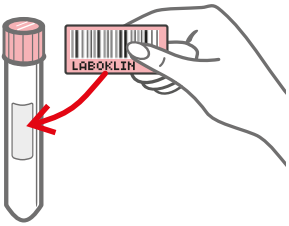
Bar code labels:

On one sheet, you will find the labels for 6 patients one below the other. For each patient, there are labels for your laboratory journal, the submission form and to mark the sample tubes/vessels to be sent.

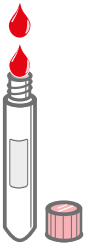
There are pre-printed labels for serum, EDTA blood and EDTA plasma; **for any other label, the material must be added in handwriting.**

Please stick the bar code exactly over the tube label so that the content is still visible through the uncovered areas.

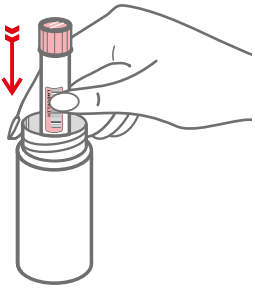
Labelling of samples and shipping materials



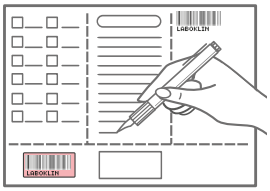
Step 1
Stick the bar code onto the test tube



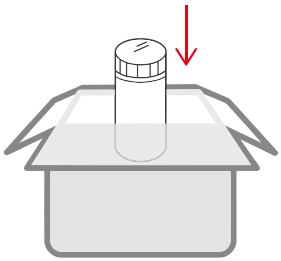
Step 2
Fill the test tube



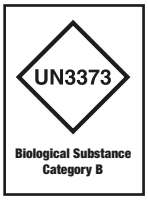
Step 3
Test tube into shipping container



Step 4
Completely fill in submission form and, if necessary, sample list. Stick an additional bar code from the same code line onto it.

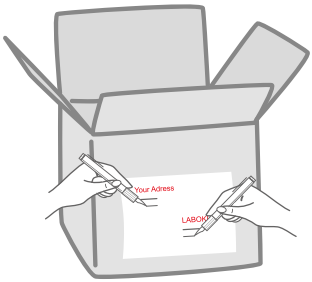


Step 5
Put the sample, the submission form and, if required, the sample list into a cardboard transport box (Labopak).



Step 6
Close the box and stick a waybill on top.
Do not cover the label!
It must stay fully visible.

Exempt Animal Specimen



Step 7
Pay attention to correct shipping information

1.10 Packaging and Transport

1.10.1 Packaging Requirements

Please remember to pack your shipment according to EU regulations (European Agreement concerning the International Carriage of Dangerous Goods by Road, ADR, and International Air Transport Association, IATA):
Generally, transport containers that are transparent, break-proof and contain absorbent material for leakage protection should be used and then packed, together with the submission form and cushioning material (not provided by the lab), in the transport (courier) box (min. dimension of 100 x 100 x 100 mm). Volume restriction: sample of 1000 ml (applies to liquid samples) or a total weight of 4 kg (applies to illiquid samples). LABOKLIN provides such protective outer packaging free of charge.

There are two possible **categories of samples.** The outer package needs to be tagged according to the respective category with the labels shown in the illustration above.
An **exempt animal specimen** is a patient sample for which there is minimal likelihood that pathogens are present (e.g. blood and blood components or formalin-fixed tissue samples). Classification must depend on professional judgement which is based on the anamnesis, the signs, the patient's individual circumstances and local endemic conditions. In case of doubt, it is recommended to ship as infectious substance of Category B.
Infectious category B samples (swabs, urine, faeces etc.) must be marked as "Biological substance, Category B" and **"UN 3373"**; while the specification "UN 3373" needs to be in a rhomb of at least 5 cm x 5 cm of size. The edge of the rhomb must be at least 2 mm wide and the letter height of both specifications must be at least 6 mm.

Important:
The sender is liable for the goods to be transported (i.e. sender is liable to recourse in case of damage/costs caused by samples that are not properly packed).
If requirements are not met, there is a risk of your shipment being returned to you by the courier company.
Please adhere to your local national regulations as well as to the EU regulations concerning the transport of the biological samples no matter whether you send them per post or courier. In different countries, different rules can apply.

Please do not to leave any needles in the sample tubes!
Do not seal the tubes!
If protective covers/transport containers are used, the lids will remain securely closed.

For shipment from a non-EU country, please contact LABOKLIN in advance.
Should you have any other questions, please do not hesitate to contact your local LABOKLIN representative or contact us directly: service@laboklin.com.

1.10.2 Transport of Cooled or Frozen Samples

For certain tests, it is necessary to cool or freeze the samples after collection. The cold chain must not be interrupted **until the sample arrives at the laboratory.**

Information on which samples need to be sent refrigerated is provided with the respective services. In this Compendium, it is done in text form, on the submission forms, in a specific way which is explained in Chapter 1.10.2.2.
If there are any differences between the requirements for refrigeration and freezing for direct shipment to Bad Kissingen and shipment to other Laboklin laboratories, the test descriptions in the Compendium will refer to the respective country-specific submission forms and Catalogues of Prices and Services.

1.10.2.1 Shipping Material and Preparation for Refrigerated Transport

The samples are neither refrigerated during transport by post nor by courier. Therefore, send samples which need to be cooled/frozen with a **cold/ice pack** and, if necessary, in an additional **polystyrene box**.

Via "MyLab" oder by using the special order forms for shipping materials, you can order a special box from Laboklin; it consists of a polystyrene box and a special sample cooling/freezing pack, which can be used to cool 2 sample tubes all around.

To prepare the transport of refrigerated samples, please pre-cool the samples as well as the cooling material for 1–2 hours, as the cooling/freezing capacity of the cold/ice pack and box alone is not enough to adequately refrigerate or freeze samples. The cooling material can also be frozen before shipping refrigerated samples – only when shipping a whole blood sample for doing a blood count, contact between the sample and the frozen material must be avoided.
Before **transporting frozen samples**, the cooling material AND the samples must be stored in the freezer at approx. -20 °C for at least 10 hours. Depending on the parameter to be examined, shipping on dry ice may also be necessary. Please contact the laboratory for further information.

1.10.2.2 Information on Submission Forms about Cooling Samples

Samples that need to be refrigerated are marked with "!" behind the name of the service. If freezing is required, it is explicitly stated. If there is a mark for refrigeration in services that require the submission of several materials, often only one of them needs to be cooled. In this case, there is an additional "!" behind the material that must be cooled.

Example:
"Transition Cow Profile + NABE ! S/1ml+H!/15ml"
→ Only the urine sample must be sent in refrigerated.

If at least refrigeration is required but freezing is preferred, the note "preferably frozen" is added to the "!". Currently, this applies to online submission forms (and the Catalogue of Prices and Services); for printed submission forms, please refer to the information sheet on the critical parameters in pre-analysis.

Examples:

"Behaviour Profile (dog) 2 ! (preferably frozen)	S+EB/3ml" → Serum and EDTA blood must be at least refrigerated when shipped, if possible even frozen.
"Large Vitamin Profile ! (EB, HB preferably frozen)	EB,HB!+S/3ml" → EDTA blood and heparin blood respectively must be refrigerated or preferably frozen when shipped.
"Equine Cushing/PPID Profile ! (S preferably frozen)	EP!+S!+NaFB/2ml" EDTA plasma must be sent in refrigerated and serum needs to be refrigerated or better frozen

Please note: If a blood count is requested in addition to this service, then EB and a blood smear are also required. They may not be frozen under any circumstance!

1.11 Reordering Tests

Stating the diagnostic reference number, you can request additional tests for sample material that has already been sent in if

- reordering is done within the sample storage period (see below)
- the sample contains sufficient material
- the maximum sample age that may be indicated for the newly requested test is not exceeded (e.g. for morphology, flow cytometry). Generally, parameters with special requirements for pre-analytics (refrigerated or frozen) cannot be reordered.

Reordering can be done

- by e-mail to nachbestellung@laboklin.com
- by MyLab
- by telephone +49 971 7 20 20 via the switchboard or as part of our specialist counselling
- by fax to +49 971 6 85 46
- by post

For reorders that shall be invoiced to the animal owner/bearer, please read the notes in Chapter 28, p. 483.

Storage periods depend on the type of sample material and the purpose of the submission, i.e. the type of test that was originally requested. The periods specified below apply to samples tested in Bad Kissingen (as of December 2025).

Storage after clinical-chemical and haematological examinations, allergy tests, serological examinations (antibody detection; antigen detection, except those from faeces):

- serum, heparin plasma, citrate plasma, EDTA plasma: 14 days
- EDTA blood, heparin blood: 7 days
- urine: 7 days
- uroliths: 7 days (in most cases, however, the material is needed completely for analysis)
- punctures and CSF: 7 days
- blood smears, bone marrow cytology: 14 days

Storage after bacteriological, mycological and parasitological examination (detection by culture, all types of faecal analysis incl. antigen detection from faeces), tests for maldigestion:

- faeces: 7 days
- skin/hair, swabs, urine, milk: 14 days
- punctures: 4 weeks
- isolated pathogens: 7 days

Storage after pathogen detection using PCR:

- independent of the sample material (blood, CSF, urine, swab, tissue, feather, etc.): 2–3 weeks
- extracted DNA/RNA: 1 year
- Please note that extracted DNA/RNA is only suitable for reorders of further tests using PCR/genetic methods, but not for tests that require microbial growth. It is therefore not possible to request an additional antibiogram/antimycogram if the sample had been sent in for PCR pathogen detection.

Storage after histopathological/cytological examination:

- wet material (tissue samples): 3 weeks
- cytology object slides/cytology samples: 3 weeks
- paraffin blocks: 3 years
- sections: 5 years

Storage after testing for hereditary diseases or coat colours/DNA profiles, determination of breed, parentage:

Storage of extracted DNA: at least 5 years

Storage after sex determination:

Storage of extracted DNA: 1 year

2 Profiles and Screenings

Laboklin offers numerous **profiles** and **screenings** with complementary parameters. These include clinical chemistry profiles and screenings, serological profiles, symptom-based pathogen profiles as well as travel profiles, toxicological and heavy metal screenings. Compared to ordering the parameters individually, they offer a significant price advantage and facilitate the compact request of many parameters for complex diagnostic tasks, e.g. by combining clinical chemistry parameters with serological diagnosis of pathogens and/or direct pathogen detection by PCR in one profile. The compilation of the profiles and screenings is regularly adapted to new findings.

Our profiles and screenings are specifically compiled for the following **species**:

- dogs, cats
- horses
- camelids
- ruminants
- pigs
- small mammals
- birds
- reptiles, amphibians, fish (incl. quarantine profiles and hibernation profiles)

All compilations of our profiles/screenings are sorted by species in the current **Catalogue** of Prices and Services and on our **Laboklin website** in the separate "Products" section.

The profiles for the following categories can also be found in this Compendium:

➢ Allergy profiles	see Chapter 6, p. 84 (dog, cat) and p. 89 (horse)
➢ Hygiene profiles	see Chapter 24.1, p. 468
➢ Aquarium/pond profiles	see Chapter 23, p. 467
➢ PCR profiles	see Chapter 14.5 Pathogen Detection Profiles, p. 278
➢ Faecal profiles	see Chapter 17 Tests for Indigestion and Diarrhoea, p. 308
➢ Cytology profiles	see Chapter 19.3 Cytology, p. 326

3 Haematology

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

3.1 Blood Cells

Complete **Blood Count**	
Material	EB 1 ml + blood smear Small mammals: EB, HB 0.5 ml + blood smear Birds, reptiles, amphibians, fish: HB 0.5 ml + blood smear
Method	Mammals: flow cytometry Birds, reptiles, amphibians, fish: flow cytometry, leucocyte count and leucogram: microscopy
Species	Mammals, birds, reptiles, amphibians, fish
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ A leucogram is done in addition to a small blood count. For **dogs** and **cats**, the reticulocyte count, including haemoglobin concentration (Ret-He), and the erythrocyte indices are additionally provided. The reticulocyte count is also performed for selected **small mammals**. ▪ For reliable results, the **sample** should **not be older than 48 hours.** ▪ An air-dried, unstained and unfixed blood smear needs to be submitted in addition to EB or HB in case further examinations are necessary. ▪ In turtles, tortoises and some **bird** species (corvids, hornbills, ostriches, cranes, some duck species), determination from EB is not possible due to the cell lysis effect.

Small **Blood Count**	
Material	EB 1 ml (+ blood smear) Small mammals: EB, HB 0.5 ml (+ blood smear)
Method	Flow cytometry
Species	Mammals
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ For reliable results, the **sample** should **not be older than 48 hours.** ▪ The small blood count includes the parameters erythrocytes, leukocytes, platelets, haemoglobin and haematocrit, and for **dogs** and **cats**, the erythrocyte indices MCV, MCHC and MCH (see below).

Blood Smear, Cytological (Morphology)

Material	Blood smear + EB 1 ml Small mammals: blood smear + EB, HB 0.5 ml Birds, reptiles: blood smear + HB 0.5 ml
Method	Microscopy
Species	Mammals, birds, reptiles; amphibians and fish on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ The morphology of the peripheral blood cells is assessed. ▪ Heparin blood is not recommended in mammals as there is a risk of artefacts. ▪ A complete blood count is included in this service. ▪ For a diagnostically conclusive interpretation, please provide the **medical history, diagnostic task** and **previous findings**. ▪ **Dog:** For the microscopic examination of **Pelger-Huët anomalies**, fresh, evaluable blood smears from a clinically healthy animal are required. When ordering via a printed submission form, please indicate that Pelger-Huët anomaly is suspected. The test is offered as a separate service in the online submission form.

Bone Marrow Cytology

Material	Bone marrow smear (up to 10 slides) + bone marrow aspirate (see Chapter 1.1.4, p. 20) + peripheral blood: blood smear + EB 1 ml
Method	Blood count: flow cytometry Cytological assessment of bone marrow: microscopy
Species	Dog, cat, horse, others on request
Duration	2–5 working days
Note	▪ For diagnostically conclusive findings, it is **essential** to **also** send in a **detailed clinical history with diagnostic task** together with the bone marrow material, peripheral blood and blood smears! ▪ Cellularity as well as cell morphology in the bone marrow are assessed for special diagnostic tasks such as cytopenia (anaemia, leukopenia, thrombocytopenia) of unspecified cause or haematopoietic neoplasms. ▪ A current corresponding blood count is required for a complete diagnosis. ▪ Sampling for bone marrow cytology – see pre-analytics (Chapter 1.1.4, p. 20).

Leukogram

Material	EB, HB 1 ml + blood smear Small mammals: EB, HB 0.5 ml + blood smear Birds, reptiles, amphibians, fish: HB 0.5 ml + blood smear

Method	Mammals: flow cytometry Birds, reptiles, amphibians, fish: microscopy
Species	Mammals, birds, reptiles, amphibians, fish
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ For reliable results, **EB** or **HB** should **not be older than 48 hours** upon arrival at the laboratory. ▪ Determination of a differential blood count is only useful if the total leukocyte count is known. ▪ In turtles, tortoises and some bird species (corvids, hornbills, ostriches, cranes, some duck species), a determination from EB is not possible due to the cell lysis effect.

Leukaemia/Lymphoma Profile from blood/puncture fluid/bone marrow ➢ **see Chapter 7, p. 99**

MCV, MCHC, MCH

Material	EB 1 ml
Method	Flow cytometry
Species	Dog, cat, horse, ruminants, pig, others on request (not birds, reptiles, amphibians, fish)
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The calculated erythrocyte indices help to differentiate between causes of anaemia. ▪ Since the cell volume of erythrocytes varies with the ageing of the blood, the indices have to be interpreted with caution in shipped samples. ▪ These indices are included in the blood count and cannot be ordered separately.

Reticulocytes

Material	EB, HB 1 ml or, in small mammals, EB, HB 0.5 ml
Method	Flow cytometry
Species	Dog, cat, small mammals, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Reticulocytes are juvenile erythrocytes. Determining their number is necessary to be able to differentiate between regenerative and non-regenerative anaemia. ▪ For reliable results, the **sample** should **not be older than 48 hours.** ▪ Additionally, in **dogs, cats, rabbits** and **guinea pigs,** the haemoglobin concentration of the reticulocytes (Ret-He) is determined.

Thrombocytes/Platelets	
Material	Blood smear, EB, if applicable HB 1 ml
Method	Flow cytometry
Species	Mammals
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The most common coagulation disorders in dogs are caused by thrombocytopenia. Platelet measurement is recommended prior to planned surgery. ▪ Low counts are also seen in cases of tick-borne infections and travel-related diseases. ▪ Platelet aggregates in the sample can cause pseudothrombocytopenia. ▪ Validity check by microscope for platelet concentrations <90 G/l or <60 G/l (equidae). ▪ No microscopic platelet count. ▪ Detection of thrombocyte antibodies: see Chapter 7, p. 102.

3.2 Coagulation

Valid results can only be obtained if the **expiry date** of the **citrate tube** has not been exceeded and the **fill level** has been correctly observed after collection (also see Chapter 1.1.2, p. 16 and Chapter 1.1.4, p. 20).

Important: The centrifuged **citrate plasma** must be put in an **uncoated tube without anticoagulant** (also see Chapter 1.1.2, p. 16).

The sample material for determining **coagulation factors** should arrive at the laboratory in a frozen state, as temperatures in the critical range of 2 to 6 °C trigger cryoactivation. Please note the instructions for pre-analytical handling, which must be followed when transporting frozen samples in order to maintain the frozen state (see Chapter 1.10.2.1, p. 33).

Activated **Clotting Time**

This test can be performed by veterinarians in their own practice. The appropriate tubes (ACT tubes) are subject to a fee and can be ordered from us. Please pay attention to the detailed instructions for use included in the delivery.

D-Dimers	
Material	CP (1 part citrate + 9 parts blood) 0.5 ml (centrifuged immediately, pipetted off; frozen until arrival at the laboratory) Please note the introduction to this chapter!

Method	Photometry
Species	Dog, cat, horse
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	D-dimers are generated by lysis of cross-linked fibrin. D-dimers are, for example, detectable if there are internal bleedings as well as in surgical interventions and neoplasia. Particularly high amounts of D-dimers are generated in case of thromboembolism and disseminated intravascular coagulation (DIC). In diagnostic work, D-dimers are mostly used for DIC. D-dimers are a parameter of the DIC Profile.

Factor VIII

Material	CP (1 part citrate + 9 parts blood) 0.5 ml (centrifuged immediately, pipetted off; frozen until arrival at the laboratory) Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Factor VIII deficiency is the most common single factor deficiency and the cause of haemophilia A. ▪ The determination of single factors is useful if there are changes in partial thromboplastin time.

Factor IX

Material	CP (1 part citrate + 9 parts blood) 0.5 ml (centrifuged immediately, pipetted off; frozen until arrival at the laboratory) Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Haemophilia B is a congenital deficiency in factor IX activity, which occurs less frequently than haemophilia A. ▪ The determination of single factors is useful if there are changes in partial thromboplastin time.

Factor XI

Material	CP (1 part citrate + 9 parts blood) 0.5 ml (centrifuged immediately, pipetted off; frozen until arrival at the laboratory) Please note the introduction to this chapter!
Method	Coagulometry
Species	Cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Fibrinogen

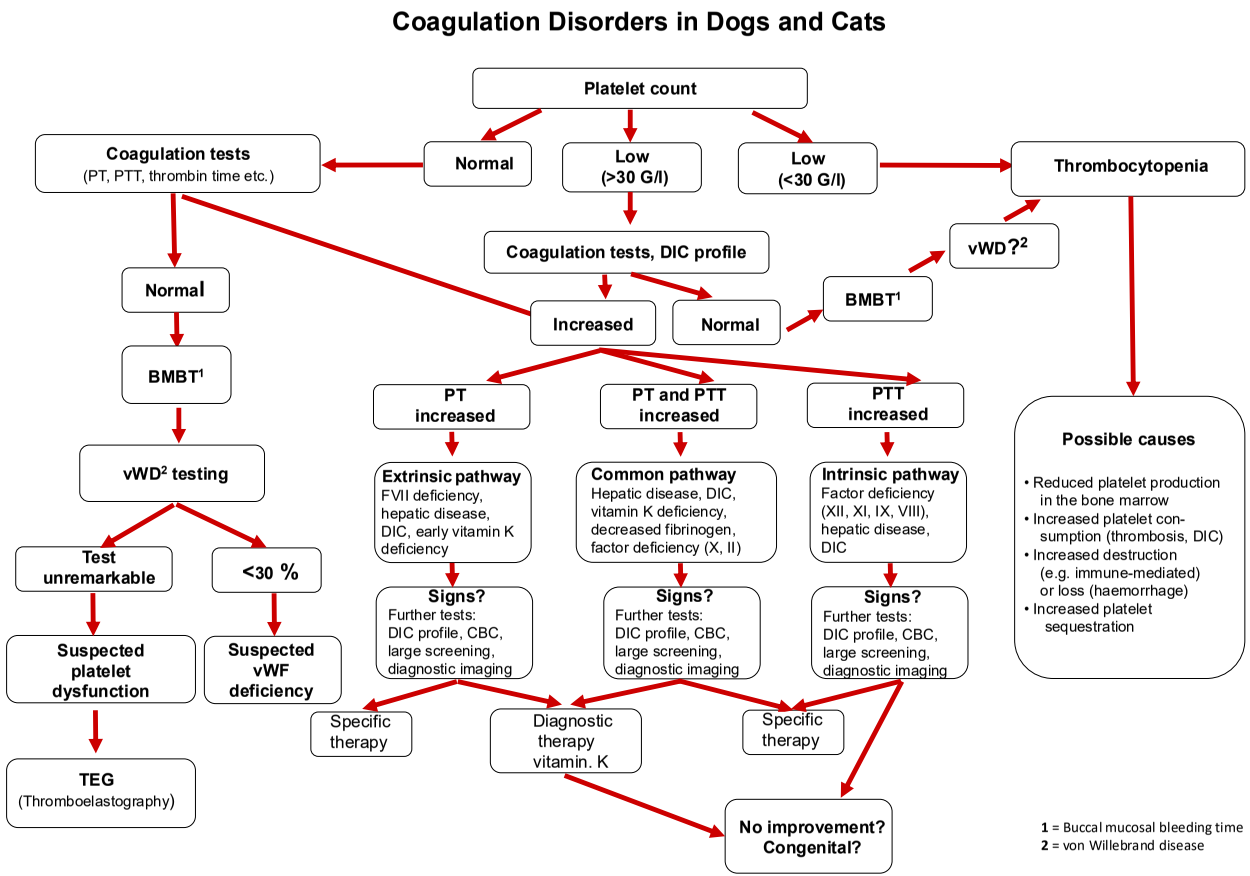
Material	CP (1 part citrate + 9 parts blood) 0.5 ml Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog, cat, horse, cattle
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Determination is recommended if disseminated intravascular coagulation or hypofibrinogenaemia are suspected. ▪ As fibrinogen is an acute-phase protein, the concentration will rise in case of acute inflammation.

PT, Prothrombin Time

Material	CP (1 part citrate + 9 parts blood) 0.5 ml Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog, cat, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	This test comprises the coagulation factors of the extrinsic system. It has to be taken into account, however, that levels may be normal in chronic coagulation. PT is used as diagnostic aid in suspected poisoning with vitamin K antagonists (coumarin and warfarin derivatives) and for therapy monitoring while vitamin K is administered.

PTT, Partial Thromboplastin Time

Material	CP (1 part citrate + 9 parts blood) 0.5 ml Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog, cat, horse, cattle, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ PTT is used to monitor coagulation factors of the intrinsic system and can be used as global test to identify coagulopathies. ▪ An isolated prolongation of PTT without changes in the PT may indicate a factor deficiency (factor VIII, IX, XI and XII). Haemophilia A or B can be identified by determining the concentration of single factors (VIII, IX).



Diagnostic flow chart of coagulation disorders in dogs and cats

Thrombin Time

Material	CP (1 part citrate + 9 parts blood) 0.5 ml Please note the introduction to this chapter!
Method	Coagulometry
Species	Dog, cat, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ This test covers the third phase of coagulation, the change from fibrinogen to fibrin. ▪ It is recommended for monitoring the treatment with heparin or streptokinase as well as in cases of suspected disseminated intravascular coagulation (DIC). Temporarily lowered concentrations of fibrinogen are seen after intensive surgery as well as in cases of DIC. ▪ If DIC is suspected, the DIC Profile may be used to confirm or disprove the diagnosis.

Thrombocyte Antibodies ➢ **see Chapter 7, p. 102**

Von Willebrand Antigen

Material	CP (1 part citrate + 9 parts blood) 0.5 ml (centrifuged immediately, pipetted off; frozen until arrival at the laboratory) Please note the introduction to this chapter!
Method	Photometry
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Determination of the von Willebrand antigen is used for further evaluation of coagulation disorders. ▪ The von Willebrand disease (vWD) has been described in many dog breeds; only genetic testing can detect whether the disease is carried.

3.3 Blood Typing

Blood Group	
Material	EB 1 ml
Method	Agglutination test for determining the serological blood group
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat) It is possible to send out rapid blood typing tests for dogs and cats for use in the practice. If umbilical cord blood is used, it is important to avoid contamination with the mother's blood.
Note	**Dog:** ▪ DEA 1 positive/negative ▪ Prior to blood transfusions, it is necessary to test donor and recipient animals for blood group compatibility (see Crossmatch Test). **Cat:** ▪ A, B, C (formerly AB) ▪ In cat breeds, the blood groups of the parent animals should be determined before mating in order to avoid neonatal iso-immune haemolytic anaemia. Genetic testing in A animals is indicated to detect carriers of the recessive B gene. **Profiles:** ▪ Serological blood typing is also part of the Blood Donation Profiles for dogs or cats, which can be requested from 1 July 2026 via "Other parameters" on the printed submission forms and can still be ordered directly online. Further information can be found in the Catalogue of Prices and Services or on the Laboklin website.

Genetic **Blood Groups (cat)**	
Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All In European Shorthair, there may be discrepancies between serology and genetics!
Duration	3–5 working days
Note	The AB system is the major blood group system in domestic cats. The most common blood types are A and B. Cats with blood type B usually have high anti-A antibody titres and cats with blood type A usually have low anti-B antibody titres. Some breeds have the rather rare blood type C (also called blood type "AB"). Cats with blood type C do not have anti-A or anti-B antibodies and are thus universal receivers in case of blood transfusions.

Genetic blood typing in cats allows for genetic differentiation of the serologically determined blood group before breeding. This makes it possible to identify the recessive b allele which is associated with the B serotype. Cats with two copies of the b allele have blood type B. Genetically, a cat with blood type A may either be a homozygous AA or a heterozygous Ab carrier. Genetic testing is therefore recommended to clarify the genetic basis of A and C (AB) cats (see also Chapter 21.3.1, p. 429).

Crossmatch Test

Material	EB 1.5 ml (For the maximum **age of the sample**, taking into account country-specific testing conditions, see **submission form**.)
Method	Dog, cat: immunochromatography; horse: flow cytometry
Species	Dog, cat; horse (indication: whole blood transfusion, other/additional indications **only** upon prior request).
Duration	Reporting of results on the day the sample is received (Mon–Fri) Samples received on a Saturday are tested on the same day; results are communicated the following Monday.
Note	▪ Please contact us before taking samples. ▪ Testing for possible negative effects between donor and recipient blood. ▪ Dog and cat: To ensure a safe whole blood transfusion, the test includes the major and minor crossmatch test. (Major crossmatch test: donor erythrocytes + recipient plasma; Minor crossmatch test: recipient erythrocytes + donor plasma) ▪ Crossmatch tests for dogs and cats can also be sent out for use in the practice.

3.4 Blood Parasites

Babesia – Microscopic ➢ **see Chapter 14.4.4, p. 252**

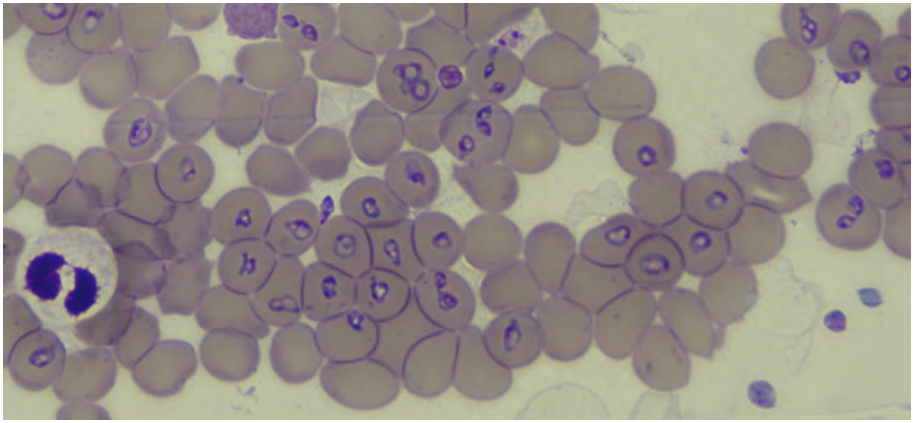
Blood Parasites – Microscopic	
Material	EB 1 ml + blood smear Birds: EB, HB 0.5 ml + blood smear Reptiles: HB 0.5 ml + blood smear
Method	Microscopy
Species	Mammals, birds, reptiles
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Please note that, in mammals, smears from HB may not always be suitable due to the formation of artefacts. ▪ Testing is particularly useful in acute stages of the disease.

Haemosporidia (avian) ➢ **see Chapter 14.4.17, p. 267**

Hepatozoon ➢ **see Chapter 14.4.18, p. 268**

Microfilaria – Knott Test ➢ **see Chapter 14.4.13, p. 265**

Trypanosoma ➢ **see Chapter 14.4.27, p. 277**



Babesia in the feathered edge of a blood smear (dog, Diff-Quik, 1000x magnification)

4 Clinical Chemistry

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

4.1 Enzymes

ALT (GPT)
Alanine Aminotransferase (Glutamate Pyruvate Transaminase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ In **dogs** and **cats**, ALT is generally liver-specific; in **horses**, **ruminants** and **pigs**, however, it is hardly relevant, as there is little ALT activity in the liver. ▪ The enzyme is found almost exclusively in the cytoplasm of hepatocytes. Even slight cell damage in the liver can cause the ALT concentration in serum to rise.

α-Amylase

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ In acute pancreatitis, enzyme activity is increased over a period of 3–5 days. As it is produced in the liver, pancreas and small intestine, the enzyme is not very specific for diagnosis. Changes in enzyme activity can also occur due to diseases of other organs as well as in renal dysfunction. ▪ In order to confirm the diagnosis of pancreatitis, determination of PLI is recommended (see PLI).

AP (Alkaline Phosphatase)

Material	S, HP 0.5 ml Ejaculate or sperm-rich fraction 0.5 ml (dog only)
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The enzyme is present in almost all organs. AP is diagnostically relevant in diseases of the skeletal and the hepatobiliary system. In **dogs**, there is also a steroid-induced isoform, which is mainly used to diagnose hyperadrenocorticism (Cushing's syndrome). ▪ Bone diseases: High serum AP concentrations occur in osteitis deformans and allow differentiation from osteoporosis. In bone tumours, the increase in concentration correlates with osteoblast activity (very high levels in osteosarcoma, low levels in benign tumours). Elevated serum AP concentrations along with low calcium concentrations are found in cases of rachitis and osteomalacia. ▪ Hepatobiliary system: Elevated serum AP concentrations may indicate cholestasis. ▪ **Young animals**: physiological concentration in serum up to 2.5-fold ▪ **Dog** (serum): Corticosteroid-induced AP can be diagnosed by determining the heat-stable isoenzyme (see service described below: heat-stable Alkaline Phosphatase). ▪ **Dog** (ejaculate): AP is determined from the sperm-rich fraction and mainly originates from the epididymis. Measuring the AP level in ejaculate can make it easier to differentiate between testicular-related oligo-/azoospermia and inadequate ejaculation or obstructive azoospermia. This test can be requested online using a dedicated service number or, for the printed submission form, via "Other parameters".

AP (heat-stable 65 °C)
(heat-stable **Alkaline Phosphatase)**

Material	S 0.5 ml
Method	Photometry
Species	Dog; not relevant for other species
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The heat-stable isoenzyme of AP is induced by endogenous or exogenous steroid hormones (especially glucocorticoids, progesterone). It can be used to assess steroid activity, particularly if hyperadrenocorticism (Cushing's syndrome) is suspected.

- This test is only useful when combined with the determination of "total AP" if the latter is elevated ("total AP" must be requested separately; see AP above). The percentage of residual activity can be calculated from "total AP" and heat-stable (steroid-induced) AP.

AST (GOT)
Aspartate Aminotransferase (Glutamate Oxaloacetate Transaminase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, birds, reptiles, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ AST is not organ-specific. Elevated concentrations can be caused by liver and muscle damage; it is not possible to distinguish between cardiac and skeletal muscle. A simultaneous increase in CK indicates a myogenic origin (CK activity rises rapidly and falls quickly, while AST activity rises and falls more slowly). ▪ **Cats**: AST is less sensitive to liver cell damage than ALT. If AST concentrations are elevated, CK should also be measured to differentiate from muscle damage. ▪ **Horses**: Elevated AST concentrations indicate muscle or liver lesions, depending on the accompanying parameters. CK and LDH help to determine the cause; GLDH and γ-GT are more specific to the liver. ▪ **Cattle**: The combination of AST and CK is prognostically useful in downer cows; persistently high AST concentrations with high CK concentrations indicate extensive muscle damage and a poor prognosis.

Cholinesterase

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ In cases of intoxication with organophosphates or phosphoric acid esters, inhibition of acetylcholinesterase leads to a significantly decreased activity of this enzyme in blood plasma. ▪ Cholinesterase is considered a liver-specific parameter in **birds**. A decreased concentration indicates liver cell damage or a reduced synthesis capacity of the liver.

CK (Creatine Kinase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, birds, reptiles, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Highest activity in skeletal muscles, followed by cardiac and brain tissue ▪ CK is a sensitive but non-specific marker for muscle cell damage. Elevated serum concentrations occur in myopathies, traumata, i.m. injections or after heavy exertion. ▪ Brain damage does not cause increased serum CK concentrations if the blood-brain barrier is intact.

GLDH (Glutamate Dehydrogenase)

Material	S, EP, HP 0.5 ml or S, HP 0.2 ml in reptiles
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The enzyme is liver-specific and located in the mitochondrion. Thus, elevations are indicative of massive destruction of liver cells and necrobiotic processes, especially in the centrilobular area. If concentrations of GLDH are increased, but at the same time ALT concentrations are changed only slightly, it indicates chronic inflammation of the liver. ▪ **Dog:** Single values have no diagnostic significance. Slight elevation of GLDH and stronger elevation of transaminases indicate acute disease of the liver. Opposite enzyme activity indicates chronic processes. ▪ **Rabbit:** GLDH is the most sensitive liver enzyme – an acute parameter (acute hepatopathy with centrolobular damage; strong increase in activity in anorexia, intoxication).

γ-GT (γ-Glutamyl Transferase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, horse, ruminant, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note
- γ-GT is a membrane-bound enzyme found primarily in the liver and bile ducts. Elevated activity in serum/plasma occurs mainly in liver disease and cholestasis.
- **Horses:** Significant increase in activity in cholestasis. Elevated concentrations may also be seen in other diseases with liver involvement (e.g. colic, enteritis).
- **Cattle:** γ-GT correlates with the degree of hepatic fatty degeneration and parenchymal swelling.
- After colostrum intake, **ruminant neonates** physiologically show very high γ-GT concentrations in serum/plasma during the first week of life.

α-HBDH (α-Hydroxybutyrate Dehydrogenase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note
- This isoenzyme of LDH is found in many kinds of tissue, especially in cardiac and skeletal muscles and in the liver; the activity of α-HBDH varies depending on the species.
- If α-HBDH in the LDH/α-HBDH ratio is disproportionately increased, it indicates possible damage of the cardiac muscle. Determination of c-Troponin I concentration has replaced the analysis of α-HBDH in case of this indication, though.
- Proportional or slight elevations of the enzyme point to other causes (e.g. liver damage, damage of skeletal muscles, haemolysis). In this case, CK and AST concentrations should be considered.

LDH (Lactate Dehydrogenase)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, rat, birds, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note
- LDH is composed of five isoenzymes and is found in many tissues, especially in the liver, in cardiac and skeletal muscles.
- Since erythrocytes contain high concentrations of LDH, even slight haemolysis can lead to elevated serum concentrations.
- Increased activity occurs in myopathies, cardiomyopathies and liver diseases.
- The ratio of α-HBDH to LDH can indicate involvement of cardiac or skeletal muscles.

Lipase (DGGR)

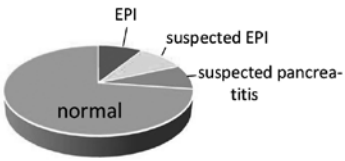
Material	S, (EP, HP) 0.5 ml
Method	Photometry (using DGGR reagent)
Species	Dog, cat, horse, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Measurement mainly covers the activity of pancreatic lipase, but also the lipase activity in other tissues (stomach, small intestine). A threefold increase in value indicates acute pancreatitis. ▪ In order to confirm the diagnosis of pancreatitis, pancreatic lipase immunoreactivity (PLI) should be determined. ▪ **Horse:** Pancreatitis can occur along with colic or other gastrointestinal diseases. Elevated lipase concentrations are also found in horses engaged in high-performance training.

PLI (Pancreatic Lipase Immunoreactivity)

Material	S 0.5 ml
Method	ELISA
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Detection of specific pancreatic lipase in suspected pancreatitis. The determination of pancreatic lipase in the serum of dogs and cats is considered to be the most sensitive non-invasive marker for the diagnosis of pancreatitis. As part of an inflammatory reaction, the pancreatic acinar cells are destroyed leading to an increase in the pancreatic lipase concentration in the serum.

TLI Test (Trypsin-like Immunoreactivity)

Material	S 0.5 ml
Method	CLIA (dog), ELISA (cat)
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat); Cat: 1–2 working days
Note	▪ Most sensitive test for the detection of exocrine pancreatic insufficiency. ▪ Renal insufficiencies may lead to increased TLI values. ▪ Dogs and cats **should** fast for 12 hours prior to sampling.



TLI results:
With 8.9%, exocrine pancreatic insufficiency (EPI) is not uncommon in cats of all ages.

4.2 Substrates

Albumin	
Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, ferret, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Albumin is synthesised in the liver and is the most important protein in plasma for transport and colloid osmotic pressure. It is a negative acute-phase protein, i.e. its concentration decreases during inflammatory responses. ▪ Hypoalbuminaemia results from loss via kidneys and intestines, through bleeding, synthesis disorders due to liver dysfunction, inflammation and a negative acute-phase reaction (mild hypoalbuminaemia). ▪ Hyperalbuminaemia mainly occurs as a relative increase in case of dehydration. ▪ **Birds**, **reptiles**, **small mammals**: Due to species-specific differences, serum protein electrophoresis is recommended for evaluating the protein pattern. ▪ For the determination of microalbumin in cerebrospinal fluid, please refer to p. 63; for analysis in urine, see Chapter 5, p. 77.

Bile Acids	
Material	S 0.5 ml (for omnivores and carnivores, **fasting** is required 12 hours prior to blood collection) HP, S 0.2 ml in reptiles
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Serum bile acid concentration correlates with liver function. ▪ Elevation of bile acids can also indicate the existence of a portosystemic shunt, except in horses. ▪ Single determinations may be within the reference range despite a disease being present; the performance of a bile acid stimulation test is therefore preferable – except in horses.

Bilirubin (total)	
Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, horse, ruminants, South American camelids, pig, others on request

Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ The breakdown of haemoglobin and other cytochromes produces bilirubin. Visible icterus correlates with concentrations of 17 µmol/l or more, except in horses (horse: > 75 µmol/l). ▪ Prehepatic icterus leads to an increased concentration of haemoglobin in the blood. ▪ Intrahepatic icterus: Increase in bilirubin concentration due to damage of liver cells ▪ Posthepatic icterus (rare): Increase caused by retention of bile ▪ Inanition icterus (special form of icterus in **horses** and **cattle**): This type of hyperbilirubinaemia occurs during lipomobilisation, as the free fatty acids that are released compete with bilirubin for transport proteins, resulting in higher levels of free bilirubin in the blood.

Bilirubin II (direct)

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	In the liver cells, bilirubin II is formed from bilirubin I by glucuronidation. Determination is only useful in case of elevated levels of total bilirubin. Measurement can be strongly affected by lipaemia.

L-**Carnitine**

Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; cooled until arrival at the laboratory)
Method	LCMS
Species	Dog, cat
Duration	2–6 working days
Note	▪ Testing for carnitine concentrations in **dogs** (and possibly cats) helps to assess energy metabolism, particularly mitochondrial β-oxidation of long-chain fatty acids. Carnitine acts as an essential carrier that transports fatty acids into the mitochondria. A deficiency can be primary (genetic, rare) or secondary due to diseases such as liver failure, pancreatitis, malabsorption, cardiomyopathies or long-term malnutrition. ▪ The significance is similar in **cats**, but they are less efficient at synthesising carnitine and are more sensitive to deficiencies, e.g. in anorexia or hepatic lipidosis.

Cholesterol	
Material	S, EP, HP 0.5 ml (a 12-hour **fasting period** is recommended for omnivores and carnivores)
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Cholesterol is mainly synthesised in the liver and the mucosa of the small intestine. It serves as a starting substance for bile acids, steroid hormones and cell membrane components. ▪ Hypocholesterolaemia is caused by liver failure (reduced synthesis capacity), malabsorption or maldigestion, acute inflammatory responses, starvation or cachexia. ▪ Hypercholesterolaemia is caused by cholestasis and liver disease, endocrine disorders (e.g. hypothyroidism, Cushing's syndrome), obesity and lipid metabolism disorders or dietary factors (high-fat diet).

Cholesterol: HDL (High-Density Lipoproteins) / LDL (Low-Density Lipoproteins)	
Material	S, EP, HP 0.5 ml (a 12-hour **fasting period** is recommended for omnivores and carnivores)
Method	Photometry
Species	Dog, cat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ LDL (low-density lipoprotein) and HDL (high-density lipoprotein) are the most important carriers for transporting cholesterol in the blood. ▪ LDL transports cholesterol from the liver to the tissues ("transport out of the liver"). ▪ HDL takes cholesterol from the tissues and brings it back to the liver ("reverse cholesterol transport"). ▪ The LDL to HDL ratio reflects the balance between cholesterol release and uptake and can indicate lipid metabolism disorders. ▪ In **dogs** and **cats**, measurement of LDL and HDL is not routinely carried out, but can be diagnostically helpful in case of lipid metabolism disorders, endocrine diseases or hepatic dysfunction. In dogs, an increase in LDL and total cholesterol is common with hypothyroidism and hyperadrenocorticism (Cushing's syndrome). ▪ In **cattle** and **horses**, HDL is physiologically predominant, while LDL accounts for only a small proportion of total cholesterol. ▪ HDL and LDL can be requested separately on the submission form.

Creatinine

Material	S, EP, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, Western European hedgehog, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ In addition to SDMA, creatinine is the most specific indicator for renal function. Due to the reserve capacity of the kidneys, elevated concentrations only occur when glomerular function is reduced by more than 70%. Lipaemia and haemolysis may influence the test results. ▪ In well-muscled or trained **dogs**, creatinine may be slightly increased physiologically without there being a renal dysfunction.

Cystatin B

Material	H 0.5 ml (cooled until arrival at the laboratory)
Method	ELISA
Species	Dog
Test frequency	1–2 x per week
Note	▪ Cystatin B is an intracellular protease inhibitor that occurs in numerous tissues and is released into the urine in increased amounts when renal tubule cells are damaged. ▪ An elevated urinary cystatin B/creatinine ratio indicates tubular kidney damage. ▪ Cystatin B is considered a sensitive marker of early or active tubular cell damage and may be elevated even before changes in classic renal function parameters. The findings should be interpreted in the context of other renal parameters (e.g. UPC, sediment, SDMA, creatinine) and the clinical situation.

FGF-23 (Fibroblast Growth Factor-23)

Material	S 0.5 ml
Method	ELISA
Species	Dog, cat
Duration	3–7 working days
Note	▪ FGF-23 is a hormone-like protein that is mainly produced in osteocytes and osteoblasts. It regulates phosphate and vitamin D metabolism by increasing renal phosphate excretion and inhibiting calcitriol synthesis. ▪ It is an early marker for phosphate metabolism disorders in chronic kidney disease (CKD) and helps to assess the progression of nephropathies.

- Elevated FGF-23 concentrations may already be detectable before serum phosphate and serum creatinine concentrations begin to increase.

Fructosamines	
Material	S 1 ml or S 0.5 ml in small mammals
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, horse, ruminants, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Fructosamines are formed by an irreversible binding of glucose to serum proteins (glycosylation). ▪ Determination is used for the diagnosis and long-term monitoring of patients with diabetes mellitus, as the glucose bound to serum proteins reflects the average glucose level of the past 2–3 weeks. Elevated fructosamine concentrations can also be found in hyperproteinaemia and hypothyroidism. ▪ Low fructosamine concentrations are associated with protein deficiency, increased protein metabolism or, in cats, also with hyperthyroidism. ▪ **Horse:** often increased in case of EMS

Glucose	
Material	NaFB, S 1 ml or CSF
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Increased glucose concentrations occur in case of diabetes mellitus, in CNS diseases, pancreatitis and Cushing's disease/PPID. Concentrations may be elevated, particularly due to stress and after administration of glucocorticoids. ▪ Diseases of the liver, hypoadrenocorticism (Addison's disease) and insulinoma may cause hypoglycaemia. ▪ Medicines that can lead to hypoglycaemia include: antihistamines, beta blockers, anabolic steroids. ▪ **Dog:** Starving young dogs of toy breeds tend to develop life-threatening hypoglycaemia in stress situations. ▪ **Horse:** The determination of glucose levels is a necessary part of the diagnosis of Equine Metabolic Syndrome (EMS). For further information, please see "Insulin" (Chapter 8, p. 106).

- In **cattle,** hypoglycaemia indicates ketosis due to energy deficiency; the additional determination of β-HBA is needed. Hyperglycaemia is caused by stress and endotoxaemia.
- Hypoglycaemia-hypothermia syndrome is a life-threatening condition in newborn **lambs, kids** and **piglets**.
- The semi-quantitative detection of glucose in urine is part of the Urinalysis (see Chapter 5, p. 78).

HDL ➢ **see Cholesterol, p. 59**

β-Hydroxybutyrate (β-HBA)	
Material	S, HP 0.5 ml
Method	Photometry
Species	Dog, cat, horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Ketone bodies are formed in the organism during the degradation of fatty acids. ▪ **Ruminants:** The determination of β-HBA provides an indication of energy supply and can be used for diagnosing ketosis. **Cattle:** increased ketone body concentrations in ketosis resulting from energy deficiency, in secondary ketosis (e.g. in case of abomasal displacement) or in alimentary ketosis **Small ruminants:** for the diagnostic assessment of gestational toxicosis ▪ **Dog/cat:** Elevated concentrations occur in diabetic ketoacidosis and after prolonged fasting.

Indoxyl Sulfate	
Material	S 0.5 ml (fasting required)
Method	HPLC
Species	Dog, cat
Duration	2–4 working days
Note	▪ When breaking down tryptophan, intestinal bacteria form indole, which is metabolised in the liver to indoxyl sulfate. ▪ Indoxyl sulfate is a uraemic toxin which is physiologically excreted by the kidneys and whose concentration in serum increases in renal dysfunction. This causes continuous damage to the kidney tissue, causing the disease to progress.

Lactate	
Material	NaFB 0.5 ml
Method	Photometry
Species	Dog, cat, horse, cattle, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	Anaerobic degradation of glucose leads to the formation of lactate. Elevated lactate concentrations may be caused by increased formation of lactate due to a higher glucose uptake or increased glycogenolysis (e.g. diabetes mellitus), impaired metabolisation (hypovolaemic, cardiovascular or neurogenic shock) or enhanced formation due to oxygen deficiency in the tissue (fitness level, increase of lactate in immature neonates).

LDL ➢ see Cholesterol, p. 59

Microalbumin in urine ➢ see Chapter 5 Urinalysis, p. 77

Microalbumin (in CSF)	
Material	CSF 0.3 ml
Method	Photometry
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Microalbumin refers to micro amounts of albumin. ▪ Albumin passes from serum into cerebrospinal fluid (CSF) solely via the blood-cerebrospinal fluid barrier. Determining the albumin concentration in CSF reflects the integrity of the blood-cerebrospinal fluid barrier. A quantitative assessment is made using the albumin quotient (QAlb), calculated from the ratio of CSF albumin [mg/dl] to serum albumin [g/dl] in combination with the absolute albumin concentration in CSF (especially in dogs). ▪ An elevated QAlb indicates increased permeability of the blood-cerebrospinal fluid barrier (e.g. in inflammatory, neoplastic or traumatic CNS diseases). ▪ QAlb concentrations within the reference range indicate an intact blood-cerebrospinal fluid barrier. ▪ A valid assessment always requires a combination of CSF albumin, serum albumin and other CSF parameters (protein, cell count).

NEFA (Non-Esterised Free Fatty Acids)	
Material	S 0.5 ml
Method	Photometry
Species	Ruminants, South American camelids, pig

Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	The degradation of adipose tissue releases NEFA. They are a quick and sensitive marker of energy deficiency or of reduced feed intake in case of stress situations or disease, and serve to estimate e.g. the lipomobilisation in a catabolic metabolic state.

Protein (Total **Protein)**

Material	S, EP, HP, CSF 0.5 ml, H
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Total serum protein mainly consists of albumin and globulins. ▪ Absolute hyperproteinaemia: usually the result of chronic inflammatory processes, persistent infections or neoplastic diseases (e.g. plasmacytoma) ▪ Relative hyperproteinaemia: caused by fluid loss due to dehydration ▪ Absolute hypoproteinaemia due to protein loss via the kidneys, intestine or haemorrhage; due to reduced protein synthesis (liver dysfunction), loss into the third space (e.g. ascites, exudates) ▪ Relative hypoproteinaemia: result of increased fluid intake or dilution ▪ In cerebrospinal fluid, an increase in total protein indicates inflammatory or neoplastic CNS diseases. ▪ In urine, assessment is based on the protein/creatinine ratio (see Chapter 5, p. 80). ▪ To differentiate between individual protein fractions, serum protein electrophoresis is used (see Chapter 7, p. 100).

SDMA (Symmetric Dimethylarginine)

Material	S, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, ferret, horse
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	SDMA is formed during protein degradation, is excreted by the kidneys and is used in laboratory diagnosis for the early detection of renal dysfunction (= GFR still > 30%), even in the creatinine-blind range.

Taurine	
Material	EP 1 ml (immediately centrifuged, pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	LCMS
Species	Dog, cat
Test frequency	1 x per week
Note	Chronic taurine deficiency causes dilatative cardiomyopathy in cats. In general, most commercial diets contain sufficient amounts of taurine. Taurine deficiency may be caused by chronic malabsorption or by homemade rations.

Triglycerides	
Material	S, EP, HP 0.5 ml (a 12-hour **fasting period** is recommended for omnivores and carnivores)
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Triglycerides are neutral fats that serve as energy storage and transporter for fatty acids. They are synthesised in the liver, small intestine and adipose tissue. Serum concentration is influenced by food intake, hormone status and metabolic state. ▪ **Dog:** Hypertriglyceridaemia is associated with postprandial lipaemia, diabetes mellitus, hypothyroidism, Cushing's syndrome and acute pancreatitis, among others. ▪ **Cat:** Hypertriglyceridaemia can be detected in diabetes mellitus, obesity and hepatic lipidosis, among others. ▪ **Horse:** Elevated triglyceride concentrations can be found in EMS, PPID, food deprivation or inappetence; clinically relevant in hyperlipaemia and hyperlipidaemia syndromes. Triglycerides are suitable as monitoring parameters during SGLT-2 inhibitor treatment. ▪ **Cattle:** Elevated concentrations occur in lipomobilisation syndrome in negative energy balances, especially in the peripartal period.

Troponin I, ultra-sensitive	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	CLIA
Species	Dog, cat, rabbit, horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note	▪ Acute myocardial cell damage (highly specific myocardial parameter); an increase may indicate cardiomyopathy and should be further clarified using imaging techniques. ▪ Measurement is done using a highly sensitive chemiluminescence immunoassay, making troponin I measurement particularly valuable for prognostic purposes in the lower measurement range and suitable for monitoring subtle changes in cardiac muscle cells.

Urea

Material	S, EP, HP 0.5 ml or S, HP 0.2 ml in reptiles
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Urea is the main end product of protein metabolism in mammals. It is formed in the liver from ammonia and filtered through the glomeruli of the kidneys. ▪ Serum concentration depends on both kidney function and extrarenal factors (e.g. feeding, protein intake, protein turnover). ▪ When assessing renal function, urea concentrations should always be interpreted together with creatinine and SDMA. ▪ **Cattle:** The urea concentration in serum or milk serves as an indicator of energy and protein supply. Low concentrations indicate a deficiency in crude protein, while elevated concentrations indicate excess protein or energy deficiency. ▪ **Horses** and **small animals:** In addition to creatinine, urea is a key parameter for assessing renal function and particularly indicates disturbances in water and nitrogen balance. ▪ Urea is the most important renal parameter in **aquatic and sea turtles** and other **aquatic reptile species, amphibians and fish.**

Uric Acid

Material	S, EP, HP 0.5 ml or S, HP 0.2 ml in reptiles
Method	Photometry
Species	Dog, birds, reptiles
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ **Dog**: Especially in Dalmatians, a genetic metabolic disorder can cause elevated uric acid levels (hyperuricosuria). Clinically, this manifests as uric acid stones and a brownish-yellowish discolouration of the coat (bronzing syndrome). It can be confirmed with the genetic test "Hyperuricosuria (HUU/SLC)" (see Chapter 21.2.1, p. 369).

- **Birds:** Depending on the bird species, concentrations above 500 µmol/l indicate nephropathies or exsiccosis.
- **Birds/Reptiles:** The levels of uric acid vary, depending on various factors, such as feed intake, protein content of the ration, season and species. Uric acid is the most important renal parameter in bird species and terrestrial reptile species.

4.3 Minerals and Trace Minerals

Calcium (Ca)	
Material	S, HP 0.5 ml or S, HP 0.2 ml in reptiles
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Calcium is an essential macromineral and important for bone metabolism, muscle contraction, nerve conduction and blood coagulation. Approximately 99% of calcium is found in the skeleton, with the remainder present in the blood, partly ionised (biologically active) and partly bound to proteins, particularly albumin. ▪ It is regulated by parathyroid hormone (PTH), vitamin D (calcitriol) and calcitonin. ▪ Hypercalcaemia occurs in neoplasms (especially lymphomas, anal sac carcinomas in **dogs**), hyperparathyroidism, hypoadrenocorticism (Addison's disease) and vitamin D intoxication, less frequently in chronic kidney disease (CKD). ▪ Hypocalcaemia can be caused by hypoalbuminaemia, eclampsia/lactation hypocalcaemia, renal insufficiency, acute pancreatitis and hypoparathyroidism. ▪ In **cats**, idiopathic hypercalcaemia is the most common form; it is less common as a secondary condition resulting from CKD or urolithiasis. ▪ Hypocalcaemia in **dogs** and **cats** is usually caused by calcium loss, insufficient intake, impaired vitamin D metabolism or parathyroid hormone deficiency. ▪ **Dog, cat:** In case of concurrent hypoalbuminaemia, the calcium concentration should be corrected. **Calculation:** Corrected calcium concentration (mg/dl) = serum calcium level (mg/dl) – (0.4 x serum protein (mg/dl)) + 3.3 ▪ **Horses** have physiologically higher levels; hypocalcaemia can be observed if there is heavy sweating, sepsis, or endotoxaemia. ▪ Nutritive hypercalcaemia in **small mammals** is partly due to vitamin D3-independent intestinal absorption.

- **Cattle:** Hypocalcaemia is the most common cause of parturient paresis in cattle. To differentiate, laboratory diagnostics should be used to clarify hypophosphataemia, hypomagnesaemia, liver metabolism and the so-called "muscle enzymes" (CK, AST).

Calcium, ionised	
Material	S, HP 0.5 ml (centrifuged and pipetted off immediately after collection (plasma) or centrifuged and separated shortly after coagulation (serum) and under exclusion of air)
Method	ISE
Species	Dog, cat, birds, reptiles, horse, others on request
Duration	2–3 working days
Note	▪ Ionised Ca represents the biologically active part of the total calcium. ▪ The sample should be collected **without air** (vacutainer system). The instructions can be requested from us. ▪ This service may not be available in some countries.

Chloride (Cl)	
Material	S, HP 0.5 ml
Method	ISE
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ It is the most important extracellular anion and decisive for maintaining the osmotic balance. ▪ Hypochloraemia occurs in diseases with hyponatraemia, e.g. vomiting, abomasal reflux in case of abomasal displacement, diarrhoea and metabolic alkalosis. ▪ **Ruminants:** Hyperchloraemia occurs in all diseases which also cause hypernatraemia. The most common causes are dehydration and hyperchloremic metabolic acidosis.

Cobalt (Co)	
Material	S, H 1 ml
Method	ICPMS
Species	Horse, ruminants, South American camelids, others on request
Duration	2–6 working days
Note	▪ Cobalt is an essential trace mineral and a component of the vitamin B_{12} (cobalamin) molecule. It plays a central role in erythropoiesis, DNA synthesis and energy metabolism. In **ruminants**, cobalt is necessary for microbial vitamin B_{12} synthesis in the rumen.

- Cobalt deficiency leads to vitamin B_{12} deficiency with anaemia, growth disorders and inappetence. Cobalt deficiency is rare in monogastric animals, as vitamin B_{12} is absorbed directly from food.
- Excess cobalt rarely occurs naturally, but is usually iatrogenic due to excessive supplementation and can lead to polycythaemia, cardiac damage or neurological signs.
- In **cattle** and **sheep**, typical signs of deficiency are emaciation, reduced milk yield, hepatic fatty degeneration and hypoglycaemia ("pining").
- **Horse:** Cobalt is required in small amounts as an essential trace mineral. Excessive cobalt intake (e.g. through injections or supplements) can stimulate erythropoietin metabolism and thus increase performance. Cobalt is therefore considered a doping-relevant substance in horses.

Copper (Cu)

Material	S, HP 0.5 ml
Method	Photometry
Species	Dog, cat, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Copper deficiency can lead to depigmentation as well as growth and reproductive disorders. ▪ **Dog:** In the copper storage disease in Bedlington Terriers, copper serum levels are usually normal, elevated concentrations can only be detected in liver tissue. For the genetic test for copper storage disease in Bedlington Terriers, Doberman and Labrador Retriever see Chapter 21.2.1, p. 350. ▪ **Sheep:** In newborn lambs, copper deficiency leads to CNS signs. Oversupply, e.g. caused by mineral supplement for cattle, leads to intoxication in sheep.

Iodine (I)

Material	S 0.5 ml
Method	ICPMS
Species	Dog, cat, horse, ruminants, others on request
Duration	1–3 working days
Note	▪ Iodine is an essential trace mineral and the main component of the thyroid hormones thyroxine (T4) and triiodothyronine (T3). It is crucial for growth, metabolic regulation and energy balance. ▪ In **cattle**, iodine deficiency has been reported to result in goitre formation, fertility problems, abortions, decline in libido, reduced semen quality and hairlessness.

- Note: Do not use medications or antiseptics that contain iodine before taking samples and avoid contact between samples and plastic (adsorption possible).

(Urinary) **Iodine/Creatinine Ratio**	
Material	Urine 1 ml
Method	ICPMS, photometry
Species	Dog, cat, horse, others on request
Duration	1–3 working days
Note	Studies in different animal species show that the iodine/creatinine ratio better reflects the alimentary iodine supply than the determination of serum iodine concentration.

Iron (Fe)	
Material	S, HP 0.5 ml
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Iron is found in the body in the form of haemoglobin and myoglobin. Furthermore, it is a component of various enzymes. In serum, iron is mainly bound to transport proteins. ▪ Iron is a negative acute-phase marker, i.e. in acute inflammation there is a relative or absolute decrease in serum concentrations. ▪ Elevated serum iron concentrations occur due to the destruction of liver parenchyma (acute hepatitis, cirrhosis). In case of rarely occurring haemochromatosis, increased serum iron concentrations are associated with deposits in the liver and muscles. Elevated concentrations may also occur if the sample quality is poor. ▪ Determination of iron is also part of the Iron Metabolism Profile. This profile helps to distinguish between absolute iron deficiency (e.g. due to chronic blood loss) and functional iron deficiency (e.g. as a result of inflammatory, infectious or neoplastic processes).

Fractional Electrolyte Excretion (FE) ➢ **see Chapter 5, p. 76**

Magnesium (Mg)	
Material	S, HP 0.5 ml
Method	ICP-MS
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note
- Magnesium is essential for the energy metabolism of the cells and for neuromuscular transmission.
- Hypermagnesaemia may occur hypoadrenocorticism (Addison's disease).
- **Cattle:** Hypomagnesaemia is the most common cause of grass tetany.

Manganese (Mn)

Material	S 0.5 ml
Method	ICPMS
Species	Dog, horse, ruminants, South American camelids, pig, others on request
Duration	2–3 working days

Note
- Manganese is an essential trace mineral and a component or activator of numerous enzymes, including superoxide dismutase.
- It plays an important role in carbohydrate, lipid and protein metabolism, bone and cartilage formation, and the antioxidant protection system.
- Manganese deficiency leads to growth disorders, bone deformation, fertility disorders and reduced glucose tolerance. In **ruminants** and **pigs**, delayed growth and fertility problems are particularly relevant.
- An excess of manganese is rare, as any excess is mainly excreted in the bile. Very high concentrations can cause neurological signs (tremors, ataxia).

Molybdenum (Mo)

Material	S 0.5 ml
Method	ICP-MS
Species	Cattle, others on request
Duration	1–3 working days

Note
- Molybdenum is an essential trace mineral and component of important enzymes (e.g. xanthine oxidase, sulphite oxidase).
- Molybdenum deficiency can lead to anaemia, diarrhoea and paralysis. It should be noted that molybdenum is antagonistic to copper – this is particularly relevant for cattle and sheep on molybdenum-rich or sulphur-containing soils: High molybdenum intake can lead to secondary copper deficiency in ruminants, as molybdenum binds copper with sulphur (formation of thiomolybdates). This can result in hypochromic anaemia, bone growth disorders, diarrhoea and loss of pigment in the coat.

Inorganic **Phosphate (PO4)**

Material	S, HP 0.5 ml or S, HP 0.2 ml in reptiles
Method	Photometry
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, Western European hedgehog, birds, reptiles, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Young animals physiologically have higher concentrations than adult animals. ▪ Hyperphosphataemia is simulated in haemolytic samples. ▪ The most common causes of pathologically elevated serum concentrations are kidney disease (although hyperphosphataemia is rare in horses – hypophosphataemia is more common) and hyperthyroidism in cats. ▪ **Reptiles:** The Ca/P ratio should be approximately 2:1. ▪ **Cattle:** Apart from trauma and muscle damage, hypophosphataemia is the most important differential diagnosis of so-called "atypical milk fever" (recumbency not due to hypocalcaemia).

Potassium (K)

Material	S, HP 0.5 ml
Method	ISE
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Potassium is the most important intracellular cation and plays a central role in the electrical excitation of nerve and muscle cells. It is essential for acid-base balance and osmoregulation. Approximately 98% of the total potassium is found in the cells. ▪ **Dog:** Hyperkalaemia is characteristic of hypoadrenocorticism (Addison's disease). Hypokalaemia is common in vomiting, diuretic treatment or chronic kidney disease. ▪ **Cat:** Hypokalaemia mainly occurs in cases of chronic kidney disease, anorexia or hypokalaemic myopathy; hyperkalaemia is rare and usually a secondary effect of (iatrogenic/preanalytical) haemolysis or urinary retention. ▪ **Horse:** Potassium concentration varies depending on fitness level and diet; hypokalaemia can be observed in cases of anorexia, diuretic administration or increased sweating. ▪ **Cave:** Even with physiological serum concentrations, there may be an absolute potassium deficiency! ▪ Note: Potassium concentrations are only diagnostically conclusive if the sample is centrifuged and separated promptly.

- Pseudohyperkalaemia may occur if potassium is released from platelets, leukocytes and erythrocytes. Preanalytical haemolysis can lead to falsely elevated findings.

Selenium (Se)	
Material	S, EP, HP 0.5 ml
Method	AAS
Species	Dog, cat, horse, ruminants, South American camelids, pig
Duration	1–2 working days
Note	▪ Selenium deficiency may cause nutritional muscular dystrophy in foals. Special emphasis should therefore be placed on the selenium supply of brood mares. ▪ In **farm animals** and **camelids**, selenium is essential for a healthy immune system and high fertility. In neonates, selenium deficiency often results in a weak sucking reflex and white muscle disease.

Sodium (Na)	
Material	S, HP 0.5 ml
Method	ISE
Species	Dog, cat, rabbit, guinea pig, ferret, chinchilla, rat, birds, reptiles, horse, ruminants, South American camelids, pig
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Sodium is the most important extracellular cation. In dogs and cats, sodium is excreted mainly by the kidneys. ▪ The main causes of hypernatraemia are loss of water without concurrent loss of electrolytes (diabetes insipidus, diabetes mellitus), retention of sodium (mineralocorticoids) or a high sodium intake with food without the possibility of water uptake. ▪ The main causes of severe hyponatraemia are hypoadrenocorticism (Addison's disease), diarrhoea and vomiting; hyponatraemia is also possible when diuretics are administered.

Sodium/Potassium Ratio (Na/K Ratio)	
Material	S, HP 0.5 ml
Methode	ISE
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	A significantly reduced Na-K ratio may indicate hypoadrenocorticism (Addison's disease, clarification by ACTH Stimulation Test). However, various differential diagnoses must be considered (e.g. intestinal salmonellosis, trichuriasis, perforated duodenal ulcer).

Urinary Iodine/Creatinine Ratio ➢ Iodine/Creatinine Ratio, p. 70

Zinc (Zn)	
Material	S, HP 0.5 ml
Methode	Photometry
Species	Dog, cat, birds, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Marked zinc deficiency causes parakeratosis of the skin and mucous membranes. In **cats**, coat changes are mainly described. Serum zinc levels are not necessarily decreased in case of zinc responsive dermatosis. This clinical picture is also relevant in **South American camelids**. ▪ In **farm animals**, zinc deficiency leads to reduced feed conversion and performance depression, changes in skin and claws, parakeratosis (especially in small ruminants) as well as growth retardation and fertility disorders (incl. underdeveloped reproductive organs). ▪ **Birds:** to diagnose intoxication

5 Urinalysis

For abbreviations and additional information concerning the test descriptions see p. 11 and following. For preanalytical information on urine samples, see p. 21 f.

Kidney Profiles ➢ **see Catalogue of Prices and Services**

Kidney-specific individual parameters that are determined from blood (e.g. Indoxyl sulphate, SDMA) ➢ **see Chapter 4.2, p. 57**

BRAF Mutation (Urinary Bladder/ Urothelial Carcinoma) ➢ **see Chapter 19.5, p. 330**

Bence Jones Proteins Confirmatory Test

Material	Urine 0.5 ml
Method	Immunofixation
Species	Dog, cat, others on request
Duration	2–6 working days
Note	▪ Detection of Bence Jones proteins to confirm the diagnosis of multiple myeloma ▪ Also useful if free light chains were detected in previous urine protein electrophoresis

COLA Screening/Cystinuria (cystine, ornithine, lysine, arginine)

Material	Morning urine 1 ml (frozen upon arrival at the laboratory)
Method	LCMS
Species	Dog; cat on request
Test frequency	1 x per week
Note	▪ Quantitative determination of the amino acids cystine, ornithine, lysine and arginine ▪ For the diagnosis of cystinuria in different breeds ▪ Elevated in case of nephropathy, glomerulonephritis and renal amyloidosis, among others. ▪ Note: Evaluation of amino acid concentrations is only possible with inactive sediment. ▪ We also recommend analysing urinary sediment and determining the pH (urinalysis). To do so, please send in an additional urine sample that has **not** been frozen.

Fractional **Electrolyte Excretion (FE)**	
Material	Urine 0.5 ml + S (non-haemolysed) 0.5 ml, samples collected at the same time
Method	Photometry
Species	Dog, horse, cattle
Duration	1–2 working days
Note	▪ The FE of Na, K, P, Cl are examined. ▪ If the electrolyte excretion is put into relation with the creatinine excretion (here GFR = excretion), it indicates the FE of the electrolyte. ▪ The FE is used to diagnose a dysfunction of the renal tubules. In animals with healthy kidneys, the net excretion of an electrolyte in the urine is regulated by the glomerular filtration rate and the tubular reabsorption. If tubular reabsorption fails, the FE of one or more electrolytes usually increases and its FE values will be above the normal range.

Fanconi Profile	
Material	Morning urine 1 ml (frozen upon arrival at the laboratory)
Method	LCMS
Species	Dog; cat on request
Duration	2–6 working days
Note	▪ Quantitative determination of the amino acids alanine, arginine, cystine, glutamine, glycine, lysine, ornithine, proline, threonine and semi-quantitative determination of glucose concentration in urine ▪ For the diagnosis of acquired or congenital Fanconi syndrome in dogs ▪ We also recommend analysing urinary sediment and determining the pH (urinalysis). To do so, please send in an additional urine sample that has **not** been frozen. ▪ For genetic testing in Basenjis, see Chapter 21.2.1, p. 361.

γ-GT/Creatinine Ratio	
Material	Urine 1 ml
Method	Photometry
Species	Horse
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Shows the early stage of a tubular disease and is particularly indicated in case of acute disease.

Microalbumin (in urine)

Material	Urine 0.5 ml (ideally morning urine; quickly centrifuge sample, use supernatant)
Method	Photometry
Species	Dog, cat
Duration	1–2 working days
Note	▪ Microalbumin refers to micro amounts of albumin. ▪ The determination of microalbumin in urine is used for the early detection of glomerular damage. It allows to detect minor albumin losses that are not identified by conventional protein tests. It is a sensitive marker for early stages of renal disease and for systemic diseases involving the glomeruli (e.g. diabetes mellitus, hyperadrenocorticism in dogs, hypertension, infections such as leishmaniasis, inflammation). ▪ The test detects early signs of impaired glomerular filtration or endothelial damage even before creatinine or SDMA rise. Microalbumin may be transiently elevated (e.g. after physical exertion, fever, stress) or persistently (pathologically) elevated. ▪ In **cats**, microalbumin can be used as a supplementary parameter to the UPC ratio (see Protein/Creatinine ratio, p. 80) in hyperthyroidism and in monitoring the progression of CKD. ▪ Haematuria, pyuria or infections can cause falsely elevated results, hence the urinary sediment should also be evaluated. Urinary sediment must be requested as a separate test; if requested at the same time as the determination of microalbumin, an additional urine sample for the urine sediment must be supplied.

NABE (Net Acid-Base Excretion)

Material	Urine 15 ml, fresh (please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)
Method	Titration
Species	Cattle
Duration	2–3 working days
Note	▪ Please fill the sample container to the brim so that no air is contained. Both spontaneous urine and catheter urine can be sent in. ▪ NABE concentrations provide information about the acid-base status. The advantage of NABE compared to a simple measurement of urinary pH is its greater stability regarding stress, feed and water intake, and renal compensation. Together with the blood parameters ketone bodies (β-HBS) and free fatty acids (NEFA),

NABE represents the minimum spectrum of metabolic monitoring in cattle. NABE concentrations must, amongst others, be analysed in the context of feed intake, stage of lactation and the herd.

Protein/Creatinine Ratio (in Urine) ➢ **see p. 80**

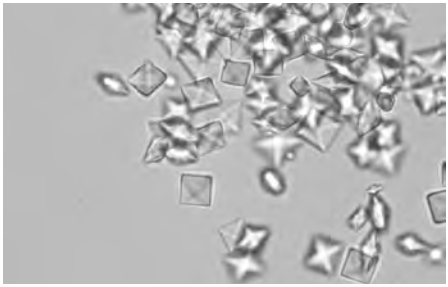
Urinalysis incl. Sediment

Material	Urine 5 ml
Method	Dry chemistry, photometry, microscopy, refractometry
Species	Dog, cat, rabbit, guinea pig, horse, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri) Samples received on a Saturday are tested on the same day; results are communicated the following Monday.
Note	▪ The specific gravity is measured in addition to the semi-quantitative measurement of clinical chemical and cellular parameters (protein, haemoglobin/myoglobin, pH value, bilirubin, urobilinogen, glucose, nitrite, ketone bodies as well as erythrocytes, leukocytes, bacteria, yeasts, cylinder, epithelia, crystals). See also the images of crystals. ▪ If the patient is currently being treated with medication (antibiotics, allopurinol, etc.), this should be noted on the submission form. ▪ This test is also offered in combination with UPC (urinary protein/creatinine ratio) or a urine culture (bacteriology). The required sample material and the duration of the service differ for these combined services (see submission form, Catalogue of Prices and Services or on the Laboklin website). ▪ If characteristic crystals (see images on the next page) are found in the sediment, the animal species, urine pH and specific gravity should be included to draw clear conclusions about the chemical composition. Larger concretions can be analysed by FTIR (see Urinary Calculi).

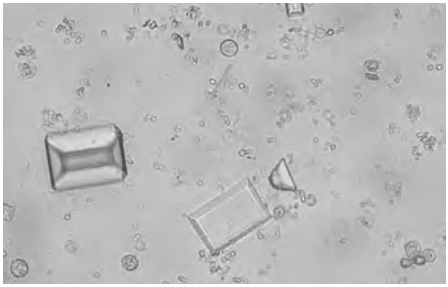
Digital **Urinary Sediment – Image Analysis**

The image upload in "MyLab" allows you to quickly get a veterinary diagnosis of digital images with unclear findings from your practice. You can upload up to 4 images with your diagnostic task via the **image analysis "Digital Urinary Sediment"** in the password-protected area of our "MyLab" website. You will receive the laboratory findings by e-mail, usually on the same day.

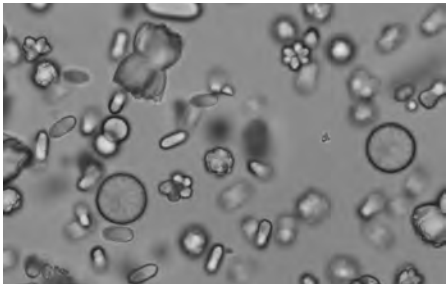
Laboklin "MyLab" https://app.laboklin.com/imageAnalysis



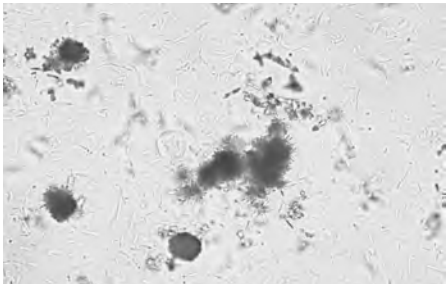
1 calcium oxalate



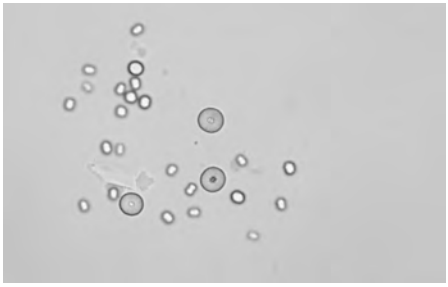
2 struvite



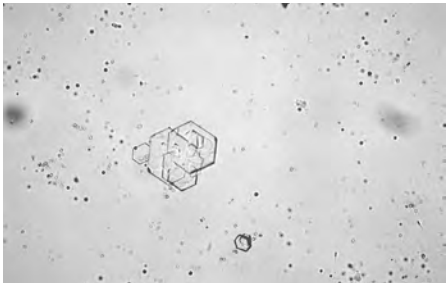
3 calcium carbonate



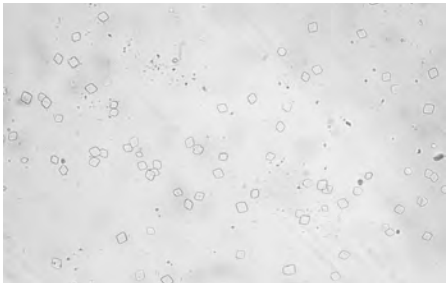
4 ammonium urate



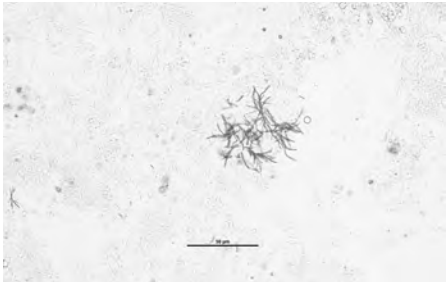
5 xanthine



6 cystine



7 uric acid



8 bilirubin

Crystals from urinary sediment (microscopy, 40x obj. (1, 6, 7, 8) and 50x obj. (2, 3, 4, 5))

Urinary Calculi (Stone Analysis)

Material	Calculi, concretions (e.g. gallstones), dry min. 5 g
Method	Infrared spectroscopy (FTIR)
Species	Dog, cat, rabbit, guinea pig, reptiles, horse, ruminants, South American camelids, others on request
Duration	1–2 working days
Note	▪ The analysis of concretions is necessary for a targeted dietary therapy and for prophylaxis. ▪ Depending on the chemical composition, urinary calculi produce characteristic curves in infrared spectroscopy (see figure for examples). ▪ The analysis is also suitable for the description of other concretions such as gallstones. If you have special material or special questions, please consult the laboratory.

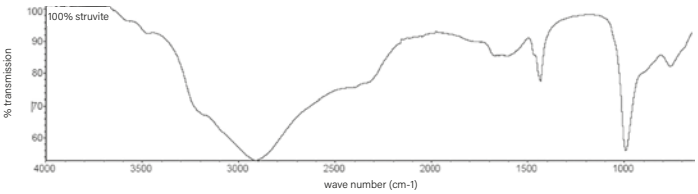
Urinary **Iodine/Creatinine Ratio** ➢ **see Chapter 4.3, p. 70**

Urine Bacteriological Culture ➢ **see Chapter 15.1, p. 293**

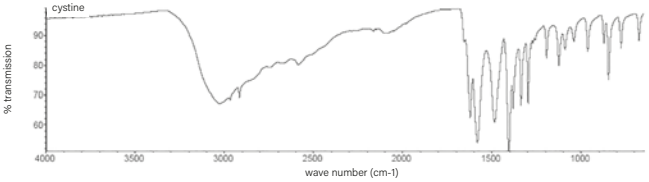
Urine Protein/Creatinine Ratio (UPC)

Material	Urine 1 ml
Method	Photometry
Species	Dog, cat, chinchilla, horse
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Parameter for early diagnosis of renal dysfunction and protein loss via urine ▪ Not conclusive in case of bloody urine or active sediment. In this case, there is no correlation between UPC and renal function. ▪ Increased values can also be caused by fever, bacterial and inflammatory processes without renal dysfunction being present.

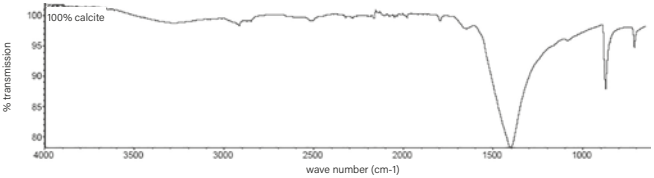
FTIR spectrum of struvite



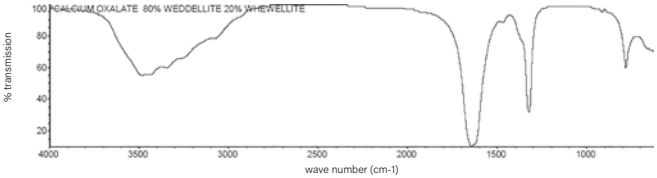
FTIR spectrum of cystine



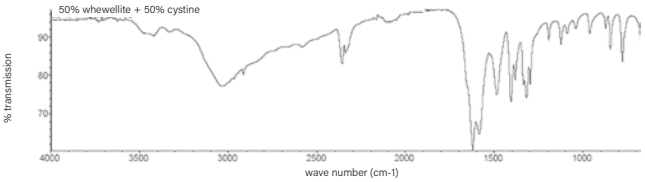
FTIR spectrum of calcium carbonate



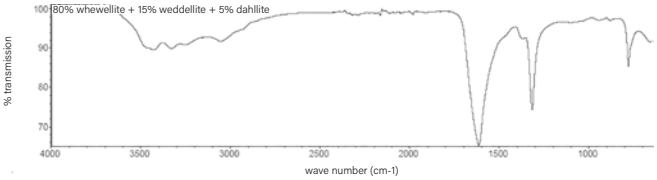
FTIR spectrum of calcium oxalate



FTIR spectrum of calcium oxalate and cystine



FTIR spectrum of calcium oxalate and dahllite



Analysis of urinary calculi by infrared spectroscopy:
FTIR spectra of struvite, cystine, calcium carbonate, calcium oxalat and mixed forms
Recording the transmission of infrared light at specific frequencies. Transmission is directly related to the oscillation energy of the molecular binding.
There are characteristic curves for each type of calculus – including mixed forms.

Urine Protein Electrophoresis

Material	Urine 1 ml
Method	Agarose gel electrophoresis
Species	Dog, cat, others on request
Duration	1–5 working days

Note

- Urine protein electrophoresis is used to differentiate the type of proteinuria and helps to determine the site of the protein loss (glomerular, tubular, mixed). It is used to supplement the quantitative analysis done by determining the protein/creatinine ratio (UPC).
- Glomerular proteinuria: predominance of albumin and high-molecular-weight proteins → indicates increased glomerular permeability (e.g. glomerulonephritis, amyloidosis)
- Tubular proteinuria: increase in low-molecular-weight proteins → reabsorption disorder in tubular damage (e.g. ischaemic, toxic, inflammatory)
- Mixed proteinuria (common in cats): combination of both patterns in chronic kidney disease
- Not recommended if urine is contaminated with blood or if prostate cysts are suspected
- If free light chains are detected, the Bence Jones Proteins Confirmatory Test (p. 75) is recommended.

Interpretation of protein patterns in urine protein electrophoresis

Type of proteinuria	Characteristic pattern	Typical causes
glomerular	predominance of high-molecular-weight proteins (e.g. albumin, transferrin, immunoglobulins)	glomerulonephritis, amyloidosis, hypertension
tubular	predominance of low-molecular-weight proteins (< 70 kDa)	toxic, ischaemic or inflammatory tubular damage
mixed	combination of both fractions	chronic kidney disease

Tubular proteins (< 70 kDa)

Normally filtered by the glomeruli and reabsorbed in the tubular cells. Elevated concentrations in urine indicate **tubular damage** or **reabsorption disorders**.

Protein	Molecular weight	Function/diagnostic value
β_2-microglobulin	12 kDa	component of MHC-I molecules; sensitive marker for **tubular damage**
lysozyme	15 kDa	antibacterial enzyme; increase in **tubular damage** or **leukocyte degradation**
retinol-binding protein (RBP)	21 kDa	transport protein for vitamin A; sensitive indicator of **early tubulopathies**
free light chains (monomer)	25 kDa	formed by plasma cells; elevated in **plasmacytoma** or **tubular reabsorption disorder**
triosephosphate isomerase	27 kDa	glycolytic enzyme; non-specific marker for **cellular damage**
free light chains (dimers)	50 kDa	common in **Bence-Jones proteinuria** (multiple myeloma)
albumin	66 kDa	may be elevated either in the **glomerulus** (increased filtration) or in the **tubules** (decreased reabsorption)

Glomerular proteins (> 70 kDa)

Only found in urine when the **glomerular filtration barrier** is **impaired**.

Protein	Molecular weight	Function/diagnostic value
transferrin	80 kDa	iron-binding transport protein; sensitive marker for **early glomerular** damage
IgG	160 kDa	immunoglobulin G; indicates **severe glomerulopathy**
IgA	165 kDa	secretory immunoglobulin; elevated in **inflammatory processes**
haptoglobin	approx. 170 kDa	acute-phase protein; elevated in post-renal conditions or urinary tract **inflammation**
IgM	800–900 kDa	very large molecule; only present if the **glomerular filtration barrier** is **severely damaged**

6 Allergy

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

6.1 Allergy Testing

Corticosteroids and other antipruritic medication should be discontinued prior to any allergy tests, including feed tests. See chapter Pre-analytics, p. 15 f.

6.1.1 Allergy testing in dogs and cats

Allergy Profiles Dog and Cat

The tests included in the profiles are listed individually after the allergy profiles in this chapter.

Food Allergen Profile (dog, cat)	
Material	S 1.5 ml
Parameter	Food Allergens Basic, Extended and Exotic

Pruritus Profile – Large (dog)	
Material	S 3.5 ml
Parameter	Seasonal and Perennial Panel, Food Allergens Basic and Extended, sarcoptes antibodies, flea saliva

Pruritus Profile – Small (dog)	
Material	S 2.5 ml
Parameter	Allergy Screening Test, sarcoptes antibodies

Pruritus Profile – Medium (dog, cat)	
Material	S 2.5 ml
Parameter	Seasonal and Perennial Panel, Food Allergens Basic and Extended

Allergy Screening Tests Dog and Cat

Allergy Screening Test (dog, cat)	
Material	S 2 ml
Method	ELISA, Fcε-receptor technology
Duration	2 working days

Note

- Cost-effective screening test to determine for which allergen group the main test should be performed or whether it is already possible to test again after cortisone administration.
- The following groups are tested: pollen (grass, herb and tree pollen), mites (house dust and storage mites), mould spores and flea saliva.
- Ideal testing time at the time of exposure (no earlier than 3–4 weeks after the onset of the signs)

All samples sent in are stored by us for 14 days. Hence, in this time frame, if there has been a positive test result, it is possible to request further tests from a sample sent in for a screening test.

Main Allergy Tests/Differentiation of Individual Allergens Dog and Cat

The main allergy tests detect individual allergens. Main allergy tests can be performed after a positive detection of the allergen group in the screening test or ordered without an allergy screening test.

Perennial **Panel (dog, cat)**

Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	2 working days

Note

- Detection of
  Mould spores: Alternaria alternata, Aspergillus fumigatus, Cladosporium herbarum, Penicillium notatum
  Mites: Dermatophagoides farinae, Dermatophagoides pteronyssinus, Acarus siro, Tyrophagus putrescentiae
- This test can also be ordered to differentiate between individual allergens if there has been a positive reaction to mites and/or mould spores in the screening test.

Seasonal **Panel (dog, cat)**

Material	S 1 ml
Method	ELISA, Fcε-receptor technology
Duration	2 working days

Note

- Detection of
  Pollen: 6-grass mix (orchard grass, perennial ryegrass, Timothy grass, meadow fescue, Kentucky bluegrass, meadow soft grass), rye, mugwort, ragweed, English plantain, nettle, common sorrel, birch, hazel, willow
- Ideal testing time at the time of exposure (no earlier than 3–4 weeks after the onset of the signs)

The Seasonal Panel for dogs and cats also includes the CHO test and, if necessary, blocking of antibodies directed against cross-reactive carbohydrate determinants (anti-CCD IgE).
- This test can also be ordered to differentiate between individual allergens if there has been a positive reaction to pollen in the screening test.

Further Main Allergy Tests Dog and Cat

Feathers/Hairs/Epithelia	
Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	1–6 working days
Note	Detection of individual **epithelial allergens**: cat, dog, rabbit, guinea pig, parrot feathers, feather mix

Flea Saliva (IgE)	
Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	2 working days
Note	A combination of flea saliva and recombinant flea saliva allergen is used as allergen.

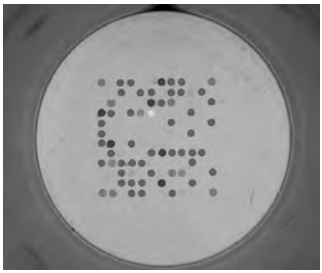
Food Allergens Basic	
Material	S 0.5 ml
Method	ELISA (microarray)
Duration	2 working days (dog), 1–6 working days (cat)
Note	▪ Determination of IgG and IgE antibodies against 19/16 individual allergens Dog: beef, pork, lamb, chicken, turkey, duck, soy, wheat, corn, rice, egg, cow milk, barley, potato, oats, whiting, salmon, rabbit, deer Cat: beef, lamb, pork, chicken, turkey, duck, potato, soy, wheat, corn, rice, egg, cow milk, salmon, tuna, whiting ▪ Basis for the specific selection of suitable dietary components for an elimination diet

Food Allergens Exotic

Material	S 0.5 ml
Method	ELISA (microarray)
Duration	1–6 working days
Note	▪ Determination of IgE and IgG antibodies in dogs and cats against 15 "exotic" individual allergens (trout, goat, camel, buffalo, quail, hermetia, sweet potato, sunchoke, buckwheat, bean, carrot, pumpkin, zucchini, pea, yeast) ▪ Basis for the specific selection of suitable dietary components for an elimination diet

Food Allergens Extended

Material	S 0.5 ml
Method	ELISA (microarray)
Duration	1–6 working days
Note	▪ Determination of IgE and IgG antibodies against 8 single allergens which are fed rather infrequently. Dog: horse, ostrich, wild boar, reindeer, amaranth, millet, kangaroo, parsnip Cat: horse, ostrich, wild boar, reindeer, amaranth, millet, venison, rabbit ▪ Basis for the specific selection of suitable dietary components for an elimination diet



Microarray technology:
A variety of allergens and reference controls are placed in a well of the plate. Each allergen has a specific position in the well and is tested in triplicate.

Hymenoptera

Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	10 working days
Note	▪ Detection of individual allergens of bee, wasp, hornet and paper wasp. ▪ This service also includes the CHO test and, if necessary, blocking of antibodies directed against cross-reactive carbohydrate determinants (anti-CCD IgE). ▪ This service may not be available in some countries.

Insect Panel (dog, cat)

Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	1–6 working days
Note	Detection of individual allergens of deerfly (Chrysops sp.), mosquito (Culex sp.), horse fly (Tabanus sp.), stable fly (Stomoxys sp.), biting midge (Culicoides sp.) and cockroach (Blatella germanica)

Malassezia

Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	1–6 working days
Note	▪ Detection of a sensitisation (IgE) to Malassezia ▪ Can be added to the ASIT.

Mediterranean Panel

Material	S 2 ml
Method	ELISA, Fcε-receptor technology
Duration	1–6 working days
Note	Detection of individual Mediterranean allergens: ▪ **Perennial allergens** (Mites: Dermatophagoides farinae, Dermatophagoides pteronyssinus, Acarus siro, Tyrophagus putrescentiae; Mould spores: Alternaria alternata, Aspergillus fumigatus, Penicillium notatum) ▪ **Seasonal allergens** (Timothy grass, perennial ryegrass, Bermuda grass, yellow dock, English plaintain, mugwort, lamb's quarter/ goosefoot, pellitory, dandelion, nettle, ragweed, olive, cypress, pine tree, plane tree, common privet, birch) ▪ Ideal testing time at the time of exposure (no earlier than 3–4 weeks after the onset of the signs) ▪ This service also includes the CHO test and, if necessary, blocking of antibodies directed against cross-reactive carbohydrate determinants (anti-CCD IgE).

PAX Complete

Material	S 0.5 ml
Method	ELISA (microarray)
Duration	1–6 working days

Note The Pet Allergy Xplorer (PAX) test analyses over 200 allergen extracts and molecular components with CCD blocking for food and environmental allergens. The test is available separately for either food or environmental allergens or as a combined service.

Allergy Test for Use at the Veterinary Practice

Intradermal Skin Test (dog)	
Material	In vivo test on the animal
Duration	Approx. 3 weeks delivery time
Note	▪ Individual allergen vials ▪ Please include a veterinary prescription with your order (PDF in "MyLab" https://app.laboklin.com/pdfForms). ▪ Delivery will be made to the veterinary in-house pharmacy.

6.1.2 Allergy testing in horses

Allergy Profiles Horse

The tests included in the profiles are listed individually after the allergy profiles (horse) in this chapter.

Allergy Profile Skin (horse)	
Material	S 3 ml
Parameter	Seasonal, Perennial, Insect, Food Panel

Allergy Profile Respiratory (horse)	
Material	S 1 ml
Parameter	Seasonal, Perennial Panel

Allergy Screening Horse

Allergy Screening Test (horse)	
Material	S 1.5 ml
Method	ELISA
Duration	2 working days
Note	▪ Cost-effective screening test to determine for which allergen group the main test should be performed or whether it is already possible to test again after cortisone administration. ▪ The following groups are tested: pollen (grass, herb and tree pollen), mites (house dust and storage mites), mould spores and insects.

- Ideal testing time at the time of exposure (no earlier than 3–4 weeks after the onset of the signs)

All samples sent in are stored by us for 14 days. Hence, in this time frame, if there has been a positive test result, it is possible to request further tests from a sample sent in for a screening test.

Main Allergy Tests/Differentiation of Individual Allergens Horse

The main allergy tests detect individual allergens. Main allergy tests can be performed after a positive detection of the allergen group in the screening test or ordered without an allergy screening test.

Perennial **Panel (Horse)**	
Material	S 0.5 ml
Method	ELISA
Duration	2 working days
Note	▪ Detection of Mould spores: Alternaria alternata, Aspergillus fumigatus, Aspergillus niger, Cladosporium sp., Epicoccum sp., Helminthosporium sativum, Penicillium sp., Fusarium spp., Ustilago sp., Rhizopus sp. Mites: Dermatophagoides farinae, Dermatophagoides pteronyssinus, Acarus siro, Tyrophagus putrescentiae, Glycophagus domesticus, Lepidoglyphus destructor ▪ This test can also be ordered to differentiate between individual allergens if there has been a positive reaction to mites and/or mould spores in the screening test.

Seasonal **Panel (horse)**	
Material	S 0.5 ml
Method	ELISA
Duration	2 working days
Note	▪ Detection of Pollen: 6-grass mix (orchard grass, perennial ryegrass, Timothy grass, meadow fescue, Kentucky bluegrass, meadow soft grass), rye, mugwort, lamb's quarters/goosefoot, English plantain, nettle, sorrel, dandelion, rape, ragweed, hazel, alder, poplar, birch, beech, willow ▪ This test can also be ordered to differentiate between individual allergens if there has been a positive reaction to pollen in the screening test.

Insect Panel (horse)	
Material	S 1 ml
Method	ELISA
Duration	3 working days
Note	Detection of individual allergens of black fly (Simulium sp.), mosquito (Culex sp.), horsefly (Tabanus sp.), housefly (Musca sp.), biting midge (Culicoides sp.)

Further Main Allergy Tests Horse

Feathers/Hairs/Epithelia	
Material	S 0.5 ml
Method	ELISA, Fcε-receptor technology
Duration	1–6 working days
Note	Detection of individual **epithelial allergens**: cat, dog, rabbit, guinea pig, parrot feathers, feather mix

Food Panel	
Material	S 1 ml
Method	ELISA
Duration	1–6 working days
Note	▪ Determination of IgE and IgG antibodies against 8 individual allergens (soy, molasses, oats, corn, barley, wheat, yeast, lucerne) ▪ Basis for the specific selection of suitable dietary components for an elimination diet

PAX Complete	
Material	S 0.5 ml
Method	ELISA (microarray)
Duration	1–6 working days
Note	▪ The Pet Allergy Xplorer (PAX) test analyses over 200 allergen extracts and molecular components with CCD blocking for food and environmental allergens. ▪ The test is available separately for either food or environmental allergens or as a combined service.

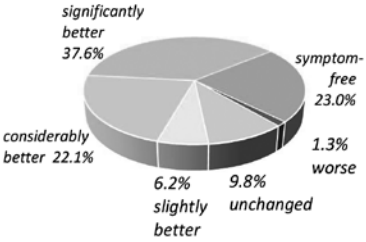
6.2 Allergen-specific Immunotherapy

Allergen-specific Immunotherapy (ASIT)

Material	Not necessary
Species	Dog, cat, horse
Duration	Approx. 3 weeks

Note

- Allergen-specific immunotherapy of different allergens after testing for individual allergens
- Please note: ASIT is not available for all testable allergens (see **prescription form**).
- Therapy has to be carried out for at least one year, if successful, it is continued for a lifetime (patient-specific solutions).
- The composition of an ASIT can also be done on the basis of any other test result (e.g. intradermal testing).
- A maximum of 8 allergens or allergen mixtures per set; if more than 8 allergens/mixtures are needed, at your request, the allergens will be spread over a double set (2 sets), for which the double price of a single set is charged.
- Please enclose a **veterinary prescription** with your order! We can send you a blank prescription form upon request, or you can find one online in the login area of the website (MyLab) or you can use the request field at the bottom of the results sheet.
- The starter set will last for approx. 37 weeks, the refill set for approx. 41 weeks.



Dog: 89% success if ASIT is started within 2 years of the onset of the disease.

Sign	Success ASIT
Pruritus	75 %
Respiratory disease	80 %
Respiratory disease within 2 years	86 %

Impressive success rates of ASIT in **horses**, especially in respiratory diseases and if therapy is started after a short duration of disease.

6.3 Digital Material on Allergies

App “4Paws”

The Laboklin app “4 Paws” for animal owners reminds users of vaccinations, drug administration and allergy treatments. The ASIT treatment plan ensures that you do not forget the scheduled injections. The app thus ensures adherence to the treatment plan and is particularly helpful in allergy treatment. Additionally, diagnoses and other important data about the animal can be saved in the app in compliance with data protection regulations. When travelling, the app reminds you of recommended preventive measures and follow-up examinations. Information on vector-borne pathogens found in the travel destination is available in the “Fact Sheets” provided in the app. The app can be installed for free from the app stores.

Download on the App Store

GET IT ON Google Play

7 Immunological Tests/Markers for Inflammation

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

AGP, α1-acid glycoprotein

Material	S 0.5 ml
Method	ELISA
Species	Cat
Duration	1–3 working days
Note	▪ AGP is an acute-phase protein in cats and shows a non-specific increase during systemic inflammatory responses. ▪ Studies have shown that significantly elevated AGP concentrations – especially if accompanied by typical clinical signs – indicate the presence of feline infectious peritonitis (FIP). ▪ When FIP has been confirmed, determining the AGP concentration can be helpful for monitoring the course of treatment, as improvements in the progression of the disease during treatment are reflected in a decrease in the AGP concentration. ▪ AGP can also be ordered directly in combination with the FIP Monitoring profile.

Acetylcholine Receptor Antibodies

Material	S 1 ml
Method	ELISA
Species	Dog, others on request
Duration	2–5 working days
Note	▪ This test is used to detect myasthenia gravis. In this disease, antibodies against acetylcholine receptors are formed. It is characterised by weakness of the striated muscles which is enhanced by stress. ▪ The weakness of the muscles may be generalised or locally limited to few muscle groups, such as those of the oesophagus (megaoesophagus).

Anti-erythrocyte Antibodies

Material	EB 1 ml
Method	Flow cytometry
Species	Horse
Duration	Reporting of results on the day the sample is received (Mon–Fri)

Note
- A positive result may indicate immune-mediated haemolytic anaemia (IMHA).
- A negative result does not rule out IMHA.

Antinuclear Antibodies (ANA)

Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, cat, horse
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	This test is used for the serological detection of autoimmune diseases (e.g. lupus erythematodes). If the test yields a negative result, a biopsy should be taken and examined, as the serological testing can be negative especially in case of local changes. Low positive titres may also occur in many general diseases.

Coombs Test (direct)

Material	EB 0.5 ml
Method	Agglutination
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note
- The test is used to detect immune-mediated haemolytic anaemia (IMHA).
- Positive reactions can also occur if there is an infection with haemotropic pathogens.
- A negative Coombs test does not rule out IMHA.
- **Horse:** If IMHA is suspected, a test for anti-erythrocyte antibodies should be performed using flow cytometry (see above).

C-reactive Protein (CRP)

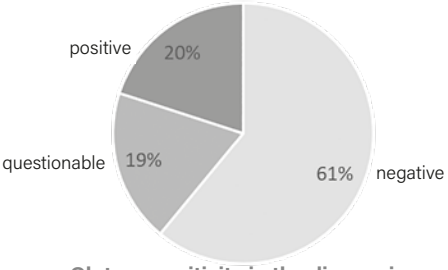
Material	S, CSF 0.5 ml
Method	Photometry
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	Inflammatory mediator (acute-phase protein) that is used to diagnose non-obvious inflammation and for therapy monitoring

Gluten Sensitivity

Material	S 0.5 ml
Method	ELISA
Species	Dog
Duration	2–3 working days

Note

- Detection of IgA against tissue transglutaminase and IgG against modified gliadin peptides
- Gluten and its subfraction gliadin are found in wheat, spelt, rye and barley.
- Gluten intolerance leads to different clinical pictures depending on the breed: gluten-sensitive enteropathy in the Irish Setter and canine epileptoid cramping syndrome (CECS, Spike's disease, paroxysmal gluten-sensitive dyskinesia).
  Mixed forms with concurrent enteral and neurological signs have been described in the literature.
  In one study, Laboklin was able to prove a clear or questionable gluten sensitivity in 39% of the dogs (see figure). The affected breeds were mainly mongrels, French Bulldogs, German Shepherds and Labrador Retrievers.



Gluten sensitivity in the diagnosis of food allergies

Haptoglobin	
Material	S 0.5 ml
Method	Photometry
Species	Dog, cat, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	Haptoglobin is an acute-phase protein. Its concentration increases due to inflammation. Haptoglobin is much more sensitive than fibrinogen.

Cellular **Immune Status**	
Material	EB, HB 3 ml + blood smear (for the maximum **age of the sample** – country-specific! – see **submission form**)
Method	Flow cytometry
Species	Dog, cat, horse
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ The cellular immune status includes a complete blood count and the determination of B-cells (CD 21+), T-cells (CD3+, CD5+), T-helper cells (CD4+) and cytotoxic T-cells (CD8+) as well as the CD4/CD8 ratio. ▪ In **dogs,** determination of the immune status is useful for monitoring leishmaniasis. Furthermore, the immune status can be helpful for monitoring pyoderma (German Shepherd), demodicosis and systemic lupus erythematodes as well as T-cell deficiency. ▪ In **cats,** the cellular immune status is used to determine the current phase of the disease in FIV-positive animals. The test is also used in FIV-positive cats with stomatitis.

- In **horses,** it is used to diagnose immunodeficiency in cases of frequent and prolonged infections.

Immunoglobulin A (IgA)

Material	S, CSF 0.5 ml
Method	ELISA
Species	Dog
Duration	2–3 working days
Note	▪ IgA is a mucosal antibody and plays a central role in the local immune defence of the respiratory system, the digestive and urogenital tracts. It is produced as secretory IgA by plasma cells in mucosal epithelium. ▪ Steroid-responsive meningitis-arteritis (SRMA) is an autoimmune inflammation of the meningeal vessels, characterised by an increase in IgA in serum and cerebrospinal fluid. Elevated IgA in cerebrospinal fluid is a highly sensitive and specific marker for SRMA. Serum IgA may also be elevated, but is less specific. ▪ Decreased IgA concentrations occur in congenital or acquired immunodeficiency (e.g. in Shar Pei or Beagles) and result in increased susceptibility to recurrent mucosal infections.

Immunoglobulin G (IgG)

Material	S 0.5 ml
Method	Capillary electrophoresis
Species	Dog, cat, horse, foal, cattle, calf, sheep, lamb, goat, goat kid, South American camelids, cria, pig, piglet
Duration	Reporting of results on the day the sample is received (Mon–Fri or, for newborns, Mon–Sat)
Note	▪ IgG is the strongest immunoglobulin fraction in blood serum. The main significance of IgG lies in the antibody-mediating (humoral) immune response. Due to its small size, IgG can diffuse from the capillaries and, thus, has an additional relevance in immune reactions in tissue spaces and on the body surface. ▪ **Newborns:** At birth, foals, calves, lambs, kids, crias and piglets have only marginal IgG concentrations in the blood. They take up IgG via the colostrum. IgG concentration is the indicator of a sufficient supply of colostrum. ▪ **Foals:** The lack of maternal antibodies is one of the most important predisposing factors for infectious diseases in foals. Compared to semi-quantitative enzyme immunoassays, determining the IgG concentration in the blood of newborn foals using capillary electrophoresis allows for precise quantification. It is thus possible to diagnose colostrum deficiency early on, before

infections occur, and to initiate therapeutic measures such as plasma transfusions in a timely manner.
- IgG for newborns and for adults can be requested via separate service IDs.

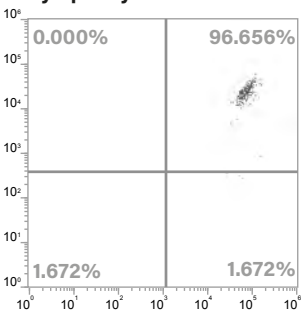
Immunoglobulin M (IgM)

Material	S 0.5 ml
Method	Photometry
Species	Dog, cat, pig, others on request
Duration	2 working days
Note	Most notably, the importance of IgM lies in the mediation of the primary immune response. IgM is also involved in the secondary immune response but its significance is lower. The secondary immune response is mainly mediated by IgG.

Insulin Antibodies ➢ **see Chapter 8, p. 107**

Leukaemia Immunophenotyping

Material	Lymph node aspirate (in an NaCl/serum mix, should be sent in a mix ratio of 50:50), peripheral blood (EB, HB 2 ml; for the maximum **age of the sample** – country-specific! – see **submission form**) + cytology/blood smear
Method	Flow cytometry
Species	Dog, cat, horse
Duration	1–2 working days
Note	▪ It is recommended to send in more sample material if possible. Up to 5 ml of sample volume are required if the total leukocyte count is low. ▪ With > 30.000 lymphocytes or positive clonality in the PARR test (see Chapter 19.4, p. 329), leukaemia immunophenotyping may allow to differentiate between lymphoproliferative neoplasia (lymphoma or leukaemia; B- and T-cell) and myeloid leukaemia. In dogs, it can additionally be differentiated between acute and chronic forms. This differentiation provides an indication of prognosis and treatment. Leukaemia immunophenotyping is also part of the Leukaemia/Lymphoma Profile.



Scatterplot of lymphocyte immunophenotyping
The lymphocyte population in this example is positive for the pan-leukocyte marker (CD45) and the B-cell marker (CD21). Here, it is a B-cell lymphoma.

Leukaemia/Lymphoma Profile

Material	**In blood/aspirate:** Lymph node aspirate (in an NaCl/serum mix, should be sent in a mix ratio of 50:50), peripheral blood (EB, HB 2 ml; for the maximum **age of the sample** – country-specific! – see **submission form**) + blood smear **in bone marrow:** bone marrow, bone marrow smears or bone marrow aspirate + peripheral blood (EB, HB 2 ml; for the maximum **age of the sample** – country-specific! – see **submission form**) + blood smear
Species	Dog, cat, horse
Parameter	Complete blood count (if peripheral blood is supplied), cytology/cytological blood smear, leukaemia immunophenotyping (by flow cytometry; lymphoid cells), progenitor cells (depending on species), lymphocyte clonality (by PARR)
Duration	2–5 working days
Note	▪ It is recommended to send in more blood, if possible, as immunophenotyping requires up to 5 ml of sample volume if the total leukocyte count is low. ▪ For a complete evaluation in case of suspected leukaemia, the leukaemia profile is always recommended and should be interpreted in correlation with the clinical picture and history. ▪ For sample collection for bone marrow cytology, see Pre-analytics (Chapter 1.1.4, p. 20). ▪ See also Leukaemia Immunophenotyping ▪ See also Lymphocytes Clonality (Chapter 19.4, p. 329)

Muscle Fibre Type 2M Antibodies (Masticatory Muscle Myositis)

Material	S 1 ml
Method	ELISA
Species	Dog
Duration	Approx. 3 weeks
Note	▪ Autoantibodies are detected against type 2M muscle fibres in the masticatory muscles, which occur primarily in the masseter and temporalis muscles (as well as in the pterygoid muscle). ▪ Clinically, affected animals usually show symmetrical atrophy of these muscle groups, sometimes with trismus and pain.

Rheumatoid Factor (Waaler-Rose Test)

Material	S 0.2 ml
Method	Haemagglutination
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)

Note
- **Dog:** The rheumatoid factor (RF) may be positive in some dogs with immune-mediated polyarthritis, rheumatoid arthritis, infectious, inflammatory and neoplastic diseases, as well as in healthy animals. The result must be interpreted together with the clinical picture, synovial fluid and inflammation parameters.
- **Cat:** RF is of only minor clinical relevance; RF can occur non-specifically in chronic infections (e.g. FIV, FeLV).

Serum Amyloid A (SAA)

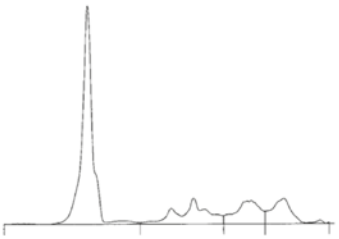
Material: S 0.5 ml
Method: Photometry
Species: Dog, cat, rabbit, horse, cattle, others on request
Duration: Reporting of results on the day the sample is received (Mon–Sat)

Note
- Non-specific inflammatory marker (acute-phase protein).
- An increase may indicate an inflammatory process, neoplasia or tissue damage. This parameter is particularly suitable for therapy monitoring.
- For equids, cattle, dogs and cats, SAA can also be requested in combination with the large screening.

Serum Protein Electrophoresis

Material: S, HP 0.5 ml
Method: Capillary electrophoresis
Species: Dog, cat, rabbit, guinea pig, ferret, birds, reptiles, horse, cattle, others on request
Duration: Reporting of results on the day the sample is received (Mon–Fri)

Note
- Includes the separation of the protein fractions albumin, α-, β-, γ-globulins and the albumin-globulin ratio. The protein fractions are also represented in form of a graph (see **figures**).
- Acute inflammation leads to an increase in the α- and/or β-globulin fraction. Polyclonal hypergammaglobulinaemia is caused by infectious, immune-mediated or neoplastic diseases. Especially in case of feline infectious peritonitis (FIP), the test is used to support the clinical suspicion. Monoclonal gammopathies are found both in plasmacytoma and in the progression of certain infectious diseases, including leishmaniasis, anaplasmosis and ehrlichiosis.
- Albumin, α- and β-globulin fractions are lowered in case of severe liver diseases.
- When using plasma, an additional small peak in the β-globulin fraction is possible due to coagulation factors.



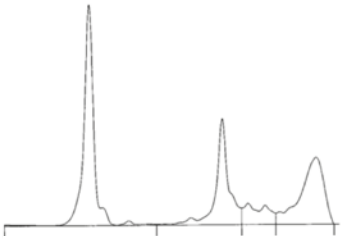
Capillary electrophoresis

Fraction	%	g/l
Albumin	56.7	37.54
Alpha	17.2	11.39
Beta	13.8	9.14
Gamma	12.3	8.14

Dog:	
Alb:	47-59%
α glob:	9-15%
β glob:	14-24%
γ glob:	8-18%

Alb/glob = 1.31
Total protein: 66.2 g/l

normal electrophoresis



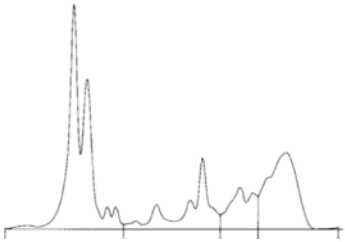
Capillary electrophoresis

Fraction	%	g/l
Albumin	40.2	42.57
Alpha	23.9	25.31
Beta	8.3	8.79
Gamma	27.6	29.23

Cat:	
Alb:	45-60%
α glob:	8-15%
β glob:	10-20%
γ glob:	10-28%

Alb/glob = 0.67
Total protein: 105.9 g/l

pronounced α2 peak, polyclonal γ peak
suspicion: acute infectious process



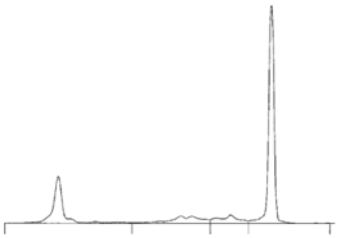
Capillary electrophoresis

Fraction	%	g/l
Albumin	45.4	31.05
Alpha	16.9	11.56
Beta	11.4	7.80
Gamma	26.3	17.99

Horse:	
Alb:	45-60%
α glob:	10-20%
β glob:	10-25%
γ glob:	8-22%

Alb/glob = 0.83
Total protein: 68.4 g/l

split albumin peak
frequently found in ponies in case of lipoproteinaemia



Capillary electrophoresis

Fraction	%	g/l
Albumin	22.1	28.20
Alpha	10.6	13.53
Beta	7.5	9.57
Gamma	59.8	76.30

Cat:	
Alb:	45-60%
α glob:	8-15%
β glob:	10-20%
γ glob:	10-28%

Alb/glob = 0.28
Total protein: 127.6 g/l

monoclonal gammopathy
in leukaemoid disease

Serum protein electrophoresis – examples for normal results, lipoproteinaemia, suspected acute infection and leukaemoid disease

Thrombocyte Antibodies (Platelet Antibodies)

Material	EB, HB 0.5 ml (For the maximum **age of the sample** – country-specific! – see **submission form**)
Method	Flow cytometry
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ If possible, it is recommended to send at least 1 ml EB as the required sample amount depends on the total platelet count. ▪ There are two possible ways for the development of thrombocyte antibodies: – Autoantibodies against platelets are formed. Only in this case, a positive test result can be expected. – Platelet damage due to immune complex diseases can secondarily also lead to the formation of antibodies against platelets. ▪ Evaluation: ≤ 10% negative, > 10% positive ▪ Detection of platelet antibodies is also part of the Thrombocytopenia Profile

Thyroglobulin Antibodies ➢ see Chapter 8, p. 117

8 Endocrinology/Tumour Markers

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

ACTH (Adrenocorticotropic Hormone), endogenous	
Material	EP 0.5 ml (**dog:** centrifuged immediately, pipetted off; frozen until arrival at the laboratory) (**horse:** centrifuged promptly, pipetted off; cooled until arrival at the laboratory)
Method	CLIA
Species	Dog, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Especially in **dogs**, endogenous ACTH is unstable in sample material – preanalytical requirements must be observed. ▪ **Horse:** Diagnosis of PPID (Cushing's syndrome) and therapy monitoring of dopamine receptor agonists ▪ Indications in **dogs**: for further differentiation in Cushing's syndrome or hypoadrenocorticism (Addison's disease)

AFP ➢ see Tumour Marker AFP, p. 118

Aldosterone	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	LCMS
Species	Dog, cat, others on request
Duration	2–6 working days
Note	▪ For the diagnosis of primary hyperaldosteronism ▪ Typical findings in hyperaldosteronism are hypokalaemia, hypernatraemia and systemic hypertension; see also RAAS Status (Chapter 9, p. 131).

Androstenedione	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; cooled until arrival at the laboratory)
Method	LCMS
Species	Dog, ferret, others on request
Duration	2–6 working days

Note	Used for diagnosing suspected sex steroid-producing disorders of the adrenal cortex and is part of the Adrenal Profile.

Anti-Müllerian Hormone (AMH)

Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; cooled until arrival at the laboratory)
Method	CLIA
Species	Dog, cat, rabbit, horse, male donkey, cattle, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ AMH is secreted in the granulosa cells of the maturing follicle and the Sertoli cells in the testes. ▪ It can be used to distinguish between castrated and intact animals. AMH concentrations in the questionable range may occur, for example, if residual ovarian tissue is present. ▪ Possible causes of high AMH concentrations are (depending on gender): sexual malformation with the formation of granulosa cell tumours (GCTs), testicular tissue, cryptorchid testicular tissue, Sertoli cell tumours, testicular atrophy. After deslorelin implantation, significantly elevated AMH concentrations (> detection limit) are measured in **male dogs** within 30 days. ▪ **Horse:** In addition to progesterone and testosterone, AMH is included in the Granulosa Cell Tumour Profile, which is useful in the diagnosis of hormonal disorders or hormone-producing ovarian tumours (granulosa-theca cell tumours) associated with behavioural changes and poor rideability in mares.

pro-**BNP (B-Type Natriuretic Peptide)**

Material	EP 0.5 ml (immediately centrifuged, pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	ELISA
Species	Dog, cat
Test frequency	2 x per week
Note	▪ BNP is a hormone produced by the cardiomyocytes of the ventricles and released into the blood when the myocardium is subjected to volume and pressure overload. It has a hormonal effect on circulation and fluid balance. It increases the renal excretion of sodium and water, lowers the intracardiac pressure and has vasodilatory effects. ▪ BNP concentration is primarily determined for the early diagnosis of dilated cardiomyopathy and is suitable as a screening test for elder patients or predisposed breeds (e.g. Doberman).

CEA ➢ see Tumour Marker CEA, p. 119

Cortisol	
Material	S, EP 0.5 ml (horse: serum only)
Method	CLIA
Species	Dog, cat, guinea pig, rat, mouse, ferret, horse, ruminants, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ As a single parameter: screening for hypoadrenocorticism (Addison's disease) (the diagnosis must be confirmed by a subsequent ACTH stimulation test) and for monitoring the medical treatment of Cushing's syndrome (see Trilostane Therapy Control, p. 118) ▪ As a functional test depending on the diagnostic task: ACTH Stimulation Test (see Chapter 9, p. 121), Dexamethasone Suppression Test (see Chapter 9, p. 126)

Saliva **Cortisol**	
Material	Saliva 0.1 ml
Method	ELISA
Species	Guinea pig, others on request
Duration	3–5 working days
Note	▪ Test vessels (Salivette®) will be provided. ▪ **Guinea pig:** Measurement also possible as part of a Saliva Cortisol Stimulation Test or a Saliva Cortisol Suppression Test (see chapter 9, p. 132 f.) for the diagnosis/therapy monitoring of Cushing's syndrome.

CPSE (Canine Prostate-Specific Arginine Esterase)	
Material	S, EP, HP 0.5 ml (centrifuged immediately (plasma) or centrifuged and separated shortly after coagulation (serum); please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)
Method	ELISA
Species	Dog, male
Duration	1–5 working days
Note	▪ CPSE is a prostate-specific enzyme and is considered a marker for prostate function in dogs. It is produced by epithelial cells in the prostate and enters the bloodstream in increased concentrations when there is increased secretory activity or tissue changes. ▪ Note: Neither a rectal examination nor ejaculation should take place within 24 hours prior to sample collection, as this will lead to falsely elevated measurement results.

- If these requirements are met, elevated concentrations indicate pathological changes in the prostate. In most cases, there is benign prostatic hyperplasia. However, further diagnostic tests (ultrasound, cytology, testing for BRAF mutation or prostate biopsy) are recommended to distinguish it from prostatitis or prostate neoplasia.

Erythropoietin	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; frozen until arrival at the laboratory)
Method	ELISA
Species	Dog
Duration	2–6 working days
Note	▪ Erythropoietin is unstable – preanalytical requirements must be observed. ▪ Used for further clarification of non-regenerative anaemia or polycythaemia. The interpretation of erythropoietin concentration should always be carried out together with the erythrocyte parameters.

fT3 and fT4 ➢ **see, p. 112 and p. 116 respectively**

IGF-1 (Insulin-like Growth Factor 1)	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; cooled until arrival at the laboratory)
Method	CLIA
Species	Dog, cat, others on request
Duration	1–3 working days
Note	▪ **Cat:** IGF-1 can be used for the diagnosis of suspected hypersomatotropism (acromegaly), especially if diabetes mellitus is difficult to control. Insulin deficiency can lead to a drop in IGF-1 concentration in the blood. In diabetics, IGF-1 should therefore be measured at the earliest 4–6 weeks after starting insulin treatment. ▪ **Dog:** Pituitary dwarfism – among other things, the diagnosis is based on low IGF-1 concentrations. For genetic testing on pituitary dwarfism, see Chapter 21.2.1, p. 392.

Insulin	
Material	S 1 ml (a 12-hour **fasting period** is recommended for omnivores and carnivores; only feed hay and straw to horses and donkeys) (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)

Method	CLIA, ELISA (cat only)
Species	Dog, cat, horse, donkey, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat) Cat: 2–6 working days
Note	▪ The findings must be interpreted together with the blood glucose concentration from blood taken at the same time. ▪ Insulinoma **dog:** Blood must be taken at the time of documented hypoglycaemia (glucose < 3.3 mmol/l or 60 mg/dl). If hypoglycaemia is present, no insulin should be detectable. At this point, concentrations in the upper reference range are already considered to be inadequately elevated. Insulin concentrations in the lower reference range or below do not necessarily rule out insulinoma. If in doubt, the test should be repeated. ▪ **Horse, donkey:** Equine metabolic syndrome (EMS)/asinine metabolic syndrome (AMS): EMS/AMS leads to a disorder of carbohydrate and fat metabolism with insulin dysregulation (ID). Increased insulin secretion (partly) compensates for decreased insulin efficiency. Insulin-dysregulated horses/donkeys therefore have significantly elevated insulin concentrations. At the same time, fasting glucose is physiological (compensated) or elevated (not compensated). Further test: Oral Glucose Test with Insulin Determination (see Chapter 9, p. 127) and oral Karo Light Syrup® Test (see Chapter 9, p. 130). ▪ **Horse, donkey:** Simultaneous measurement of the glucose concentration makes it possible to calculate the proxies - insulin/glucose ratio - reciprocal inverse square of insulin (RISQI) – "insulin sensitivity" - modified insulin-to-glucose ratio (MIRG) – "β-cell function (pancreas)"

Insulin Antibodies

Material	S 0.5 ml (cooled until arrival at the laboratory)
Method	ELISA
Species	Dog, cat
Duration	10–15 working days
Note	This service may not be available in some countries.

Normetanephrine/Metanephrine

Material	EP 1 ml (centrifuged immediately, pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	LCMS
Species	Dog, others on request

Duration	2–6 working days
Note	Testing for suspected pheochromocytoma. If the results are up to four times the upper reference range, overlaps with other diseases (especially Cushing's syndrome) and stress-induced catecholamine release are possible. Concentrations within the reference range do not necessarily rule out pheochromocytoma. Normetanephrine is considered the more sensitive parameter in dogs, as it can be used to distinguish more reliably between pheochromocytoma and other diseases. Medications such as phenoxybenzamine, metoclopramide, β-blockers, calcium channel blockers or sympathomimetics can increase catecholamine concentrations.

(Urinary) **Normetanephrine/Metanephrine-Creatinine Ratio**

Material	Urine 5 ml
Method	LCMS
Species	Dog, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	The determination in urine is not as affected by acute stress episodes than the determination in blood. Additionally, fluctuations are reduced by episodic release of hormones. The reference values provided are based on sample collection in a stress-free environment at home. For information on how to interpret the results, see normetanephrine/metanephrine.

Oestradiol-17β

Material	S 0.5 ml
Method	CLIA
Species	Dog, cat, rabbit, guinea pig, ferret, horse, cattle, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Testing for oestradiol-17β is done in case of disorders of the sexual cycle (repeated determination), neoplasia of the ovaries, ovary cysts and suspected Sertoli cell tumour. ▪ **Dog, ferret:** Diagnostic testing for suspected hyperoestrogenism and sex hormone-producing disorders of the adrenal cortex. Included in the Adrenal Profile. ▪ **Guinea pig: Not** suitable for diagnosing ovarian cysts. ▪ **Horse:** Produced cyclically in the ovarian follicles ("oestrus hormone"); during gestation, there is massive oestrogen biosynthesis in the foetal-maternal unit. Oestrone sulphate is validated for hormonal pregnancy diagnosis.

Oestrone Sulphate (= E1S)

Material	S 1 ml, urine 1 ml (only horse, donkey)
Method	LCMS
Species	Horse, donkey, llama, alpaca, others on request
Duration	2–4 working days
Note	▪ **Mare:** To determine an intact pregnancy Oestrone sulphate is secreted in increasing concentrations from approx. the 40th day onwards. After abortion or resorption, the oestrone sulphate level drops to baseline level within a few days. Reliable diagnosis is possible from day 110 onwards until approx. 1 week before foaling. ▪ **Llama/alpaca:** Diagnosis of late pregnancy (from 10th/11th month onwards). In the earlier stages of pregnancy, we recommend to determine progesterone.

PAG (Pregnancy-Associated Glycoproteins)

Material	S, HP 1 ml
Method	ELISA
Species	Cattle, sheep, goat
Duration	2–3 working days
Note	Can be used to determine pregnancy in cattle and goats from the 28th day and in sheep from the 35th day after conception.

Parathormone (PTH)

Material	S, EP 1 ml (centrifuged and separated shortly after coagulation (serum) or centrifuged immediately after sampling (EP), pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	CLIA
Species	Dog, cat, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Diagnosis of hypercalcaemia or hypocalcaemia to clarify primary hyperparathyroidism or hypoparathyroidism ▪ The concentration should be assessed together with Ca and/or ionised Ca (+ phosphate, if applicable). For **dogs** and **cats**, these and other relevant parameters can be requested via the Hypercalcaemia Profile – for further information, see the Laboklin website. ▪ Hyperparathyroidism: In case of concurrent hypercalcaemia, PTH concentrations within the reference range are already considered inadequately elevated. Secondary renal hyperparathyroidism should be ruled out. ▪ Hypoparathyroidism: Characterised by low PTH concentrations with concurrent hypocalcaemia.

PTHrp (Parathormone-related Protein)

Material	EP 1 ml (centrifuged immediately, pipetted off; cooled until arrival at the laboratory)
Method	IRMA
Species	Dog, cat
Duration	5–8 working days
Note	▪ PTHrp is unstable in sample material – preanalytical requirements must be observed. ▪ PTHrp is a hormone-like peptide that is structurally similar to parathormone (PTH) and has calcium-regulating effects. Physiologically, it is involved in growth and foetal development; pathologically, it is particularly relevant as a tumour marker in paraneoplastic hypercalcaemia. ▪ It is used to test for PTHrp-secreting tumours (especially lymphoma and anal sac gland carcinoma) as part of the diagnostic workup of hypercalcaemia.

PMSG = eCG (Pregnant Mare Serum Gonadotropin resp. Equine Chorionic Gonadotropin)

Material	S, HP 0.5 ml
Method	ELISA
Species	Horse, donkey
Duration	Horse 1–3 working days or donkey 5–8 working days
Note	▪ Determination of pregnancy between day 45 and 100. ▪ PMSG can be detected for a while after resorption or abortion, although there is no live foetus anymore. ▪ An intact pregnancy should therefore be confirmed after the 110th day by means of an oestrone sulphate test. ▪ This service may not be available in some countries for donkeys.

Progesterone

Material	S 0.5 ml
Method	CLIA
Species	Dog, cat, rabbit, guinea pig, ferret, horse, donkey, cattle, camelids, sheep, goat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Measurement is performed to monitor luteal function. ▪ **Female dog:** determination of the ovulation time, determination of the optimum time for mating, diagnosis of corpus luteum insufficiency (serial measurements) ▪ **Dog, ferret:** For the diagnosis of sex steroid-producing disorders of the adrenal cortex, see 17 OH-progesterone below.

- **Rabbit:** To diagnose ovarian (residual) tissue, an HCG stimulation test should be performed with two progesterone measurements taken 5–7 days apart. Single determinations are only diagnostically conclusive if positive.
- **Llama, alpaca:** Diagnosis of pregnancy from the 21st day of gestation onwards. In late pregnancy (10th/11th month), the determination of oestrone sulphate is also possible.
- Can be used during early pregnancy to confirm conception in **cattle, horse, sheep** and **goat**. However, as there are also increases in progesterone levels in the regular cycle, this difference is only diagnostically useful during the cycle-dependent decrease in progesterone. In horses and cattle, only samples which were taken between the 18th and the 20th day after ovulation are useful and only prove that the animals are not in heat again at the expected time. Progesterone is not specific to pregnancy. The test cannot differentiate as to whether the corpus luteum has formed during the cycle or as a result of gestation.
- **Horse, donkey:** Pregnancy-specific hormones can be determined between the 45th and 100th day (PMSG – see above) and from the 110th day onwards until approx. 1 week before foaling (oestrone sulphate – see p. 109).

17 OH-Progesterone

Material	S 0.5 ml
Method	LCMS
Species	Dog, ferret, others on request
Duration	2–6 working days
Note	▪ Testing for Cushing's syndrome ▪ **Dog:** Especially used to test for subclinical (previously atypical) Cushing's syndrome; high diagnostic sensitivity with relatively low specificity. 17 OH-progesterone is part of the extended ACTH Stimulation Test (see Chapter 9, p. 122). ▪ **Dog, ferret:** diagnosis of sex steroid-producing diseases of the adrenal cortex; part of the Adrenal Profile ▪ Gender-specific differences must be taken into account when interpreting the results.

Serotonin

Material	S 0.5 ml (at least 6 hours of **fasting** before sample collection) (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	HPLC
Species	Dog, others on request
Duration	2–6 working days
Note	▪ The test will not be performed if the required temperature conditions are not met when the samples arrive at the laboratory. Even for short transport distances, shipping in a styrofoam box with 2–3 frozen cold packs is recommended. ▪ For the clarification of behavioural disorders. Decreased serotonin concentrations have been found in case of aggression as well as in separation anxiety and other behavioural problems. ▪ The additional determination of serotonin can be helpful in diagnosis and therapy monitoring. ▪ The determination of serotonin levels is also part of the Behaviour Profile 2 (dog).

T3 (Total Triiodothyronine)

Material	S 0.5 ml
Method	CLIA
Species	Dog, cat, horse, cattle, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ T3 is the biologically active thyroid hormone and is mainly produced by peripheral deiodination of thyroxine (T4). It regulates energy and oxygen consumption, carbohydrate, fat and protein metabolism as well as growth and thermoregulation. ▪ **Dog, cat:** T3 can be determined by LCMS measurement without interference from metabolites or antibodies. This analysis can be requested via the Thyroid Mass Spectrometry profile.

f**T3 (Free Triiodothyronine)**

Material	S 0.5 ml
Method	CLIA
Species	Dog, cat, horse, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)

r**T3 (reverse T3)**

Material	S 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	2–4 working days

Note

- rT3 is an inactive metabolite of thyroxine (T4). If sufficient or large amounts of T4 are present, more rT3 is produced, while the rT3 concentration decreases when little T4 is available.

Dog:

- This parameter is primarily used to help differentiate between non-thyroidal illness syndrome (NTI, formerly known as euthyroid sick syndrome) and hypothyroidism.
- It is expected that rT3 is reduced in hypothyroidism, whereas it is not reduced in NTI (see diagnostic flow chart for hypothyroidism p. 115).

Cat:

- rT3 is significantly elevated in cats with hyperthyroidism.
- In cases of suspected hyperthyroidism where T4 is not or only marginally elevated, rT3 can provide additional information. In hyperthyroidism, it is usually significantly increased.

T3/T4 Antibodies

Material	S 0.5 ml
Method	ELISA
Species	Dog
Duration	2–3 working days

Note

- Autoantibodies against the thyroid hormones triiodothyronine (T3) and thyroxine (T4) can lead to falsely elevated or reduced concentrations when determining total T3 and total T4.
- If such antibodies are present, it can complicate the interpretation of thyroid function tests and lead to false diagnoses (e.g. alleged hypo- or hyperthyroidism).
- The detection of T3 and T4 antibodies can be done if the laboratory findings show a discrepancy (e.g. elevated total T4 with clinically suspected hypothyroidism), if there are noticeable differences in the course of hormone diagnosis or if autoimmune thyroiditis is suspected.
- For predisposed breeds, the test is also useful as part of the breeding approval process.
- If antibodies are detected, measuring T4/T3 using LCMS provides more reliable results in these cases.

T4 (Total Thyroxine)

Material	S, HP 0.5 ml or 0.4 ml in small mammals; S, HP 0.2 ml in birds and reptiles
Method	CLIA LCMS (birds, reptiles, or for dogs and cats, in the thyroid mass spectrometry profile)
Species	Dog, cat, guinea pig, birds, reptiles, horse, cattle, South American camelids, others on request
Duration	CLIA: reporting of results on the day the sample is received (Mon–Sat); LCMS: 2–4 working days
Note	▪ **Dog:** Most commonly used to diagnose hypothyroidism. Cave: A low T4 concentration is not necessarily associated with hypothyroidism. The assessment should be made together with TSH. rT3 can provide further information to help distinguish between non-thyroid causes of reduced T4 concentration. If the findings are inconclusive, a TRH Stimulation Test (see Chapter 9, p. 133) can be performed. ▪ **Therapy monitoring for hypothyroidism in dogs:** 4–6 hours after administration of thyroxine; therapy monitoring every 2–4 weeks until clinical stabilisation is achieved, then every 3–6 months. Target: middle to upper reference range. ▪ **Cat:** Most commonly used to diagnose hyperthyroidism. Elevated serum T4 concentrations indicate hyperthyroidism. T4 in the (upper) reference range does not necessarily rule out hyperthyroidism. If in doubt, a combination of determining T4, fT4 and TSH and repeat measurements can help. ▪ **Therapy monitoring for hyperthyroidism in cats:** Therapy monitoring every 2–4 weeks until good control is achieved, then every 3–6 months. Target: medium reference range. T4 concentrations that are too low should be avoided. ▪ **Dog, cat:** T4 can be determined by LCMS measurement without interference from metabolites or antibodies. This analysis can be requested via the Thyroid Mass Spectrometry profile. ▪ **Small mammals:** T4 is suitable for diagnosing hyperthyroidism. Hypothyroidism has not yet been described in small mammals. ▪ **Birds and reptiles:** Often, physiological concentrations are very low, so determination is done using LCMS with a lower detection limit of 0.02 µg/dL. ▪ **Horse:** For very rare cases of hypothyroidism, determination of T4 and T3 followed by a TRH Stimulation Test is recommended (see Chapter 9, p. 134).

Hypothyroidism in Dogs

Signs
Changes in coat condition?
Reduced mobility?
Decreased performance?
Weight gain?

+

Changes in Laboratory Parameters
Mild anaemia?
Increased triglycerides?
Increased cholesterol?

Clinical suspicion: hypothyroidism

Further Tests: Total T4 and TSH

T4 unremarkable
TSH unremarkable
→ Hypothyroidism unlikely

T4 ↓
TSH ↑
→ Hypothyroidism likely

T4 ↓
TSH unremarkable
→ Hypothyroidism or **non-thyroidal illness?**

Factors Influencing T4 Concentration:

- Breed (e.g. Greyhounds typically have lower concentrations)
- Medication (e.g. phenobarbital, sulfonamides, glucocorticoids)
- Other diseases (e.g. non-thyroidal illness [NTI])

Measurement of rT3 (Reverse T3)
rT3 is the inactive form of T3. Its measurement can assist in differentiating between NTI and true hypothyroidism.

rT3 ↓ → Hypothyroidism likely

rT3 unremarkable → Hypothyroidism unlikely

Diagnostic flow chart for hypothyroidism in dogs

f**T4 (free Thyroxine)**	
Material	S (possibly HP) 0.5 ml or 0.4 ml in small mammals
Method	CLIA
Species	Dog, cat, guinea pig, horse, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Just like T4, fT4 is affected by underlying diseases. ▪ Further diagnostic tests are recommended if fT4 concentrations are low: determination of TSH concentration, rT3 measurements, TRH Stimulation Test (see Chapter 9, p. 133).

f**T4 Dialysis**	
Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; frozen until arrival at the laboratory)
Method	Equilibrium dialysis
Species	Dog, cat
Duration	8–10 working days
Note	This service may not be available in some countries for donkeys.

Testosterone	
Material	S 0.5 ml
Method	CLIA Horse/donkey/small mammals: LCMS
Species	Dog, cat, rabbit, guinea pig, ferret, horse, donkey, cattle, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat) or 2–3 working days (horse, donkey, small mammals)
Note	▪ Used for checking endocrine testicular function, ovarian tumours in mares (diagnosis via Granulosa Cell Tumour Profile (testosterone, AMH, progesterone) recommended), differentiation between cryptorchid and castrated male animals. ▪ **Stallion:** Testosterone should be assessed for cryptorchidism as part of an HCG Stimulation Test (see Chapter 9, p. 129). ▪ **Small mammals:** To diagnose testosterone-producing tissue, an HCG Stimulation Test (see Chapter 9, p. 128) should be performed with testosterone determined twice at an interval of one hour. Single determinations are only diagnostically meaningful if positive.

Thymidine Kinase (TK-1)

Material	S 0.5 ml (centrifuged and separated shortly after coagulation, pipetted off; cooled until arrival at the laboratory) **Horse:** S, puncture fluid (chest or abdominal cavity fluid) 0.5 ml (cooled until arrival at the laboratory)
Method	CLIA
Species	Dog, cat, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Thymidine kinase (TK-1) is the enzyme which helps introduce the nucleoside thymidine into the DNA by converting deoxythymidine to deoxythymidine phosphate (dTMP). It is thus essential for DNA synthesis. ▪ The activity of serum thymidine kinase 1 (sTK-1) correlates closely with DNA synthesis and cell proliferation. The main indications for the determination of thymidine kinase in malignant haematopoietic neoplasms are therapy monitoring and early detection of relapse. ▪ Thymidine kinase is mainly excreted renally. Therefore, if the concentration is increased, it is necessary to exclude impaired renal function in differential diagnosis. ▪ Patients with hepatic cirrhosis may also show elevated concentrations. ▪ Growing patients physiologically have higher concentrations. ▪ Thymidine kinase is also included in the profiles Tumour Diagnostics Small (dog, cat, horse) and Tumour Diagnostics Large (dog). ▪ **Horse:** Determination of thymidine kinase in puncture fluid is requested as a separate service.

Thyroglobulin Antibodies (TgAb)

Material	S 0.5 ml
Method	ELISA
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ The presence of thyroglobulin autoantibodies indicate autoimmune thyroiditis and are associated with an increased risk of developing hypothyroidism. ▪ They can provide information on reproductive fitness in predisposed breeds. Breed predisposition: Doberman, Golden Retriever, Beagle, Cocker Spaniel, Rhodesian Ridgeback, Irish Setter, Akita, Boxer, and others. ▪ The detection of TGAA is not equivalent to clinically manifest hypothyroidism. Hypothyroidism can also occur without TgAb being present.

Thyroid-stimulating Hormone (TSH)

Material	S 0.5 ml
Method	CLIA
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ **Dog:** for the diagnosis of hypothyroidism in combination with T4 or fT4 ▪ Determination of TSH can be used for therapy monitoring if TSH was initially elevated at the time of diagnosis. ▪ **Cat:** For therapy monitoring: Rising TSH concentrations indicate the development of iatrogenic hypothyroidism.

Trilostane Therapy Control (Vetoryl®)

Material	S 0.5 ml
Method	CLIA
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Parameter	1 x cortisol (before the administration of trilostane) 2 x cortisol (2 x pre-pill determination or pre- and post-pill determination)
Note	▪ Pre-pill cortisol can be measured once or twice: If measured twice (2x pre-pill), cortisol is measured at an interval of one hour. Trilostane should only be administered after the second sample has been collected. ▪ If the time of taking the pills has to be changed because of the blood sampling, it needs to be done at least one day in advance. ▪ Separate cortisol reference values apply for monitoring trilostan therapy (pre-pill: 14–50 ng/ml). ▪ Not suitable for patients in poor general condition and for animals from which blood cannot be sampled stress-free. In these cases, the ACTH stimulation test is still recommended.

Tumour Marker AFP (Alpha Fetoprotein)

Material	S (possibly also EP, HP) 1 ml
Method	CLIA
Species	Dog, cat, horse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Concentrations are elevated in benign liver diseases (**dog** – in part slight), liver tumours (from slight to marked increases) and during pregnancy (physiologically).

- **Therapy monitoring:** In case of previous positive findings after surgical and/or chemotherapy, concentration should be within normal range. Relapse monitoring (every 6 months).

Tumour Marker CEA (Carcinoembryonic Antigen)

Material	S (possibly also EP, HP) 1 ml
Method	CLIA
Species	Dog, cat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Elevated concentrations occur primarily due to tumours of the gastrointestinal tract and the mammary glands, but also due to inflammatory processes. ▪ **Therapy monitoring:** In case of previous positive findings after surgical and/or chemotherapy, concentration should be within normal range. Relapse monitoring (every 6 months).

Tumour Test Nu.Q®

Material	EP 0.5 ml (4 hours of **fasting** are recommended before blood collection)
Method	ELISA
Species	Dog
Duration	1–5 working days
Note	▪ To determine the concentration of nucleosomes in the blood: Nucleosomes are released into the blood in increased amounts during apoptosis and cell necrosis. This particularly occurs in disseminated neoplasms. ▪ Indications include tumour screening in patients with no clinical signs, therapy monitoring and early detection of recurrence. ▪ Sensitivity is highest in lymphoma and haemangiosarcoma. ▪ A negative result does not rule out a tumour. A positive result must be confirmed by further diagnostic measures. ▪ Not suitable for clinically ill dogs. The concentration of nucleosomes also increases as a result of inflammatory cell death.

Urinary Normetanephrine/Metanephrine-Creatinine Ratio ➢ see p. 108

9 Function Tests/Calculations

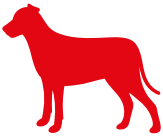
Depending on the type of function test and the species, fasting might be required before blood collection. Excitement and stress should be avoided. Please note the information on pre-analytics for the individual tests.

ACTH Stimulation Test	
Indication	▪ Diagnosis of hypoadrenocorticism (Addison's disease) ▪ Clarification of iatrogenic Cushing's syndrome ▪ Suspected Cushing's syndrome ▪ Horse: clarification of hypoadrenocorticism (Addison's disease)
Species	Dog, cat, horse, guinea pig, others on request
Material	S 2 x 0.5 ml
Test procedure	▪ First blood collection = baseline value ▪ **Dog:** injection of 5 µg ACTH/kg as Cosacthen® i.v./(i.m.) ▪ **Cat:** injection of 5 µg/kg Cosacthen® i.v./(i.m.) ▪ Second blood collection (= stimulation value) **dog/cat:** one hour post injection ▪ **Guinea pig:** baseline cortisol, 2 IU ACTH/kg, i.v./i.m., 2nd sample collection after 4 hours ▪ **Horse:** injection of 100 IU ACTH i.v. Second blood collection 2 hours post ACTH administration = stimulation value in **horses**
Parameter to be determined	Cortisol
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	▪ To assess cortisol concentration, previous glucocorticoid treatment should be ruled out (except when clarifying iatrogenic Cushing's syndrome). ▪ Clinical issue diagnosis of hypoadrenocorticism (Addison's disease): **Dogs** with hypoadrenocorticism typically have concentrations in the lower reference range or below. Stimulation typically results in no or only a slight increase in cortisol concentrations. The intake of steroids can produce similar results. ▪ Clinical issue diagnosis of Cushing's syndrome: Cushing's syndrome may be considered if the clinical signs are consistent and stimulation values are elevated. In dogs, the ACTH stimulation test is considered more specific but less sensitive than the low-dose dexamethasone suppression test for diagnosing Cushing's syndrome. False negative results are common, especially if Cushing's syndrome is caused by an adrenal tumour. ▪ Other underlying conditions (e.g. diabetes mellitus) can also lead to elevated stimulation values.

- Clinical issue therapy monitoring for Cushing's syndrome: When treating with trilostane (Vetoryl®), the target stimulation value is between 20 ng/ml and 50 ng/ml. For evaluating this treatment, "Trilostane Therapy Control" (p. 118) is also available.
- **Horse:** In healthy animals, the cortisol level increases by approximately 80%; horses with hypoadrenocorticism (Addison's disease) show very low baseline values which do not or only slightly increase after stimulation.
- **Guinea pig:** for therapy monitoring of Cushing's disease; at the time of diagnosis, it is not possible to differentiate between pituitary and adrenal Cushing's syndrome; there are no reference values available.
- In **guinea pigs**, an ACTH stimulation test can also be performed using saliva (to be requested as Salivary Cortisol Stimulation Test). Sample tubes (Salivette®) are provided; the saliva samples are examined using ELISA.

ACTH Stimulation Test Extended	
Indication	Suspected endocrine-active adrenal neoplasia, adrenal hyperplasia and early (subdiagnostic) Cushing's syndrome
Species	Dog
Material	S 2 x 0.5 ml
Test procedure	▪ First blood collection = baseline value ▪ Injection of 5 µg ACTH/kg as Cosacthen® i.v./(i.m.) ▪ Second blood collection 1 hour post ACTH injection = stimulation value
Parameter to be determined	Cortisol and 17 OH-progesterone
Method	Cortisol: CLIA; 17 OH-progesterone: LCMS
Duration	Reporting of partial results (cortisol) on the day the sample is received (Mon–Sat); final results after 2–6 working days
Interpretation	A significant increase in 17 OH-progesterone while cortisol concentrations are within reference range may indicate subdiagnostic (atypical) Cushing's syndrome. However, it should be noted that the specificity is relatively low. Differential diagnoses should be excluded.

Hypoadrenocorticism in Dogs



Predisposed Breeds

- Proven or very likely hereditary component (e.g. Poodle, Portuguese Water Dog, Nova Scotia Duck Tolling Retriever, Soft Coated Wheaten Terrier, Bearded Collie)
- Familial occurrence (e.g. Leonberger, Pomeranian)
- Increased risk (e.g. Great Dane, West Highland White Terrier, Rottweiler, Pyrenean Mountain Dog)
- Reduced risk (e.g. Golden Retriever, Yorkshire Terrier, Lhasa Apso)

+

Signs

- Recurrent gastrointestinal issues (e.g. loss of appetite, vomiting, diarrhoea)
- Lethargy, decreased activity, collapse
- Polydipsia/polyuria

+

Laboratory parameter changes

- Mild non-regenerative anaemia
- Lymphocytosis
- Azotaemia
- Hyperkalaemia
- Hyponatraemia
- Low Na/K ratio
- Hypercalcaemia
- Hypoglycaemia

Basal cortisol

< 22 ng/ml → Hypoadrenocorticism possible → ACTH stimulation test

> 22 ng/ml → Hypoadrenocorticism unlikely

ACTH stimulation test:

- Cortisol rises adequately → Hypoadrenocorticism unlikely
- Zero or insufficient cortisol response → Hypoadrenocorticism possible

Caution: Pre-treatment with glucocorticoids

Diagnostic flow chart for hypoadrenocorticism in dogs

Cortisol/ACTH Ratio	
Indication	Clarification of hypoadrenocorticism (Addison's disease) – especially as an alternative if synthetic ACTH is not available for performing an ACTH stimulation test
Species	Dog
Material	EP + S 0.5 ml (plasma centrifuged immediately, pipetted off; frozen until arrival at the laboratory)
Parameter to be determined	Cortisol, ACTH
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	▪ Previous glucocorticoid treatment must be ruled out before assessment. Ratios below the cut-off value indicate the presence of primary hypoadrenocorticism (Addison's disease). ▪ Endogenous ACTH is unstable in sample material from dogs. Preanalytical requirements must be observed – see information under Material.

Bile Acid Stimulation Test	
Indication	Liver function testing
Species	Dog, cat
Material	S 2 x 0.5 ml
Test procedure	▪ First serum sample = value after fasting (10 hours) ▪ Feeding of 100 g meat plus 5 g fat/10 kg bdw ▪ Second serum sample 2 hours after feeding = post prandial value
Parameter to be determined	Bile acids
Method	Photometry
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	Elevated concentrations of serum bile acids (pre- and/or postprandial) are associated with liver dysfunction or a portosystemic shunt. However, concentrations below 80–100 µmol/l are also seen in other diseases (e.g. Cushing's syndrome, chronic enteropathy) and should be considered in the differential diagnosis. Post-hepatic cholestasis (bile duct obstruction/rupture) also causes an increase in bile acid concentration in the blood.

Protein-corrected **Calcium Concentration**	
Indication	May be helpful in cases of reduced total calcium with concurrent hypoalbuminaemia to estimate the likelihood that it is true hypocalcaemia. Determination of ionised calcium should be preferred to correcting the protein-corrected calcium concentration.

Species	Dog, cat – only after consultation with the laboratory
Material	S 0.5 ml
Parameter to be determined	Calcium, protein
Calculation	Protein-corrected **calcium concentration** in mmol/L = ((serum calcium concentration in mmol/l x 4.008) - (0.04 x serum protein in g/l) +3.3) x 0.2495
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Urine **Cortisol/Creatinine Ratio (UCCR)**

Indication	Clarification of Cushing's disease including differentiation between adrenal and pituitary forms
Species	Dog
Material	Morning urine 1 ml each
Test procedure	▪ Collection of morning urine day 1 = sample 1 ▪ Collection of morning urine day 2 = sample 2 ▪ Administration of dexamethasone on day 2: orally 3 x 0.1 mg/kg bdw throughout the day ▪ Collection of morning urine day 3 = sample 3
Parameter to be determined	Cortisol, creatinine
Method	Cortisol: CLIA; creatinine: photometry
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Interpretation	▪ Interpretation of the ratio of day 1 and day 2: The ratios from the samples taken on days 1 and 2 are used to evaluate the probability of Cushing's syndrome. ▪ The sensitivity of the UCCR test is increased by performing repeated measurements. Positive or divergent findings should be verified using a low-dose dexamethasone suppression test. Negative findings indicate that Cushing's syndrome is unlikely. However, if there is strong clinical suspicion, it is recommended to perform a low-dose dexamethasone suppression test. ▪ Interpretation of the ratio of day 3: (An increased ratio on day 1 and day 2 is a prerequisite) > 50% of the average value of the first two samples indicate a cortisol-producing adrenocortical tumour. The presence of non-suppressible pituitary Cushing's disease is possible. < 50% of the average value of the first two samples indicate a pituitary-dependent Cushing's disease or another disease which causes increased cortisol secretion (e.g. diabetes, stress, gastrointestinal diseases, diseases with protein loss).

Dexamethasone Suppression Test (low dose) dog, cat, guinea pig

Indication	Testing for Cushing's syndrome
Species	Dog, cat, guinea pig
Material	S 2 x 0.5 ml or 3 x 0.5 ml
Test procedure	▪ First blood collection = baseline value; ▪ Administration of dexamethasone: **Dog** i.v. (or i.m.): 0.01 mg/kg bdw **Cat** i.v. (or i.m.): 0.1 mg/kg bdw **Guinea pig** i.m. or i.v.: 0.1 mg/kg bdw ▪ Blood collection 4 hours post injection = 1st suppression value ▪ Blood collection 8 hours post injection = 2nd suppression value
Parameter to be determined	Cortisol
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	**Dog, cat:** ▪ Both suppression values < 10 ng/ml: Cushing's syndrome unlikely ▪ One suppression value < 10 ng/ml: Cushing's syndrome questionable ▪ Insufficient suppression: A lack of suppression may indicate the presence of Cushing's syndrome if the clinical picture is appropriate. Insufficient suppression is also seen in other diseases. **Guinea pig:** ▪ Evaluation: adequate suppression and interpretation as in dogs, reference values not available ▪ For testing using saliva, see the Saliva Cortisol Suppression Test on p. 133 in this chapter.

Dexamethasone Suppression Test (low dose) horse (Overnight Dexamethasone Suppression Test)

Indication	Suspected PPID (Cushing's disease)
Species	Horse
Material	S 2 x 0.5 ml or 3 x 0.5 ml
Test procedure	▪ First blood collection = baseline value (blood sampling at around 4–6 pm) ▪ Injection of 2 mg/50 kg bdw of dexamethasone i.v. ▪ Blood sampling approx. 15 hours after administration of dexamethasone (at around 8–10 am) = 1st suppression value – may be omitted ▪ 2nd suppression value after approx. 18–20 hours (at around 10 am–1 pm) – the decisive value ▪ Because of the circadian rhythm, the indicated times of the day should be observed.
Parameter to be determined	Cortisol

Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	▪ PPID: one or both suppression values > 10 ng/ml ▪ Cave: In late summer/autumn, healthy horses, too, possibly suppress insufficiently.
Note	▪ Can be performed as an alternative to the TRH Stimulation Test (see p. 134). ▪ PPID (formerly known as Cushing's disease) in horses is caused by "pituitary adenoma" (hyperplasia of the pars intermedia). The hyperplastic cells have no cortisol receptors, that is why in PPID, the exogenous administration of dexamethasone does not suppress the endogenous secretion of corticoids as it does in healthy horses.

Oral **Glucose Test with Insulin Determination**

Indication	Testing for equine metabolic syndrome (EMS)
Species	Horse
Material	S 1 ml (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)
Test procedure	Fasting required, only reduced feeding of hay/straw. In the morning administration of glucose 1 g/kg bdw
Parameter to be determined	Insulin
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	An insulin concentration > 69 µU/ml indicates insulin dysregulation (ID).

GnRH Stimulation Test

Indication	▪ Detection of endocrine active tissue of the gonads (ovary, testis) ▪ Suspected ovarian remnant syndrome (dog) ▪ Clarification of cryptorchidism
Species	Dog, rabbit, horse
Material	S 2 x 1 ml
Test procedure	**Dog (female):** ▪ First blood collection = baseline value (oestradiol) ▪ Injection of 0.32 µg of GnRH buserelin (Receptal®)/animal i.v. ▪ Second sample after 3 hours = stimulation value **Dog (male):** ▪ First blood collection = baseline value (testosterone) ▪ Injection of 0.32 µg of GnRH buserelin (Receptal®)/animal i.v. ▪ Second sample after 1 hour = stimulation value

Rabbit (male):
- First blood collection = baseline value (testosterone)
- Injection of 0.8 µg of GnRH buserelin (Receptal®)/animal i.m.
- Second sample after 1 hour = stimulation value

Rabbit (female):
- First blood collection = baseline value (progesterone)
- Injection of 0.8 µg of GnRH buserelin (Receptal®)/animal i.m.
- Second sample after 5–7 days = stimulation value

Horse (male):
- First blood sample in the morning = baseline value (testosterone)
- Injection of 0.04 mg of GnRH/horse i.v.
- Second sample after 1 hour = stimulation value

Parameter to be determined: Oestradiol-17β (female dog) or testosterone (male dog, male horse, male rabbit) or progesterone (female rabbit)

Method: CLIA; testosterone: LCMS

Duration:
Female animals:
Reporting of results on the day the sample is received (Mon–Sat),
Male animals:
Dog: Reporting of results on the day the sample is received (Mon–Sat)
Rabbit, horse: 2–4 working days

Interpretation
- In dogs, cats and rabbits, the determination of the AMH concentration (see Chapter 8, p. 104) largely replaces the GnRH Stimulation Test.
- **Female dog:** depending on the current cycle phase; significant increases are only expected in diestrus and late anoestrus
- **Intact male dog:** post stimulation concentrations > 1 ng/ml of testosterone are expected
- **Rabbit:** Stimulation values of > 1 ng/ml of testosterone or > 4 ng/ml of progesterone indicate hormone-producing tissue.
- **Horse:** depending on the clinical issue

HCG Stimulation Test dog, male cat, rabbit

Indication
- Detection of endocrine active tissue of the gonads (ovary, testis).
- Suspected ovarian remnant syndrome (dog)
- Clarification of cryptorchidism

Species: Dog, male cat, rabbit

Material: S 2 x 0.5 ml

Test procedure

female dog, male dog, male cat:
- First blood collection = baseline value (male dog, male cat: testosterone, female dog: oestradiol)
- Injection of 500 IU of HCG/animal i.v.
- Second sample after 1 hour (male cat: after 2 hours) = stimulation value (perhaps additional blood sample after 30 minutes)

Rabbit (male):
- First blood collection = baseline value (testosterone)
- Injection of 250 IU of HCG/animal i.m.
- Second sample after 1 hour = stimulation value

Rabbit (female):
- First blood collection = baseline value (progesterone)
- Injection of 250 IU of HCG/animal i.m.
- Second sample after 5–7 days = stimulation value

Parameter to be determined: **Dog/male cat:** testosterone (male) or oestradiol (female dog)
Rabbit: testosterone (male) or progesterone (female)

Method: CLIA; rabbit: LCMS

Duration: Female animals:
Reporting of results on the day the sample is received (Mon–Sat),
Male animals:
Dog, cat: Reporting of results on the day the sample is received (Mon–Sat)
Rabbit: 2–4 working days

Interpretation:
- In most cases, the determination of the AMH level (see Chapter 8, p. 104) provides comparable information.
- **Male dog:** Post-stimulation testosterone concentrations > 1.0 ng/ml indicate that there is testicular tissue.
- **Female dog:** Stimulation of oestradiol secretion strongly depends on cycle phase. Significant increases are expected in diestrus and late anoestrus.
- **Rabbit:** Stimulation values of > 1 ng/ml of testosterone or > 4 ng/ml of progesterone indicate hormone-producing tissue.

HCG Stimulation Test horse, donkey

Indication:
- Detection of endocrine active tissue of the gonads (testis)
- Clarification of cryptorchidism

Species: Horse, donkey

Material: S 2 x 0.5 ml

Test procedure:
- First blood collection = baseline value (testosterone)
- **Horse:** injection of 5000–10000 IU of HCG (Ovogest®)/animal i.v. or **donkey:** injection of 6000 IU of HCG/animal i.v.
- Second sample after 1 hour = stimulation value

Parameter to be determined: Testosterone

Method: LCMS

Duration: 2–4 working days

Interpretation: **Stallion:** A significant increase in testosterone would prove the presence of testosterone-producing tissue. Borderline results can be further clarified by determining the Anti-Müllerian Hormone (AMH).

In most cases, the determination of the AMH concentration (see Chapter 8, p. 104) provides comparable information.

Insulin/Glucose Ratio (I/G ratio)

Indication	Determination of pancreatic beta-cell activity
Species	Horse
Material	S + NaFB 1 ml (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)
Test evaluation	Ratio = serum insulin (µU/ml)/serum glucose (mmol/l)
Parameter to be determined	Insulin, glucose
Method	Insulin: CLIA; glucose: photometry
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	Values ≥ 6 indicate increased pancreatic beta-cell activity.
Note	In horses, the insulin/glucose ratio is part of the EMS Profile (Equine Metabolic Syndrome) and the PPID Profile (Equine Cushing).

Insulin Tolerance Test with Glucose Determination

Indication	Suspected insulin resistance
Species	Horse
Material	2 x NaFB 1 ml
Test procedure	▪ Fasting not required ▪ Blood sample taken to determine baseline glucose (sample 0) ▪ Then i.v. injection 0.10 IU of insulin/kg bdw ▪ Repeat sampling to determine glucose after 30 min. ▪ Then feed promptly!
Parameter to be determined	Glucose
Method	Photometry
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	Healthy horses have blood glucose levels of < 50% of the initial value 30 min after the injection of insulin and these levels should have risen back to the initial level at the latest after 2 hours. **Cave:** risk of hypoglycaemia in insulin-sensitive horses

Karo Light Syrup® Test, oral **"Sugar" Test with Insulin Determination**

Indication	Suspected insulin dysregulation (ID)
Species	Horse
Material	S 1 ml (centrifuged and separated shortly after coagulation, pipetted off; please pay attention to the note – country-specific – on the submission form regarding the temperature during storage/transport!)

Test procedure	▪ Fasting required, only reduced feeding of hay/straw. ▪ Give 0.45 ml/kg bdw of Karo Light Corn Syrup® per os ▪ Blood collection after 60 and/or 90 min to determine insulin
Parameter to be determined	Insulin
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	An insulin concentration of > 30 µU/ml indicates insulin dysregulation.

Luteal-placental Shift

Indication	To determine the timing of placental progestogen synthesis between days 100 and 120 of a pregnancy in mares
Species	Horse
Material	S 1 ml
Parameter to be determined	5α-dihydroprogesterone (DHP), progesterone
Method	LCMS
Duration	2–5 working days
Interpretation	▪ The DHP/progesterone ratio is < 1 in cyclic mares or in early pregnancy, and > 1 after the luteal-placental shift around the 100th to 120th day of pregnancy. ▪ Absolute DHP concentrations (follow-up examinations) provide information about placental function when diseases occur during advanced pregnancy.

RAAS Status (renin-angiotensin-aldosterone system status)

Indication	Differentiated analysis of disorders of blood pressure and electrolyte regulation: ▪ differentiation between primary and secondary hyperaldosteronism ▪ cardiac and renal diseases ▪ systemic hypertension ▪ monitoring of pharmacological RAAS blockades (ACE inhibitors, ARBs (angiotensin receptor blockers), MRAs (mineralocorticoid receptor antagonists))
Species	Dog, cat
Material	S 1 ml (centrifuged and separated shortly after coagulation, pipetted off; frozen until arrival at the laboratory – please contact the laboratory for transport options in advance)
Parameter to be determined	Renin activity, angiotensin I+II concentration and aldosterone concentration (quantitative)
Method	LCMS
Duration	2–6 working days

Interpretation

Angiotensin I (Ang I)
↑ Ang I = increased renin release (volume deficiency, Na deficiency, heart failure, medication)
↓ Ang I = decreased renin release (hypervolaemia, primary hyperaldosteronism)

Angiotensin II (Ang II)
↑ Ang II = increased ACE activity or RAAS activation
↓ Ang II = successful ACE blockade, e.g. after administration of enalapril, or low activation of the renin-angiotensin-aldosterone system (e.g. in primary hyperaldosteronism)

Aldosterone
↑ Aldosterone while ↓ Ang II → Aldosterone escape = autonomous, ACE-independent aldosterone production
↑ Aldosterone while ↑ Ang II → classic RAAS activation
↓ Aldosterone → suppressed RAAS axis or hypokalaemia

Renin activity (PRA-S) – indirectly determined via Ang I + Ang II
↑ PRA-S = renin release through negative feedback (e.g. after administration of ACE inhibitors, volume deficiency)
↓ PRA-S = renin suppression (volume overload, hypertension, high sodium intake, primary hyperaldosteronism)

ACE activity (ACE-S) – determined by the Ang II/Ang I ratio
↑ ACE-S = high conversion of Ang I → Ang II → active RAAS
↓ ACE-S = functional inhibition of ACE, e.g. after administration of enalapril, or low Ang II production

AA2 ratio (aldosterone/Ang II) – the most important marker for functional examination
low AA2: aldosterone proportional to Ang II → classic axis intact
high AA2: aldosterone disproportionately high despite low Ang II → Ang II-independent aldosterone production (primary hyperaldosteronism)

Saliva Cortisol Stimulation Test

Indication	Therapy monitoring for Cushing's syndrome
Species	Guinea pig
Material	2 x saliva 0.1 ml each (sample containers (Salivettes®) will be provided)
Test procedure	▪ 1st saliva sample collection baseline cortisol ▪ injection of 2 IU ACTH/kg bdw, i.v./i.m. ▪ 2nd sample collection after 4 hours
Parameter to be determined	Cortisol

Method	ELISA
Duration	3–5 working days
Interpretation	If treatment is adequately controlled, no or only a minimal increase in cortisol concentration is observed.

Saliva Cortisol Suppression Test

Indication	Suspected Cushing's syndrome, adrenergic/pituitary
Species	Guinea pig
Material	3 x saliva 0.1 ml each (sample containers (Salivettes®) will be provided)
Test procedure	▪ 1st saliva sample collection = baseline cortisol ▪ Injection of 0.1 mg/kg bdw dexamethasone i.m. (i.v.) (high-dose dexamethasone suppression test) ▪ 2nd sample collection after 4 hours ▪ 3rd sample collection after 8 hours
Parameter to be determined	Cortisol
Method	ELISA
Duration	3–5 working days
Interpretation	▪ pituitary Cushing's syndrome and/or bilateral adrenal hyperplasia: adequate suppression (as in dogs) after 4 hours, then rising again ▪ adrenergic Cushing's syndrome: no suppression

TRH Stimulation Test dog (1 x T4 + 2 x TSH)

Indication	Additional testing for suspected hypothyroidism
Species	Dog
Material	S 2 x 1 ml
Test procedure	▪ First blood collection = baseline value ▪ Injection of TRH (10 µg/kg bdw i.v.) ▪ Second sample 45 min post injection = stimulation value
Parameter to be determined	▪ T4 (sample 1) ▪ TSH (samples 1 and 2)
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	If the percentage increase in TSH remains below the cut-off, hypothyroidism is likely. rT3 provides further assistance in distinguishing hypothyroidism from non-thyroidal illness of decreased T4 concentration.

TRH Stimulation Test horse (2 x T4)	
Indication	Suspected hypothyroidism
Species	Horse
Material	S 2 x 0.5 ml
Test procedure	▪ First blood collection = baseline value ▪ Injection of TRH 0.5 mg/pony up to 1 mg/horse, slowly i.v. ▪ Second sample 4 hours post injection = stimulation value
Parameter to be determined	T4
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	Euthyroid: 2- to 3-fold rise in T4 4 hours post injection

TRH Stimulation Test horse (2 x ACTH)	
Indication	▪ Clarification of PPID (Cushing's disease) ▪ If the results of ACTH determination or of the Dexamethasone Suppression Test (low dose) do not correlate with the clinical findings or are inconclusive (TRH Stimulation Test with high sensitivity and specificity).
Species	Horse
Material	EP 2 x 0.5 ml or 3 x 0.5 ml (centrifuged immediately, pipetted off; cooled until arrival at the laboratory)
Test procedure	▪ First blood collection = baseline value ▪ Slow injection of 1 mg of TRH i.v. horses > 250 kg bdw (horses < 250 kg bdw: 0.5 mg) ▪ Second sample exactly 10 min post TRH injection = stimulation value ▪ A third blood sample may additionally be taken 30 minutes after administration of TRH.
Parameter to be determined	ACTH
Method	CLIA
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Interpretation	▪ Cut-off value 10 min after stimulation: < 100 pg/ml; borderline: 100–220 pg/ml; positive: > 200 pg/ml ▪ Cut-off value 30 min after stimulation: < 40 pg/ml; borderline: 40–90 pg/ml; positive: > 90 pg/ml ▪ These values are valid for the months of January to June. ▪ The stimulation test is not recommended from July to December. However, if the result is negative during this period (< 100 pg/ml after 10 minutes, < 40 pg/ml after 30 minutes), a diagnosis of PPID is very unlikely.

10 Vitamins

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

β-Carotene	
Material	S, HP 0.5 ml
Method	HPLC
Species	Cattle, others on request
Duration	2–6 working days
Note	In cattle, β-carotene deficiency can lead to fertility disorders.

Folic Acid	
Material	S (possibly also HP) 0.5 ml
Method	CLIA
Species	Dog, cat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Reduced concentrations may indicate intestinal malabsorption. ▪ Elevated concentrations are associated with intestinal dysbiosis. ▪ Haemolysis is seen as the cause for falsely elevated folic acid concentrations.

Vitamin A	
Material	S, EP, HP 1 ml
Method	HPLC
Species	Dog, cat, birds, reptiles, horse, cattle, goat, others on request
Duration	2–6 working days

Vitamin B1 (thiamine)	
Material	EB, HB 1 ml (whole blood only; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	HPLC
Species	Dog, cat, ruminants, others on request
Duration	2–6 working days
Note	▪ Analysis must be requested within one day after the samples have arrived at the laboratory. ▪ **Ruminants:** Cerebrocortical necrosis (CCN) is often caused by thiamine deficiency, especially in neonates and fattening animals.

Vitamin B2	
Material	EB, HB 1 ml (whole blood only; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	HPLC
Species	Dog, cat, cattle, others on request
Duration	2–6 working days
Note	Analysis must be requested within one day after the samples have arrived at the laboratory.

Vitamin B6	
Material	EB, HB 1 ml (whole blood only; please pay attention to the note – country-specific! – on the submission form regarding the temperature during storage/transport!)
Method	HPLC
Species	Dog, cat, cattle, others on request
Duration	2–6 working days
Note	▪ Analysis must be requested within one day after the samples have arrived at the laboratory. ▪ Vitamin B6 deficiency can lead to hyperexcitability and behavioural problems. ▪ The determination of vitamin B6 is also part of the Behaviour Profiles (dog).

Vitamin B12	
Material	S (or possibly HP) 0.5 ml
Method	CLIA
Species	Dog, cat, horse, ruminants, alpaca, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	▪ Reduced concentrations may indicate intestinal malabsorption. ▪ Increased concentrations are usually the result of supplementation. Occasionally, they may also be seen secondary to various pathological conditions (in **dogs** and **cats**, particularly gastrointestinal and hepatobiliary diseases). ▪ **Ruminants:** Synthesis of vitamin B12 in the rumen can only take place insufficiently if too little cobalt is ingested with the feed. Vitamin B12 deficiency leads to disorders of the energy metabolism with lack of appetite, apathy, growth and performance depression and anaemia as well as possible diarrhoea.

Metabolism of vitamin D_2 and vitamin D_3

Vitamin D (25-OH)

Material	S (or possibly HP) 0.5 ml
Method	CLIA
Species	Dog, cat, birds, reptiles, ruminants, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Vitamin D (1,25-(OH)2)

Material	S 1 ml
Method	LCMS
Species	Dog, cat
Duration	2–6 working days
Note	See also the diagram on vitamin D metabolism, p. 137

Vitamin D2/D3 (25-OH)

Material	S 1 ml
Method	LCMS
Species	Birds, reptiles, horse, camels, South American camelids
Duration	2–6 working days
Note	See also the diagram on vitamin D metabolism, p. 137

Vitamin E

Material	S, EP, HP 0.5 ml
Method	HPLC
Species	Dog, cat, birds, reptiles, horse, ruminants, South American camelids, pig, others on request
Duration	2–3 working days

Vitamin H (Biotin)

Material	S 1 ml
Method	LCMS
Species	Horse
Duration	2–6 working days

Vitamin Profiles ➢ **see Catalogue of Prices and Services**

11 Nutrition

Providing dogs and cats with food that meets their needs is a key component of prevention and treatment in small animal medicine. By calculating individual rations, it is possible to provide dogs and cats with a nutritionally balanced diet that is tailored to their needs and takes into account their respective life stage, health status as well as special requirements – including those of the owner.
Computer-assisted ration calculation allows for precise assessment and adjustment of nutrient supply. It does not only contribute to optimising health, but is also an important tool for supporting dietary treatment decisions.
To be able to check the ration or calculate it, we require detailed information about the animal's previous diet, preferences and health status. For this, please complete the questionnaire which we will gladly provide you on request.

BARF Profile (clinical chemistry) ➢ **see Catalogue of Prices and Services**
Iodine-Creatinine Ratio ➢ **see Chapter 4.3, p. 70**
BARF Faecal Profile ➢ **see Chapter 17.1.1, p. 308**

Ration Check	
Material	Completed questionnaire for ration check and calculation
Method	Computer-assisted calculation
Species	Dog, cat
Duration	Usually 6 working days, individual deviations possible depending on processing effort
Note	Ration Check & Ration Calculation can be requested separately or together as one service.

Ration Calculation	
Material	Completed questionnaire for ration check and calculation
Method	Computer-assisted calculation
Species	Dog, cat
Duration	Usually 6 working days, individual deviations possible depending on processing effort
Note	The preceding ration check is essential for Ration Calculation. Ration Check & Ration Calculation can be requested separately or together as one service.

12 Drug Level

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

Bromide	
Material	S, EP, HP 1 ml
Method	ICP MS
Species	Dog, cat
Duration	4 working days
Note	**Therapy monitoring** under bromide treatment. Determination can be done at the earliest 6 weeks after starting therapy. Lower drug levels are required during combination therapy with phenobarbital.

Cyclosporine	
Material	EB 1 ml (whole blood only; frozen until arrival at the laboratory)
Method	CLIA
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	**Therapy monitoring:** Determination is suitable for monitoring treatment with cyclosporine.

Diazepam	
Material	S 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	2–5 working days
Note	Measurement of serum diazepam is mainly used to: ▪ Investigate suspected intoxication (e.g. accidental ingestion, overdose) ▪ Check for doping or treatment compliance ▪ Assess the progression of serum concentrations over time after the administration of diazepam (e.g. as part of the treatment of seizure disorders)

Digoxin	
Material	S 1 ml
Method	CLIA
Species	Dog, cat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Sat)

Note	**Therapy monitoring** at the earliest 7 days after initial application and approx. 6–8 hours after the last drug administration

Levetiracetam

Material	S 0.5 ml
Method	LCMS
Species	Dog
Test frequency	1 x per week
Note	▪ **Therapy monitoring**, effective levels only determined for dogs ▪ Clinical signs should be considered when adjusting treatment. ▪ Blood sampling preferably right before the administration of medication

Phenobarbital

Material	S (possibly also EP, HP) 1 ml
Method	CLIA
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	**Therapy monitoring:** Determination is suitable for monitoring phenobarbital and primidone therapy. In dogs, primidone is immediately metabolised to phenobarbital. Determination should take place at the earliest two weeks after starting long-term therapy. Sampling can be done regardless of when the drug is administered.

Further Drug Tests by Drug Groups

All drug tests can be requested individually.

Antidepressants

Material	S 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	2–6 working days
Note	▪ Choose between fluoxetine, mirtazapine and trazodone. ▪ Reference intervals may not be available for all of the listed medications. If you need help, our expert advisors will be happy to assist you.

Anticonvulsants

Material	S 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	2–6 working days
Note	▪ Choose between brivaracetam, gabapentin, lacosamide, pregabalin, topiramate, valproate and zonisamide. ▪ Reference intervals may not be available for all of the listed medications. If you need help, our expert advisors will be happy to assist you.

Benzodiazepines

Material	S 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	2–6 working days
Note	▪ Choose between clonazepam, lorazepam and midazolam. ▪ Reference intervals may not be available for all of the listed medications. If you need help, our expert advisors will be happy to assist you. ▪ For diazepam, see separate section on p. 140.

Drug Testing for Doping Analysis in Horses

Especially for horses, there is a series of drug level tests available as part of the **doping analysis**.

- Screening for doping-relevant substances
- Antiphlogistics Screening
- Glucocorticoid Screening
- NSAID Screening
- Sedativa/Tranquilizer
- Stimulants
- Tricyclic antidepressants

Screening for doping-relevant substances provides a comprehensive overview; for specific clinical suspicions, the parameters listed below can be selected individually. Turnaround time is 2–3 weeks after the sample is received. Further information on the tests above can be found in the Directory of Tests Horse. It can be requested as a printed copy and is also available on our Laboklin website (under Specialist Information – Compendium/Directory of Tests) as a browsable catalogue or for download.

We will be pleased to answer any questions that you may have.

13 Intoxication

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

Cadmium

Material	S 1 ml
Method	ICP-MS
Species	On request
Duration	2–6 working days
Note	▪ Cadmium is a toxic heavy metal that primarily accumulates in the liver and kidneys and poses significant chronic health risks to animals due to its long biological half-life. Exposure occurs mainly through industrial emissions, contaminated soil and contaminated feed. ▪ In veterinary medicine, cadmium measurement is used to diagnose heavy metal toxicity, assess chronic renal damage, monitor environmental exposure in livestock and ensure food safety in farm animals. Cadmium can affect various organ systems, particularly the renal tubular system, the liver and bone metabolism; toxic effects on reproduction have also been described. ▪ Cadmium concentrations are interpreted taking into account the animal species, the clinical picture and the history of exposure. Elevated concentrations can indicate relevant environmental contamination and has potential implactions under food safety legislation, particularly in **farm animals**.

Cannabis (THC)/Cannabinoids

Material	S 0.5 ml
Method	LCMS
Species	Dog, cat, rabbit, horse, others on request
Duration	1–2 working days
Note	To detect exposure, THC and two metabolites are measured: ▪ THC (tetrahydrocannabinol) and the metabolites 11-OH-THC (11-hydroxytetrahydrocannabinol) and THC-COOH (11-nor-9-carboxy-THC) do not occur naturally in animals. ▪ THC and 11-OH-THC have psychoactive effects. ▪ The half-life of THC in blood is short and is reported to be 20–30 minutes.

Clinical signs (**dog, cat**):
- common: lethargy, ataxia, vomiting followed by CNS depression, urinary incontinence, sensitivity to noise, mydriasis, hyperaesthesia, bradycardia, hypothermia and tremors
- rare: hypotension, bradypnoea, aggression, tachycardia, nystagmus, convulsion, death
- Clinical signs occur within 1 to 2 hours after exposure and usually subside within 12 to 72 hours.

Evaluation:
- The detection of THC in serum and 11-OH-THC concentration > 1 ng/ml indicate recent cannabis intake.
- Long-term intake is indicated by THC-COOH concentrations > 1 ng/ml.

α-Chloralose	
Material	S, urine 0.5 ml
Method	LCMS
Species	Dog, cat
Duration	1–2 working days
Note	- α-chloralose is an over-the-counter poison for pest control. - α-chloralose has a narcotic effect and impairs thermoregulation. It can lead to severe hypothermia, neurological signs, salivation, hypoglycaemia and circulatory failure and can result in death.

Cobalt ➢ **see Chapter 4.3, p. 68**

Coumarin Activity (vitamin K1/vitamin K1 epoxide ratio)	
Material	S 0.5 ml (centrifuged shortly after coagulation, pipetted off; cooled until arrival at the laboratory)
Method	LCMS
Species	Dog, cat
Duration	1–2 working days
Note	- The concentrations of vitamin K1, vitamin K1 epoxide and the ratio of vitamin K1 epoxide to vitamin K1 can indicate previous intoxication with coumarin derivatives. - The test can also be performed while vitamin K is being administered.

Heavy Metal Toxicity Screening ➢ **see Catalogue of Prices and Services**

Lead	
Material	EB, HB at least 1 ml (whole blood only)
Method	AAS
Species	Dog, cat, small mammals, birds, reptiles, horse, cattle, sheep, others on request
Duration	1–2 working days
Note	Because it is stored in the bones, lead can only be detected in higher concentrations in the blood in case of acute poisoning. Over 95% of lead in the blood is bound in erythrocytes, so as test material, whole blood is absolutely necessary. An elevated iron level in the serum is an additional indication of possible lead poisoning.

Meadow Saffron (Colchicine)	
Material	Urine 1 ml
Method	LCMS
Species	Horse, donkey, ruminants and others (e.g. dogs after medication)
Duration	1–2 working days
Note	Colchicine is the main toxin of the meadow saffron. Horses and other grazing animals can ingest it via hay and silage or directly on the pasture. Colchicine poisoning leads to severe salivation, (bloody) diarrhoea, ataxia and colic and can lead to death from respiratory paralysis. For **horses**, colchicine is categorised as a doping-relevant substance.

Poison Screening	
Material	Urine, (vomit/stomach contents, S, EB) 5 ml
Method	GCMS
Species	Dog, cat, horse, farm animals, others on request
Duration	10–15 working days
Note	▪ Global screening test, qualitative detection of, for example, coumarin derivatives. A written medical history is a must; please add information about medication prior to sample collection. ▪ This service may not be available in some countries for donkeys.

Ragwort (Senecionine)	
Material	Urine 1 ml
Method	LCMS
Species	Horse, ruminants, others on request
Duration	1–2 working days

Note

- The toxins senecionine and senecionine N-oxide are detected in urine.
- Senecio species, especially the well-known ragwort (Senecio jacobaea), are a common problem in pastures, hay and silage, as they contain a large amount of different pyrrolizidine alkaloids as cumulative hepatotoxins.
- The detection of the toxins senecionine and senecionine-N-oxide indicates the oral ingestion of toxic plant parts within the last hours to days.

Sycamore (Hypoglycin A)

Material	S 1 ml
Method	LCMS
Species	Horse
Duration	1–2 working days
Note	Hypoglycin A is found in the seeds of various maple species (sycamore, box elder and Japanese maple) and is one of the causes of atypical myopathy (seasonal pasture myopathy) in horses. Atypical myopathy leads, for example, to generalised weakness, stiffness, colic, increased respiratory and heart rate as well as myoglobinuria and is often fatal.

Thallium (Rodenticide)

Material	EB, urine 0.5 ml
Method	ICPMS
Species	Dog, cat, horse, cattle, others on request
Duration	2–6 working days
Note	Thallium is a cumulative cytotoxin that can cause systemic intoxication. Cases of acute intoxication can be detected using EDTA blood or urine.

14 Infectious Diseases: Pathogenic Agents and Antibody Detection

For abbreviations and additional information concerning the test descriptions see p. 11 and following.

The following pages contain information on the diagnosis of infectious agents (viruses/bacteria/fungi/parasites). You will find details on the required material, the methods used, the species examined and on the duration of testing. Tests include antibody and antigen detection, molecular biological methods (PCR, realtime PCR, droplet digital PCR), bacterial and mycological culture for pathogen detection as well as pathology (histology, cytology).

14.1 Viruses

If the diagnostic procedures listed above cannot be used in viral infections in **reptiles** or have not yielded any findings that match the clinical picture, we also offer virus cultivation by means of **cell culture**. For this, we need tissue or a swab, each put into **cell culture medium** (which we can provide you with) or, if need be, in some sterile physiological saline solution. For cell culture, samples should be sent refrigerated; the test duration is expected to be at least 4 weeks. There will be no further reference to this examination option in this document.

14.1.1 Adenoviruses

Adenoviruses are non-enveloped, double-stranded DNA viruses, which are characterised by a high tenacity. They belong to the linear double-stranded DNA viruses. Adenoviruses are strictly host-specific and only in exceptional cases infection of related or unrelated animal species occurs. They mostly cause mild respiratory signs and are involved in many multifactorial disorders.

Dog

Hepatitis contagiosa canis (HCC)

HCC is caused by **canine adenovirus 1 (CAV-1).** The virus is shed in urine and faeces and transmission occurs directly or indirectly. After oronasal infection, the virus first multiplies in the tonsils and subsequently in the endothelium of the blood vessels, in hepatocytes as well as in cornea and uvea. Deposition of immune complexes can result in glomerulonephritis and uveitis with a corneal oedema (“blue eye”). HCC can be acute or chronic. Especially in unvaccinated puppies, HCC can take a peracute or acute course and can be fatal. Not only dogs, but also all other species of the family Canidae are susceptible to an infection with CAV-1.

As consistent vaccination against HCC has been carried out in Germany for some time now, the virus CAV-1 has largely disappeared from dog populations. However, CAV-1 still occurs in Eastern European countries.

Infectious laryngotracheitis
Infectious laryngotracheitis is caused by **canine adenovirus 2 (CAV-2).** The virus has a strong affinity to the epithelia of the respiratory tract and is a component of the "kennel cough complex".

Reptiles
Adenoviruses, which have mostly been documented in lizards and snakes, play an important role in reptiles. Literature particularly describes adenoviruses in bearded dragons (Pogona). The clinical picture is often non-specific. In **Pogona,** mainly young animals are affected. Clinical signs which are often seen are anorexia, apathy, diarrhoea and opisthotonus. Boas, colubrids and vipers belong to the **snake** families that are often affected. Gastrointestinal signs are very typical. The liver, too, is very frequently affected. Transmission probably occurs through the faeces.

Guinea pig
Guinea pig adenovirus (GPAdV) has an incubation period of 5–10 days (detection by PCR on nasal mucous membranes between days 6–15 after infection) and can cause non-purulent necrotising bronchitis and bronchiolitis. The adenovirus is transmitted by direct contact between animals. Shedding of the virus via oral/nasal secretions and faeces has been described. Especially young and immunocompromised animals are susceptible to the virus. Clinical signs may include inappetence, nasal discharge and tracheobronchitis. In some cases, an infection may result in peracute death. A high mortality rate is mainly seen in young animals.

Birds
Adenovirus infections are often subclinical in adult birds, but can lead to severe disease in young birds or immunocompromised animals. As with reptiles, the clinical picture is non-specific. Depending on the serotype, different signs such as reduced food intake, loss of performance (in commercial poultry), hepatitis, respiratory signs, diarrhoea, etc. can be observed – adenoviruses are very often involved in multifactorial disorders.

Adenovirus – Pathogen Detection		
Material	**Dog:**	CAV-1: EB, tissue (e.g. liver), urine, (faeces) CAV-2: swab without medium (e.g. eye, nose, pharynx), bronchoalveolar lavage
	Guinea pig:	swab without medium from the mucous membranes (mouth, pharynx, trachea), tissue (e.g. lungs), faeces
	Birds:	swab without medium (cloaca or pharynx), tracheal lavage, faeces, tissue (e.g. intestine or liver)
	Reptiles:	swab without medium (cloaca), tissue (small intestine, liver)

Method	Realtime PCR (dog), PCR (guinea pig, birds, reptiles)
Species	Dog, guinea pig, birds, reptiles
Duration	1–3 working days (dog, guinea pig) 2–4 working days (birds, reptiles)

Adenovirus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, rabbit, guinea pig, rat, mouse, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri) (dog) 3–5 working days (small mammals)
Note	▪ **Dog:** Differentiation between vaccination and infection titre can only be done by testing serum pairs. Because of extensive vaccination, the disease has become extremely rare. ▪ This service may not be available in some countries.

14.1.2 Alongshan Virus

Alongshan virus is a flavivirus discovered in China in 2017. There was an increased occurrence of feverish illnesses in humans with frequent hospitalisations. Apart from flu-like symptoms with fever and very severe headaches, there are no known cases of permanent damage or death in humans. In humans, infections caused by the Alongshan virus are a differential diagnosis for TBE, anaplasmosis, rickettsiosis and leptospirosis. Nothing is known about diseases and signs in animals, but antibodies against the virus have already been detected in horses, sheep, goats, cattle and wild ruminants. The pathogen is probably prevalent throughout Eurasia. The virus has already been detected in Finland and Germany. Ixodes ticks have been described as potential vectors.

Alongshan Virus – Pathogen Detection	
Material	EB, S, tick
Method	PCR
Species	No limitations known
Duration	1–3 working days

Aujeszky's Disease Virus ➢ see Herpesviruses, p. 170

14.1.3 Avipoxvirus

Avipoxviruses are only known to cause **avian pox** in birds. They occur in many different bird species. Susceptibility of domestic and wild birds to avian pox infections is only partly understood. Avipoxviruses are primarily transmitted through insects and aerosols.

Birds also become infected through contaminated animals or food and possibly through blood-sucking parasites as well. Introduction into the population mainly happens when buying additional animals or following exhibitions. Infection is also possible when birds peck each other.
There are different characteristic forms. The cutaneous form is the most common one and is characterised by papular efflorescences of the non-feathered skin areas. Mild forms often develop benign skin tumours (head, legs) as a result of the long convalescence period (weeks/months).
The mucous form is characterised by similar lesions on the mucosa of the beak cavity, tongue, pharynx or larynx (fowlpox). The septicaemic form typically displays general symptoms such as ruffled feathers, somnolence, cyanosis and anorexia without exterior pox lesions. Avian pox infections are usually not fatal (exception: canarypox => usually fatal). Avipoxvirus infection is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Poxvirus (Avipoxvirus) – Pathogen Detection	
Material	Crusts/skin material from skin lesions, tissue (pigeon: small intestine, canary: oesophagus)
Method	PCR
Species	Birds
Duration	1–3 working days
Note	The diagnosis can also be made by the histological detection of inclusion bodies.

14.1.4 Bluetongue Virus (BTV)

Bluetongue virus (BTV) is an orbivirus transmitted by biting midges of the genus Culicoides. There are 24 known serotypes.
BTV first spread in Germany between 2006 and 2008, primarily with serotype 8. In 2019, there were again isolated infections with serotype 8, and since the end of 2023, serotype 3 has been spreading throughout Germany. The situation in Europe is dynamic, with serotype 12 also spreading northwestward in Europe recently.
Infection with BTV causes **bluetongue disease** in cattle, sheep and goats, which is characterised by fever, apathy, circulatory disorders, pneumonia and ulcerations on the mucous membranes of the head, teats and the hooves.
Sheep in particular show a severe course of the disease, and the mortality rate can be as high as 50%. In goats and cattle, bluetongue disease is milder, but death is still possible. South American camelids can become infected too, but rarely show clinical signs of the disease.
Infection with the bluetongue virus (serotypes 1–24) is listed under the **EU Animal Health Law (AHL)**.

Bluetongue Virus (BTV) – Pathogen Detection	
Material	EB, tissue (liver, spleen)
Method	Realtime PCR
Species	Ruminants, South American camelids
Duration	1–3 working days
Note	▪ Detection of BTV-1 to 24 (differentiation not possible!) or BTV-3 and BTV-8 as separate, serotype-specific tests ▪ If registration of the PCR result in the relevant national livestock database is required, please provide the official holding or premise identification number and the animal's official ear tag number, or as applicable under national regulations. ▪ We offer a discount if more than 10 samples are sent in at the same time. In this case, please contact us before sending the samples.

Border Disease Virus (BDV) ➢ **see Bovine Viral Diarrhoea Virus (Pestiviruses), p. 154**

14.1.5 Borna Disease Virus

Borna disease virus is a non-segmented, enveloped RNA virus belonging to the family Bornaviridae.

Mammals

Numerous species of mammals are susceptible to this virus. It is of clinical relevance particularly in horses and in sheep. Cattle, goats and South American camelids can also contract the disease. In cats, only one case of Borna disease has been confirmed after the "staggering disease" has recently been attributed to the rustrela virus (see p. 194). Borna disease viruses have a strong neurotropism and trigger non-purulent meningoencephalomyelitis, associated with anorexia, apathy, somnolence and multiple neurological dysfunctions. Animals suffering from **Borna disease** develop motor and behavioural disorders.

Shrews constitute the virus reservoir. They are asymptomatic but infected for life. Other mammals such as horses and sheep as well as humans may be dead-end hosts. The modes of transmission have not yet entirely been clarified; infection probably occurs through the nerve endings of the nasal and pharyngeal mucosa.

According to current knowledge, dead-end hosts do not shed the virus. No natural infections of mammals by horses, sheep or humans have been confirmed. Experimental infections from horse to horse (sheep to sheep, cat to cat) are possible.

In horses and sheep, in addition to the signs listed above, a lowered head posture, separation from the herd, empty chewing and salivation have been described and, at a later stage, recumbency and flailing movements. A seasonal increase of the disease from March to September has been described in horses and sheep.

There is often little or no immune response, which makes it difficult to diagnose by testing for antibodies. The incubation period is unknown. The progression of a clinically manifested infection is fatal (duration of the disease usually 1–3 weeks). Clinically inapparent infections are also possible. In humans, encephalitis caused by Borna disease virus has so far been almost always fatal. Up to now, only a few of these cases have been described.
Borna disease virus infections are not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Birds

Proventricular dilatation disease (PDD) is a globally distributed, serious disease particularly affecting psittacines (large parrots) like macaws, amazons or grey parrots. PDD either affects the gastrointestinal tract, the central nervous system or both areas. This means, on the one hand, there may be digestive disorders such as diarrhoea, vomiting or regurgitation as well as anorexia and the excretion of undigested seeds in faeces. On the other hand, PDD can manifest itself through neurological dysfunctions like ataxia and coordination disorders, tremor or paresis. Both symptom complexes are associated with depression, general weakness and excessive loss of weight.
In addition to peracute and acute deaths, especially in older birds, chronic progressions of the disease can also be observed. Moreover, clinically inapparent birds can be infected with the virus. Breeding flocks and new additions should thus be tested for an infection with avian bornavirus (ABV).
The safest way to detect an ABV infection requires a combination of antibody and pathogen detection. Both test results should always be interpreted together with the clinical signs.

Bornavirus – Pathogen Detection	
Material	Mammals: CSF, tissue (brain), EB (viraemia), intraocular fluid (horse), retina (horse) Birds: swab without medium (crop AND cloaca), tissue (brain, gastrointestinal tract)
Method	Realtime PCR
Species	Cat, horse, psittacines (esp. large parrots), ruminants, South American camelids
Duration	1–3 working days
Note	**Psittacines:** PCR detects the strains parrot bornavirus PaBV-1, PaBV-2, PaBV-4 and PaBV-7.

Bornavirus – Antibody Detection	
Material	S 0.5 ml
Method	IFAT Birds: ELISA

Species	Dog, cat, birds, horse, ruminants, South American camelids, others on request
Duration	1 week 2–4 working days (birds)

14.1.6 Bovine Respiratory Syncytial Virus (BRSV)

Bovine respiratory syncytial virus (BRSV) is an enveloped RNA virus of the family Paramyxoviridae and causes respiratory tract diseases in cattle. It is mainly calves that develop this disease. Infection primarily occurs in the winter months and is characterised by sudden fever, slight hyperpnoea, apathy, rhinitis and cough. Mild bronchiolitis, multifocal lesions and interstitial pneumonia with syncytia formation will develop. The duration of the disease is 3–10 days. In severe cases, it can result in death, otherwise the fatality rate is low. Persistent infections have been described; they may be the reason for maintaining the infection within a herd.
In cattle, BRSV is involved in enzootic bronchopneumonia; it predisposes calves to the adherence of Mannheimia haemolytica.
There are different vaccines available. However, reinfections may occur after some months.

BRSV – Pathogen Detection	
Material	Swab without medium (nose, pharynx), lavage sample, tissue (e.g. trachea or lung)
Method	Realtime PCR
Species	Cattle
Duration	1–3 working days
Note	▪ Particularly in the first phase of infection, BRSV can be detected by means of PCR. ▪ This pathogen detection can be requested individually and it is also part of the PCR tests Bovine Respiratory Profile 1 and 3 (see Chapter 14.5.4, p. 288).

BRSV – Antibody Detection	
Material	S, HP 1 ml
Method	ELISA
Species	Cattle
Duration	2–4 working days
Note	This antibody detection is part of the serological Bovine Respiratory Profile.

14.1.7 Bovine Viral Diarrhoea Virus (BVDV)/ Border Disease Virus (BDV)

BVDV and BDV are RNA viruses that belong to the genus Pestivirus in the family Flaviviridae. They are related to the virus causing European, or classical, swine fever, from which the genus takes its name.

Bovine Viral Diarrhoea Virus (BVDV)
BVDV, a pestivirus, is the causative agent of **bovine viral diarrhoea/mucosal disease (BVD/MD)** in cattle, two diseases that are prevalent worldwide. Sheep, goats, South American cameldis, wild ruminants and pigs are also susceptible to the virus.
BVD virus has 2 genotypes (BVDV-1 and BVDV-2) and the biotypes cytopathogenic (cp) and non-cytopathogenic (ncp).
Infection in cattle results in different signs depending on the time of infection. Transient infections (temporary infections of already born animals) are often asymptomatic, but may lead to diarrhoea, fever, cough and erosions of the mucous membrane particularly in young animals, and to reduced milk yield and fertility disorders (repeat breeding, abortions) in cows. Transiently infected animals temporarily shed the virus to a certain extent (nasal discharge, saliva, faeces, semen).
In pregnant animals, infection in early gestation causes early abortions. During mid-gestation, persistently infected calves develop due to foetal immune tolerance. In late gestation, there is a tendency for calves to be born with malformations of the central nervous system (oculocerebellar syndrome).
Persistently infected calves (PI animals) develop during the infection of the mother between the 40th and the 120th day of gestation, because the immune system of the calf does not recognise the virus as "foreign". PI calves are usually born without abnormalities and shed large quantities of the virus in all secretions and excretions throughout their lives. PI animals are typically seronegative, but can also form antibodies after being infected with a heterologous BVD strain.
If a PI animal is additionally confronted with a cp virus strain through mutation of the prenatally acquired strain or a new, postnatal infection, it will develop a severe and always fatal **MD.**
Infection with the BVD virus is listed under the **EU Animal Health Law (AHL)**.

Border Disease Virus (BDV)
The most common pestivirus infection in sheep and goats is caused by BDV, which is closely related to BVD virus.
While the infection is clinically inapparent in non-pregnant animals, infection in pregnant animals can lead to abortions and is an important differential diagnosis when abortion and stillbirth occur. In addition, weak, underdeveloped and sometimes malformed lambs are born, which have a hairy coat and central nervous system-related tremors, hence the term **"hairy shaker disease"**.

The severity of **border disease** depends on when the pregnant female becomes infected: Females infected before the 50th day of pregnancy abort or resorb their foetuses. Between the 50th and the 85th day of gestation, infection can result in either immunotolerant persistently infected lambs, which are lifelong virus shedders, or in the weak and malformed lambs and goat kids described above. Offspring infected late in pregnancy have sufficient immunity and are born healthy.

BVDV – Pathogen Detection	
Material	EB, milk, faeces, tissue (e.g. ear tissue tag samples, spleen, brain, abortion material)
Method	Realtime PCR
Species	Cattle
Duration	1–3 working days

BVDV/BDV (Pestiviruses) – Antibody Detection	
Material	S, milk 0.5 ml
Method	ELISA
Species	Cattle, sheep, goat
Duration	2–4 working days
Note	As the viruses are closely related, the test detects antibodies against both the bovine viral diarrhoea virus and the border disease virus.

14.1.8 Caliciviruses

Caliciviruses see also
- ➢ *European Brown Hare Syndrome Virus (EBHSV), p. 166*
- ➢ *Rabbit Haemorrhagic Disease Virus (RHDV), p. 189*

There are numerous strains of **feline calicivirus (FCV)** with only slight serological differences but large genetic divergence, resulting in wide variations in virulence. Signs of FCV therefore range from inappetence and fever to joint and muscle pain to a severe systemic progression of the disease. Acute oral signs and diseases of the upper respiratory tract are frequently described. In rare cases, interstitial pneumonia occurs. The typical proliferate and exudative ulcers in the oral cavity are often aggravated by secondary bacterial infections.

Calicivirus Cat (FCV) – Pathogen Detection	
Material	Swab without medium (conjunctiva, oral cavity or pharynx), EB (only during the viraemia phase)
Method	Realtime PCR
Species	Cat
Duration	1–3 working days

Note	Due to genetic divergence, not all strains can be detected by means of PCR. Detection in the blood is only possible during the viraemia phase.

Calicivirus Cat (FCV) – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Differentiation between vaccination and infection titre is usually only possible by analysing serum pairs. Therefore, detection by PCR is preferable.

14.1.9 Carp Edema Virus (CEV)

Carp Edema Virus was first described in Japan in 1974 and in Germany in 2014 and belongs to the family Poxviridae. Three different CEV lines have been identified that can lead to clinical signs in koi carp and carp. **Koi sleepy disease** typically occurs at water temperatures of 15–25 °C, but especially in carp, temperatures may also be much lower. The incubation period depends on the water temperature. Signs are lethargy and lying motionless on the ground. Additionally, there may be erosive or haemorrhagic skin lesions with oedema of the underlying tissue as well as an excessive production of mucous on skin and gills. Secondary infections are possible.
In differential diagnosis, koi herpesvirus (KHV), spring viraemia of carp (SVC), a high organic load of the water and infestation with ectoparasites need to be considered.

Carp Edema Virus (CEV) – Pathogen Detection	
Material	Tissue (gill biopsy)
Method	Realtime PCR
Species	Fish
Duration	1–3 working days

14.1.10 Chronic Bee Paralysis Virus (CBPV)

Chronic bee paralysis virus is an RNA virus which, so far, cannot be assigned to any family. This virus affects adult bees. Infected animals are unable to fly, they crawl on the ground, often have a bloated abdomen and diarrhoea; the affected bees die 5–10 days after the onset of the disease. **Loss of hair** and an asymptomatic progression are possible. Transmission occurs through bee faeces. Whether the Varroa mite is involved in spreading or in worsening the course of the disease is debatable. There are often self-healing processes in the colonies. If the progress is particularly severe, an artificial swarm can be created with brood hatched in an incubator.

Chronic Bee Paralysis Virus (CBPV) – Pathogen Detection	
Material	Bee heads
Method	Realtime PCR
Species	Bees
Duration	1–3 working days

14.1.11 Circoviruses

Circoviruses are non-enveloped DNA viruses characterised by high environmental resistance and pronounced genetic variability.

Dog

Canine Circovirus

Canine circovirus was first detected in canine blood samples in the USA in 2012/2013 and was described in a dog with necrotising vasculitis and granulomatous lymphadenitis. In a subsequent study, it was mainly found in faecal samples from dogs with diarrhoea. In 2014, it was detected in Italy and in 2015 in Germany as well. Circoviruses can also be found in healthy dogs; further studies will be necessary to clarify questions on the pathogenesis and epidemiology.

Canine circovirus should be considered in the differential diagnosis in case of diarrhoea/vomiting, lethargy, hepatic diseases, haemorrhage and vasculitis. Co-infections with other, mainly enteropathogenic agents are frequently observed. Similarly, an infection with canine circovirus can further complicate other infectious diseases.

Psittacidae

Psittacine Beak and Feather Disease (PBFD)

PBFD is characterised by an impaired growth of the beak, the feathers and claws. The disease is globally distributed and affects many parrot species. Cockatoos, grey parrots, eclectus parrots, lovebirds (Agapornis spp.) and lorikeets are particularly susceptible to infection, with cockatoos and grey parrots developing particularly severe courses of the disease.

Nestlings mostly die peracutely, while the course of the disease is acute in fledglings. Animals show clinical signs of lethargy, loss of appetite as well as vomiting and/or diarrhoea. Death is possible within 1–2 weeks. Changes in the developing feathers are pathognomonic – but usually only visible in chronic forms. Symmetric feather loss occurs or the feathers get stuck in the shaft and will then break off. Lesions on the beak and, rarely, on the claws will only occur later on.

Transmission of the virus mainly takes place horizontally. The virus is spread with the faeces, the shedding of developing feathers and with the crop content of feeding parent birds. Thus, nestlings can be infected very early on. Vertical transmission is also possible, but of secondary importance. Here, hatching birds are infected through egg shells that are contaminated with circoviruses.

Pigeon

Pigeon Circovirus (PiCV)

Circovirus infections mainly occur in pigeons aged 6 weeks to 12 months (**young pigeon disease syndrome**). The clinical picture is non-specific; signs include lethargy, anorexia, diarrhoea, wasting and PBFD-like changes in the feathers. The disease is accompanied by immune suppression, and organ alterations occur, particularly in the central immune system and the spleen. In addition to the clinically manifest form especially in young pigeons, there is also a high number of subclinically or persistently infected animals.

Pig

Porcine Circovirus 2 (PCV-2)

Porcine circovirus type 2 (PCV-2) is associated with the so-called **post weaning multisystemic wasting syndrome (PMWS)**. PMWS is usually observed in weaners and less frequently in suckling piglets. Affected animals show a progredient loss of weight as well as respiratory disorders with coughing, which are often complicated by secondary bacterial infections. PCV-2 can be detected in the tissue of infected piglets by means of PCR. In conjunction with PMWS, co-infections of PCV-2 with porcine parvovirus or PRRSV are being discussed.

Circovirus – Pathogen Detection		
Material	**Dog:**	faeces, EB (viraemia), tissue (esp. liver, lymphoid tissue, intestine, kidney)
	Psittacidae:	2–3 feather shafts (recently plucked), blood (EB or 1–2 drops on a filter paper), cloacal swab, (faeces)
	Pigeon:	2–3 feather shafts (recently plucked), swab without medium (cloaca), blood (EB or 1–2 drops on a filter paper, viraemia!), faeces, tissue (bursa Fabricii, spleen, liver)
	Pig:	EB, swab without medium (nose or pharynx), lavage sample (BAL), tissue (e.g. lung, trachea, abortion material or foetal organs)
Method	Realtime PCR (dog, Psittacidae, pig: PCV-2)/PCR (pigeon)	
Species	Dog, Psittacidae, pigeon, pig	
Duration	1–3 working days	
Note	The PCR test Circovirus (PBFD) for Psittacidae does **not** detect circovirus infections of other bird species.	

14.1.12 Coronaviruses

SARS-CoV-2 see ➢ *Chapter 13.1.47, p. 195*

Coronaviruses are enveloped RNA viruses which have club-shaped appendages on their surface that look like a crown under the electron microscope and have thus given the virus family its name. As they are genetically highly variable, transmission of coronaviruses to and among different species is possible. They belong to a large group of RNA viruses that can cause respiratory and/or enteral diseases in various animal species and in humans.

Dog

An infection with **canine enteric coronaviruses (CECoV, also CCoV or CCV)** is usually asymptomatic or may lead to mild, non-haemorrhagic diarrhoea. In puppies, however, severe courses of the disease with haemorrhagic gastroenteritis are possible. The most noticeable signs are vomiting and watery to bloody diarrhoea, accompanied by severe dehydration. The virus is excreted via the faeces; the duration of excretion is usually less than two weeks.
CECoV is also infectious to other canids as well as to cats and pigs, but the pathogenicity of these species is not yet known.
Canine respiratory coronavirus (CRCoV) was first detected in a dog in 2003. It appears to have originated from bovine coronavirus, since both viruses share very close similarities. In general, respiratory coronavirus can frequently be detected in the majority of dogs suffering from kennel cough (also known as canine infectious respiratory diseases (CIRD) complex).
In many dogs with mild or moderate signs, such as cough or nasal discharge, but also in asymptomatic dogs, the virus can mainly be found in the trachea.

Cat

There are two pathotypes of feline coronaviruses **(FCoV)**: For one, they occur as weakly virulent enteric FCoV. These viruses are merely "diarrhoea pathogens" which infect the intestinal epithelial cells. For another, there is a form altered by mutations in the spike protein which can replicate massively in macrophages and thus cause feline infectious peritonitis (FIP).
A cat from a multi-cat household is more likely to excrete the virus than a cat from a single-cat household. The higher the infection pressure, the more likely it is that enteric coronaviruses mutate and cause FIP.
According to different studies, 1–12% of the cats infected with FCoV actually develop FIP. Often, two different forms of FIP are distinguished: the wet (effusive) and the dry (granulomatous) form. Clinically, the signs of FIP range from pyogranulomatous swelling of the serosa and organs (especially liver, spleen and lungs) to severe polyserositis with the formation of highly viscous effusions (ascites, but also thoracic/pleural effusions). Cats often develop anaemia with icterus, emaciation and high fever. There may also be CNS symptoms and, due to the deposition of precipitates, uveitis.

A positive titre indicates that the cat had been in contact with coronaviruses. This is the case with most adult animals. They do not suggest that this cat will contract FIP. Shedders of enteric FCoV can be identified by PCR from faecal samples. In animals suffering from FIP, there are often only low to negative antibody titres. In this case, the antibodies have been bound in immune complexes; thus, antibodies are no longer detectable. For further evaluation, a serum protein electrophoresis and the determination of the albumin/globulin ratio can be included. Diagnostic information is provided by an increase in the gamma globulin fraction and an albumin/globulin ratio below 0.6. In addition, a positive PCR result for FCoV from effusions or tissue can be an important indicator of FIP and, in combination with electrophoresis (and the Rivalta test or cytology), can contribute to the diagnosis.
FIP is generally considered to be a disease that affects individual animals. A higher incidence of cases in animal shelters or multi-cat households is due to higher infection pressure and the corresponding higher rate of reinfection and viral mutation.

However, in 2023, there was a severe outbreak of FIP in Cyprus (Attipa et al., Nature, 2025 Jul 9;645(8079):228–234). Within seven months, the number of cases confirmed by PCR increased by more than 40-fold compared to 2022. Subsequent tests detected a highly pathogenic recombinant feline/canine coronavirus, which is referred to as **FCoV-23**. Preliminary data indicate **direct transmission** of this virus: It seems to cause FIP without requiring a change in biotype. We offer the specific detection of FCoV-23 if there is a positive PCR result for coronavirus. Among the samples submitted to Laboklin, FCoV-23 has already been detected in cats from various European countries.

Ferret

Ferret enteric coronavirus can cause epizootic catarrhal enteritis (ECE) in ferrets with mucoid, greenish, malodorous diarrhoea, especially in adult animals. It is shed in saliva and faeces.
Ferret systemic coronavirus can cause a disease similar to FIP, which mainly affects ferrets under 18 months of age. Signs may be non-specific (including diarrhoea, weight loss, lethargy, hyporexia/anorexia, vomiting). In some cases, neurological signs, such as paresis, ataxia, tremor or seizures, can be observed.
Information on the detection of SARS-CoV-2 can be found in Chapter 14.1.47, p. 195.

Horse

Equine coronavirus (**ECoV**) is a betacoronavirus that has been detected in the USA, Japan and Europe and is associated with fever, colic and diarrhoea. Adult horses are particularly affected during the cold season. Neurological abnormalities are rarely observed – secondarily caused by hyperammonaemia. Infections can affect several animals in a herd, but are largely self-limiting. However, secondary complications can worsen the course of the disease.
Transmission is mainly via the faecal-oral route.

Cattle and Wild Ruminants

Bovine coronaviruses (**BCoV**) cause enteric and respiratory diseases in cattle and wild ruminants. These include calf diarrhoea, winter dysentery in adult cattle and respiratory diseases in cattle of different ages.

Pig

In pigs, coronaviruses cause highly contagious, sometimes epidemic **transmissible gastroenteritis (TGE)**. TGE virus presents an economic problem in all countries with intensive pig production. Loss of income occurs in the affected farms as a result of piglet losses, growth retention and reduced weight gain.

An infection with porcine coronavirus leads to a local infection of the intestinal tract, mostly in the jejunum and ileum. As the disease progresses, the villous epithelium is rapidly lost. Clinically, this is manifested in a watery malodorous diarrhoea. TGE is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Coronavirus – Pathogen Detection		
Material	**Dog:**	CECoV: faeces CRCoV: swab without medium (pharynx, nose, trachea), BAL
	Cat:	Qualitative detection: enteral FCoV: faeces/ FIP: puncture fluid (effusions), CSF, EB, intraocular fluid, tissue (e.g. kidney or omentum) Quantitative detection: faeces, puncture fluid (effusions), EB FCoV-23, Cyprus variant: puncture fluid (effusions), CSF, EB
	Ferret:	faeces, EB (viraemia phase), CSF (neurological signs), tissue (intestine, lymph nodes)
	Horse:	faeces
	Cattle:	faeces, swab without medium (nose), tissue (e.g. lung)
	Pig:	faeces, tissue (e.g. intestine)
Method	Realtime PCR	
Species	Dog, cat, ferret, horse, cattle, pig	
Duration	1–3 working days FCoV-23: 2–4 working days (subsequent to a positive coronavirus test)	
Note	▪ In small animals, a pooled faecal sample is recommended as this increases sensitivity.	
	Cat:	▪ Faeces: Detection of enteric FCoV for assessing the infection pressure in the group and to help decide on possible rehabilitation. A cat is considered free if PCR was negative in 3 tests at weekly intervals and each time pooled faecal samples from 3 days were examined. ▪ Puncture fluid: A high number of viruses detected in the abdominal and/or thoracic effusion strongly indicates FIP (always in conjunction with other diagnostic parameters such as protein electrophoresis, albumin/globulin ratio)

- EDTA blood: alternative sample material if there is no effusion (note: possibly lower sensitivity and viraemia phase with enteric FCoV)
- **Qualitative PCR:** This service is also offered in combination with the FIP screening.
- **Cyprus variant:** We offer specific detection of FCoV-23 following a positive feline coronavirus test. This may assist in a more refined assessment of the virus's transmissibility.
- **Quantitative PCR:** Quantification can be requested separately as an individual test, added subsequent to a qualitative PCR, or ordered in combination with the FIP screening or FIP monitoring (+AGP) as "FIP screening/monitoring".

- **Ferret:** Differentiation between enteric and systemic coronaviruses is performed automatically.
- **For pathogen detection of SARS-CoV-2 see Chapter 14.1.47, p. 195**

Coronavirus, bovine and feline – Antibody Detection	
Material	**Cat:** S, HP, ascites 0.5 ml **Cattle:** S, HP 1 ml
Method	ELISA (cat FCoV, cattle BCoV)
Species	Cat, cattle
Duration	Reporting of results on the day the sample is received (Mon–Fri) (cat) or 2–5 working days (cattle)
Note	A positive titre merely confirms contact with coronaviruses. **Cat:** For the online submission forms, there are two different service IDs – one for samples from ascites material and one for serum or plasma.

14.1.13 Cytomegalovirus

Cytomegaloviruses belong to the herpesviruses and have been detected in different rodents. They are considered strictly host-specific. In guinea pigs, salivary and lacrimal glands become inflamed and respiratory signs may occur as well. In rare cases, there might also be signs of paralysis.

Cytomegalovirus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Guinea pig, rat, mouse
Duration	3–5 working days
Note	This service may not be available in some countries.

14.1.14 Deformed Wing Virus (DWV)

Deformed wing virus (DWV) is an RNA virus from the family Iflaviridae, which causes wing deformities in adult honey bees. All developmental stages can be affected. If already the larva is infected, it will develop crippled wings, a bloated abdomen and discolouration during metamorphosis, and the animal dies shortly after emerging. The virus causes a latent infection that persists. Thus, bees without any signs can still be carriers. The Varroa destructor mite is among the vectors of this virus and its move to other colonies poses a major problem in the spreading of the disease. There is no causal therapy.

Deformed Wing Virus (DWV) – Pathogen Detection	
Material	Bees
Method	Realtime PCR
Species	Bees
Duration	1–3 working days

14.1.15 Distemper Virus

Canine distemper virus (CDV) belongs to the genus Morbillivirus (measles-distemper-rinderpest group). Susceptible species include members of the families Canidae (such as dog, fox, wolf), Procyonidae (like raccoon), Mustelidae (such as ferret, badger, marten) and Felidae (tiger, lion). Distemper is enzootic worldwide. Transmission takes place orally or airborne via secretions and excretions of infected dogs or clinically healthy carriers. Intrauterine infections are also possible. Distemper is a febrile general disease with an acute to subacute course. A respiratory, an intestinal, a central nervous and a cutaneous form of the disease can be distinguished.
Virus excretion begins after approx. 7 days (up to 60 to 90 days p.i.), during which a typical cyclic infection with leukocyte-associated (possibly also non-cell-bound) viraemia occurs. Depending on the ability of the immune system to produce neutralising antibodies, distemper can take a mild or fatal course.

Distemper Virus – Pathogen Detection	
Material	Qualitative PCR: swab without medium (eye, nose, pharynx or tonsil), EB (viraemia), CSF, urine, faeces Quantitative PCR (dog): swab without medium
Method	Realtime PCR
Species	Dog, ferret, big cats, racoon, other species
Duration	1–3 working days
Note	**Dog:** Quantitative PCR can also be requested following qualitative PCR. The viral load can indicate whether the viruses are field or vaccine strains. A high viral load indicates a field infection, even if the dog has previously been vaccinated with live vaccine against distemper. A low viral load denotes a vaccine strain, if a distemper

vaccination was given in the last few weeks. Otherwise, it may be a beginning or abating field infection. For medium viral load, we offer distemper vaccine PCR – unless vaccination was carried out with Vanguard® (Zoetis).

Distemper Virus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, ferret, others on request
Duration	1–2 working days
Note	Differentiation between vaccination and infection titre can only be done by testing serum pairs.

14.1.16 Epizootic Haemorrhagic Disease Virus (EHDV)

Like BTV, EHDV is an orbivirus and is transmitted by biting midges of the genus Culicoides; transplacental transmission is also possible. In cattle, the clinical signs are comparable to those of a BTV infection: In addition to fever, lethargy, reduced milk yield, etc., there are lesions on the skin and mucous membranes and haemorrhagic lesions. In sheep and goats, the infection is usually asymptomatic. The virus was first detected in the EU in 2022 and has since spread from Spain and Italy. In North America, it particularly causes disease in white-tailed deer and is associated with high mortility rates. Infection with the epizootic haemorrhagic disease virus is listed under the **EU Animal Health Law (AHL)**.

Epizootic Haemorrhagic Disease Virus (EHDV) – Pathogen Detection	
Material	EB, tissue (spleen), abortion material
Method	Realtime PCR
Species	Cattle, sheep, goat
Duration	1–3 working days

14.1.17 Equine Arteritis Virus (EAV)

Equine viral arteritis (EVA) is a worldwide distributed, contagious viral infection of Equidae caused by the equine arteritis virus (EAV). Confirmed outbreaks seem to have increased in recent years. The majority of naturally acquired infections is subclinical; however, seroconversion still occurs. When clinical signs appear, they vary in type and severity: fever, depression, anorexia and peripheral oedema, conjunctivitis ("pink eye"), urticaria and abortion. In young animals, pneumonia and pneumoenteritis may also be seen. The virus is mainly transmitted through ejaculate. Persistently infected carrier stallions carry the virus in their accessory sex glands and intermittently shed it in the genital secretions. Geldings, prepubescent stallions and mares cannot be carriers.

Especially in animals with systemic disease, excretion can also occur through other body secretions, such as aerolised secretions of the respiratory tract, urine, abortion material, etc.
Infection with EAV is listed under the **EU Animal Health Law (AHL)**.

Equine Arteritis Virus (EAV) – Pathogen Detection	
Material	Swab without medium (conjunctiva, pharynx), EB (viraemia), sperm, urine, abortion material
Method	Realtime PCR
Species	Horse, donkey
Duration	1–3 working days

Equine Arteritis Virus (EAV) – Antibody Detection	
Material	S 0.5 ml
Method	VNT
Species	Horse
Duration	3–6 working days
Note	▪ This detection is mainly required for export. It may be necessary to test paired samples after 3–4 weeks. ▪ Differentiation between vaccine and infection titre is not possible!

14.1.18 Equine Hepacivirus (EqHV)

Hepaciviruses belong to the Flaviviridae. Equine hepacivirus was formerly known as non-primate hepacivirus (NPHV). Transmission mainly occurs via blood products (plasma, tetanus antitoxin, PMSG, etc.) as well as through iatrogenic or vertical routes.
The virus is hepatotropic and is associated with hepatic disease (hepatitis). Infection can also be subclinical.

Equine Hepacivirus (EqHV) – Pathogen Detection	
Material	S, EB, tissue (liver, also paraffin-embedded)
Method	Realtime PCR
Species	Horse
Duration	1–3 working days
Note	This test is also part of the PCR profile Hepatotropic Viruses (horse), see Chapter 14.5.3, p. 286.

14.1.19 Equine Infectious Anaemia Virus (EIAV)

Equine infectious anaemia (EIA) is a worldwide distributed disease in Equidae, caused by a retrovirus, with acute lethal to chronic recurrent forms. Characteristic signs are recurrent fever, anaemia, thrombocytopenia, distal oedema and considerable weight loss. Transmission takes place via infected blood, blood-sucking insects, iatrogenic through infected injection equipment, but also intrauterine.
Once infected horses remain infectious and seropositive throughout their lives. All horses older than 6 months that are seropositive are thus considered carriers; younger horses can be seropositive through maternal antibodies. Normally, the incubation period is 1–3 weeks, but may also last up to 3 months.
This disease is listed under the **EU Animal Health Law (AHL)**.

Equine Infectious Anaemia Virus – Antibody Detection	
Material	Agar gel diffusion test (Coggins test): S 0.5 ml ELISA: S 2 ml
Method	Agar gel diffusion test (Coggins test), ELISA
Species	Horse, other Equidae
Duration	Agar gel diffusion test (Coggins test): 3 working days ELISA: Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ First antibodies can be detected 2–3 weeks post infection. If the results of the serological examination are negative but animals are suspected of being infected, the test should be repeated, possibly several times, at intervals of 3 to 4 weeks. ▪ In Germany, the authorities must be notified of a positive Coggins test. A positive ELISA must be confirmed by a Coggins test.

14.1.20 European Brown Hare Syndrome Virus (EBHSV)

European brown hare syndrome (EBHS), also called viral hepatitis of hares, is a disease of the hare species Lepus europaeus and Lepus timidus and is similar to RHD in rabbits. The disease was first described in Scandinavia in the 1980s and has since occurred in numerous European countries; several cases have been reported in Germany as well. The causative agent of EBHS is a calicivirus (genus Lagovirus), which only causes the disease in hares. As far as is known, rabbits (and other animal species, too) are not affected. The virus is shed in all secretions and excretions and is very environmentally stable. Transmission presumably occurs directly, particularly faecal-orally or indirectly through contaminated water and feed. The disease is peracute to acute and is characterised by a very high morbidity and mortality rate (up to 100%). If at all possible, signs are rarely observed in free-living wildlife. They include: weakness, apathy, disorientation, loss of shyness and movement disorders (e.g. paralysis of the hind legs). There is no known therapy.

EBHS Virus – Pathogen Detection	
Material	Faeces, tissue (e.g. liver), (urine)
Method	Realtime PCR
Species	Hare (not rabbit!)
Duration	1–3 working days

14.1.21 Feline Immunodeficiency Virus (FIV)

Feline immunodeficiency virus (FIV) belongs to the family Retroviridae. It is closely related to the human immunodeficiency virus (HIV) but is not infectious for humans. Since FIV is mainly transmitted through bite injuries, the prevalence of infected animals is highest in the group of uncastrated male cats over five years. FIV infection is spread worldwide. The prevalence in Germany is at approximately 3–5.5%. The virus persists for life. It has a clear tropism for T lymphocytes and macrophages. Similar to the clinical symptoms of HIV-infected patients, the course of FIV infection is often divided into four stages, with the final stage resembling human AIDS. However, transitions are smoother and the phase with no clinical signs is often longer than in humans. Detection should be performed, among others, in chronic recurrent and treatment-resistant infections, particularly in the oral cavity and the respiratory tract.

FIV Provirus – Pathogen Detection	
Material	EB
Method	Realtime PCR, qualitative or quantitative
Species	Cat
Duration	Qualitative PCR: 1–3 working days Quantitative PCR: 5–10 working days
Note	Quantitative PCR: estimation of provirus load (therapy monitoring)

FIV – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	ELISA
Species	Cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	A positive result indicates FIV infection. Positive titres are possible in kittens with maternal antibodies. In questionable cases, the test should be repeated after 3–6 weeks or confirmed by further tests (FIV blot/FIV provirus PCR).

FIV Blot – Antibody Detection	
Material	S 0.5 ml
Method	Line immunoassay
Species	Cat
Duration	2–6 working days
Note	In the FIV blot, antibodies against three FIV-specific antigens are detected separately. This makes the FIV blot suitable as a confirmatory test or for the clarification of questionable results. A negative result does not completely rule out an infection. False negative results can, for example, occur early or late stages of the disease.

14.1.22 Feline Leukaemia Virus (FeLV)

Like feline immunodeficiency virus (FIV), feline leukaemia virus (FeLV) belongs to the retroviruses. The prevalence of FeLV in Germany is low, but infection is still possible. Not only cats, but also other felids are susceptible to FeLV. In particular, kittens and cats from multi-cat households but also cats with a history of foreign travel are affected. FeLV is transmitted directly from cat to cat. The main source of transmission is saliva, but other secretions and excretions can also be infectious. In most cases, cats with this form develop an oropharyngeal infection. The virus penetrates the mucous membranes and multiplies there as well as in the tonsils and the retropharyngeal lymph nodes. While some cats with abortive infection are able to fight the virus in a way that no viraemia occurs, other cats develop viraemia which can be detected by an antigen test. If it can be overcome by the cat, it is called transient viraemia. It is therefore always advisable to retest a cat that is positive in the antigen test at a later time. However, some cats do not succeed in fighting off the virus sufficiently, so that the bone marrow becomes infected as well. As a result, provirus PCR is positive, regardless of whether the virus continues to circulate in the blood (progressive infection) or not (regressive infection).
Cats with progressive infection usually have the worst prognosis, younger animals are more often affected by progressive infection than older ones.

FeLV Provirus – Pathogen Detection	
Material	EB, bone marrow
Method	Realtime PCR
Species	Cat
Duration	1–3 working days
Note	Detection of provirus can confirm a positive antigen result. Regressive infections can also be detected if no antigen is present in the blood.

FeLV – Antigen Detection	
Material	S, EP, HP 0.5 ml
Method	ELISA
Species	Cat
Duration	Reporting of results on the day the sample is received (Mon–Sat)
Note	In order to distinguish abortive from progressive infections, a positive detection should always be checked. This can be done after 4–6 weeks at the earliest, but better after 16 weeks. As this is an antigen detection, a "cross reaction" in vaccinated cats can be excluded.

FIP ➢ see Coronaviruses, p. 159

14.1.23 Feline Morbillivirus (FeMV)

Feline morbillivirus (FeMV) is a member of the genus Morbillivirus in the family Paramyxoviridae which also includes canine distemper virus and rinderpest virus. Infection with FeMV is associated with chronic tubulointerstitial nephritis, which leads to chronic kidney disease, one of the most common causes of death in older cats. FeMV was first discovered in China in 2012 and has since been detected worldwide. It is currently assumed that there are two different FeMV genotypes (FeMV-1 and FeMV-2), which probably lead to different clinical manifestations. Concerning the pathogenesis, it is still unclear whether FeMV infections directly cause chronic kidney disease or whether the virus primarily affects kidney tissue that is already damaged. It seems that FeMV is not only limited to cats, as it has also been detected in opossums with pneumonia and nephritis as well as in dogs. In dogs, however, the virus has so far only been described as part of kennel cough (canine infectious respiratory disease complex).

Feline Morbillivirus (FeMV) – Pathogen Detection	
Material	Urine (at least refrigerated until arrival at the laboratory – preferably frozen)
Method	Realtime PCR
Species	Cat
Duration	1–3 working days
Note	Due to the instability of RNA viruses in feline urine, it is recommended to send in samples which are fresh and possibly frozen.

Flaviviruses, West Nile Virus Antibodies ➢ see West Nile Virus, p. 199

14.1.24 Hantavirus

In rats and mice, hantaviruses lead to a persistent infection and it is assumed they are permanently excreted in the urine as well as through faeces and saliva, without the animals showing any symptoms. Hantaviruses are specific to individual rodent species and only very rarely spread to other species. Rodents are infected in the burrow, in territorial fights or while rearing the young.
It is a zooanthroponosis which leads to severe medical conditions in humans. In Europe, the clinical picture is mainly dominated by fever and nephropathies (dialysis required) or haemorrhages.

Hantavirus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Rat, mouse
Duration	3–5 working days
Note	This service may not be available in some countries.

14.1.25 Herpesviruses

Herpesviruses occur in many animal species and are usually host-specific. Common to all herpesviruses is lifelong latency in the host organism.

Herpesviruses dog (CHV-1)

The so-called "puppy death" in dogs is caused by canine herpesvirus 1 (CHV-1). Puppies under 3 weeks of age die of haemorrhagic systemic disease. There is massive lytic virus replication at a subnormal body temperature of 36–37 °C and death occurs within 48 hours. The morbidity rate is 100%, the mortality rate is almost 95%!
Older puppies usually show mild respiratory signs, that is why an aetiological involvement in kennel cough complex is attributed to CHV.
Adult animals usually go through clinically inapparent infections. CHV-1 leads to a latent infection; after a primary cell-lytic infection, the viruses retreat into the ganglion cells. In stressful situations (e.g. birth or incipient lactation), viruses may be reactivated and then shed in saliva as well as nasal and ocular secretion. Female dogs can transmit the virus in utero to the foetuses; abortions and stillbirths are rare. In adult immunocompromised animals, a peracute course of the disease with fatal outcome is possible. A diagnosis of breeding animals is recommended.
An infection with suid herpesvirus 1 causes **Aujeszky's disease (pseudorabies)**.
For more information see Herpesviruses pig, p. 173.

Herpesviruses cat (FHV)

The main signs of feline herpesvirus 1 (FHV-1) are respiratory symptoms such as rhinitis and sinusitis with ocular and nasal discharge. Conjunctivitis, corneal ulcers, dyspnoea and anorexia may occur. Co-infections, for example with feline caliciviruses and bacteria,

are possible. After the primary infection, a lifelong latent infection develops which may be reactivated under stress at any time and thus lead to recurrent symptoms. In kittens, apart from very high fever and general weakness, there may also be deaths (fading kitten syndrome).

Herpesviruses birds

There are many different herpesviruses that are found in birds, including commercial poultry, ornamental, wild and zoo birds. The best-known and perhaps clinically most relevant herpesvirus in parrots is psittacid herpesvirus 1 (PsHV-1).
PsHV-1 is responsible for **Pacheco's disease** in parrots and is therefore also called **Pacheco's virus.** The clinical course depends on the genotype or serotype and the affected psittacine species. For budgerigars and cockatiels, mild to subclinical courses with virus shedding are reported. In large parrots, such as macaws, amazon parrots, cockatoos or grey parrots, an infection often leads to death. If symptoms occur, they are usually non-specific and consist of anorexia, apathy and poorly developed feathers. Changes in faecal/urate excretion and CNS signs have also been observed. The disease particularly breaks out in stressful situations. Therefore, a suitable preliminary examination of birds that are to be integrated into the flock is recommended in order to avoid posing a threat to the other birds.
An examination for herpesviruses may also be appropriate for other animals with systemic diseases, diseases of the respiratory system, the liver or with skin lesions or lesions of the mucous membrane at the cloaca or around the beak.
In amazon parrots and cockatoos, psittacid herpesviruses can also be detected in papillomas in the throat and the cloaca.

Herpesviruses reptiles

Herpesvirus infections are most common in a variety of chelonians, including tortoises, terrapins and sea turtles. In the veterinary practice, herpesviruses of **tortoises** of the genus Testudo play an important role. As this is a highly contagious virus infection, animals should be routinely examined for infection before being introduced into a population. In tortoises, clinical signs include nasal and ocular discharge, regurgitation, anorexia and lethargy. Necrotic plaques in the oral cavity and on the tongue are also typical.
So far, 4 different types of herpesvirus, **testudinid herpesvirus 1–4 (TeHV-1–4)**, are known in tortoises. In Europe, especially TeHV-1 and TeHV-3 are found. TeHV-3 has a broad host range among tortoises and infections are usually associated with very high morbidity and mortality rates. TeHV-1 can mostly be detected in Russian tortoises (Testudo horsfieldii). Individual cases of TeHV-2 (especially in desert tortoises) and TeHV-4 (in African tortoises) have been detected in Europe in recent years.
In **turtles,** herpesvirus infections are mainly associated with diseases of the liver, the upper respiratory tract, the upper digestive tract and the skin. In live animals, dry pharyngeal and cloacal swabs, and in dead animals, liver samples can be examined by PCR.
In **sea turtles**, herpesviruses cause fibropapillomatosis and other diseases. Virus detection by PCR is possible from altered tissue.
In **lizards,** herpesviruses are mainly seen in connection with oral lesions.

Herpesviruses amphibians

Especially in toads, infection with **bufonid herpesvirus 1 (BfHV-1)** causes proliferative to ulcerative skin lesions, which can be multifocal to confluent and are often brownish in colour. Retained skin in the affected areas leads to abnormal shedding. There may also be CNS signs as well as clinically inconspicuous infected animals. The disease seems to occur mainly in spring, after brumation and during the mating season. The virus is excreted through the skin and is probably transmitted through direct contact.
Especially in frogs, infection with **ranid herpesvirus (RaHV-3)** causes noticeable, multifocal, poorly defined light brownish to grey, slightly protruding firm skin lesions. No abnormalities were detected in virus-positive tadpoles. There may also be infected adult animals that show no clinical signs. The disease seems to occur mainly in spring, after brumation and during the mating season. The virus is excreted through the skin and is probably transmitted through direct contact.

Herpesviruses koi (KHV)

Koi herpesvirus **(KHV)** is a highly infectious virus that has caused epidemic disease in carps (koi and common carps) in recent years, depending on the water temperature. Morbidity and mortality rates can be as high as 100% within 1–2 weeks after the pathogen has been introduced. The incubation period ranges from a few weeks to several months. It depends on various external and internal factors such as stress and condition of the fish. Fish of all age groups are affected at water temperatures between 18–29 °C. Clinically, the main signs are gill necrosis, increased mucus production, haemorrhages of the skin, liver, spleen and kidneys. Surviving fish probably remain latent carriers of the virus for years and represent a potential hazard in the trade with live fish in pond management and hobby animal keeping. Immunisation by means of live attenuated vaccine is currently rejected from a scientific point of view.
Detection of koi herpesvirus is listed under the **EU Animal Health Law (AHL)**.

Herpesviruses horse (EHV)

EHV-1 and EHV-4

In horses, donkeys, mules and zebras, infections with EHV-1 as well as with EHV-4 are caused by droplet infection or direct contact. The severity of the clinical signs depends on the age and immune status of the infected animal. Particularly infections with EHV-1 are able to spread beyond the respiratory mucosa and cause severe manifestations of the disease: abortions, perinatal foal death, neurological diseases.
In case of foals infected with EHV-4, morbidity rates of up to 100% are possible, especially during the weaning period. More than 80% of the isolates come from animals with rhinopneumonitis.
Once horses are infected with herpesviruses, they remain carriers of the virus throughout their lives, and the virus can be reactivated endogenously under unfavourable conditions (stress, etc.). Lymph organs, the leukocyte fraction and trigeminal ganglion cells are the main latency organs. If the vaccinated horses are also taken into account, seroprevalence in the horse population is high.

In recent years, EHV-1-associated neurological diseases, for which a "neurotropic" strain of EHV-1 is held responsible, have been reported with increasing frequency and severity of the clinical disease. This much-feared clinical picture is referred to as **EHM (equine herpesvirus myeloencephalopathy)**.
Two different variants of EHV-1 have been described in horses (DNA_{pol} D_{752} vs. DNA_{pol} N_{752}). Each is associated with a different level of neuropathogenicity. The D752 variant is associated with most outbreaks of neurological disease and is considered neuropathogenic. However, only a fraction of the horses infected with this virus will develop neurological signs. The N752 variant is most commonly isolated in conjunction with abortions, but also in a smaller number of neurological diseases. The differentiation is particularly interesting from an epidemiological point of view.

EHV-2 and EHV-5
The involvement of EHV-2 and/or EHV-5 in keratoconjunctivitis has long been suspected and these viruses are indeed regularly detected in conjunctival swabs. In recent years, it has increasingly been shown that EHV-2 and 5 are precursors of other viral and bacterial infections of the respiratory tract. Especially in young animals, EHV-2 and/or EHV-5 were detected in treatment-resistant, partly catarrhal-purulent, partly necrotising or abscessing bronchopneumonia. EHV-5 was presented as aetiological agent of **"equine multinodular pulmonary fibrosis" (EMPF)**.

EHV-3
Coital exanthema caused by equine herpesvirus type 3 (EHV-3), which only sporadically occurs in Germany, is a mildly progressing breeding infection in horses. Clinically, blisters, pustules and erosions appear on the mucous membrane of the vestibulum, penis or prepuce as well as on adjacent skin areas. Healing takes place spontaneously after approximately 2–3 weeks, but can be complicated by secondary infections. Transmission mainly occurs through mating, but is also possible through close contact as well as rectal and vaginal examinations. Infected animals remain carriers of the virus for life.

Herpesviruses pig
Suid herpesvirus 1 causes **Aujeszky's disease (pseudorabies)** and is also called Aujeszky's disease virus (ADV) or pseudorabies virus (PrV). Pigs are the natural host; they develop different clinical signs depending on age and can survive the infection, while the infection is fatal in other animals. In domestic pigs, Germany has been free of Aujeszky's disease since 2003, but the virus occurs in the wild boar population and can mainly infect hunting dogs – also via meat waste of healthy, but latently infected wild boars. In dogs, an infection causes central nervous disorders, mostly itching and death after 1–3 days.
Infection with Aujeszky's disease virus is listed under the **EU Animal Health Law (AHL)**.

Herpesvirus – Pathogen Detection

Material	**Dog:**	abortion material, tissue of dead puppies (lung, liver, kidney), swab without medium (nose, pharynx, eye, genital tract), EB (viraemia)
	Cat:	swab without medium (eye, nose, pharynx, genital tract), EB (viraemia!), abortion material, tissue (e.g. kidney, liver)
	Birds:	2–3 plucked feather shafts, blood (EB or 1–2 drops on a filter paper), swab without medium (triple swab: eye + pharynx + cloaca), faeces, tissue (e.g. liver, kidney, spleen)
	Tortoise:	swab without medium (tongue + pharynx), tissue (liver, intestine, possibly brain)
	Turtle:	swab without medium (pharynx + cloaca), tissue (liver)
	Sea turtle:	altered tissue
	Lizard:	swab without medium (lesions, pharynx), tissue (liver)
	Amphibians:	BfHV-1 (esp. toads), RaHV-3 (esp. frogs): swab without medium (skin), skin
	Koi:	KHV: tissue (e.g. gills, brain, liver, spleen, skin or intestine), swab without medium (gills or skin)
	Horse:	EHV-1: swab without medium (nose or pharynx), broncho-alveolar lavage, abortion material incl. placenta, EB (upon request, the detection from buffy coat is also possible, in this case, at least 5 ml EB is required), CSF, aqueous humour. According to recent studies, it is recommended to also examine EB in parallel with the swabs/organ material. EHV-2: swab without medium (eye), cornea, aqueous humour; foals with respiratory signs: swab without medium (nose or pharynx), lavage (BAL) EHV-3: swab without medium (lesions on vestibule, penis, prepuce or surrounding skin), tissue (lesions) EHV-4: swab without medium (nose or pharynx), lavage (BAL), EB (buffy coat, examination of EB + organs: see EHV-1), CSF, abortion material, aqueous humour EHV-5: swab without medium (eye), EB, cornea, aqueous humour; foals with respiratory signs: swab (nose or pharynx), lavage (BAL)
Method	Realtime PCR/PCR (birds, reptiles)	
Species	Dog, cat, birds, turtle, tortoise, lizard, amphibians, horse, cattle, koi	
Duration	1–3 working days 2–4 working days (birds, reptiles) 5–10 working days (cattle)	
Note	Herpesviruses usually produce only short-term viraemia. Therefore, detection in EB is often useful only at the onset of disease.	

Tortoise: In case of a positive result, differentiation of the virus strain may be of clinical relevance because of different tendencies to spread in the population and for the prognosis of an infection. Differentiation is possible on request.

Horse: Blood tests are only useful in the febrile phase.
The submission of organ/swab material plus EB is recommended. The samples are pooled to increase the chance of detection.
If the PCR test for EHV-1 is positive, the EHV-1 virus variant is automatically differentiated free of charge.
Testing for EHV-1 and/or EHV-4 or EHV-2 and EHV-5 is also part of several profiles (see Chapter 14.5.3, p. 285).

Herpesvirus – Antibody Detection
Equine Herpesvirus 1/4 – Antibody Detection

Material	S, HP 0.5 ml Tortoise: S, HP 0.4 ml
Method	Dog, cat: IFAT Horse: ELISA Tortoise: VNT
Species	Dog, cat, tortoise, horse
Duration	Dog, cat: reporting of results on the day the sample is received (Mon–Fri) Tortoise: 5–10 working days Horse: 2–4 working days
Note	Vaccine- and infection-induced antibody titres can only be differentiated by testing paired serum samples. PCR detection should therefore be preferred if an acute infection is suspected. **Tortoise:** The test detects antibodies against TeHV-1 and TeHV-3. In Hermann's tortoises, often only low antibody titres are observed. **Horse:** Testing of paired serum at an interval of 10–14 days. A clear increase in titre would prove an acute EHV infection. However, in acute cases we recommend direct pathogen detection by PCR (from a nasal swab without medium plus EB) to verify excretion. Vaccine-induced titres cannot be distinguished from infection-induced titres.

Aujeszky's Disease Virus (Pseudorabies) – Antibody Detection

Material	S 1 ml
Method	VNT
Species	Dog, wild boar
Duration	3–6 working days

Pacheco's Virus – Antibody Detection	
Material	S 0.2 ml
Method	VNT
Species	Birds
Duration	7–10 working days
Note	This service may not be available in some countries.

Infectious Anaemia ➢ **see Equine Infectious Anaemia Virus, p. 166**
Infectious Viral Arteritis ➢ **see Equine Arteritis Virus, p. 164**

14.1.26 Influenza Virus

Influenza A viruses belong to the Orthomyxoviridae and primarily infect birds, although they also occur in many other animal species and in humans.

Horse

Equine influenza is caused by influenza A equi 2, European and American lineage. In susceptible Equidae, an infection causes fever and a rough, dry cough. In unvaccinated populations, the virus spreads quickly. Secondary bacterial infections with mucopurulent nasal discharge are frequent and mask the clinical picture, especially in partially immune populations.

Pig

Pigs may not only become infected with porcine, but also with human and avian influenza viruses and thus contribute to the creation of reassortant influenza viruses. The influenza pandemics in humans in 1918/19 and in 2009 were caused by porcine influenza viruses. In pigs, primary infections are usually linked to livestock transport. The infection spreads explosively in the population.

Dog

For a long time, dogs were thought to be immune to influenza as there were no infections in the dog population. After major outbreaks in the USA and South Korea, two canine influenza A subtypes have now been described: CIV H3N8 and CIV H3N2. In dogs, infections with canine influenza A viruses usually cause mild clinical signs such as coughing and sneezing or are even subclinical. Severe courses of the disease with high fever, dyspnoea and pneumonia are rare. Progression of the disease is often aggravated by secondary bacterial co-infections or infections with other viruses.

Ferret

Ferrets are susceptible to numerous influenza A viruses – susceptibility to human influenza A viruses is important, which is why they are often used as animal models for infection experiments. The risk of zoonosis is particularly important here! Symptoms are similar to those of humans: inappetence, apathy, fever and respiratory signs such as

sneezing and nasal discharge, neurological signs have been described as well. Young animals usually have a more severe course of the disease than adult animals and here, too, secondary bacterial infections aggravate the clinical course.

Influenza A Virus – Pathogen Detection	
Material	Swab without medium (respiratory tract), lavage (BAL), TBS
Method	Realtime PCR
Species	Mammals (**not** birds)
Duration	1–3 working days

Influenza A Virus – Antibody Detection	
Material	S 0.5 ml
Method	HAH
Species	Horse
Duration	5 working days
Note	▪ The test detects antibodies against the equine influenza A virus subtype 2 strain of the American and European lineage. A titre increase of at least 4-fold after 2 weeks is usually associated with acute infection. ▪ Differentiation between vaccine-induced and infection-induced titre is not possible. ▪ This service may not be available in some countries.

14.1.27 Iridovirus

Iridovirus see also ➢ *Ranaviruses, p. 191*

Invertebrate iridoviruses (IIV) particularly occur in insects. In addition, they are regularly found in lizards, where they might cause skin lesions. The detection of iridovirus may be of interest if the mortality rate in the population of feeder animals or lizards is increased.

Iridovirus – Pathogen Detection	
Material	Lizard: tissue (e.g. skin or liver), swab without medium (skin) Feeder animals (whole insects)
Method	Realtime PCR
Species	Reptiles (lizards) and their feeder insects (e.g. crickets)
Duration	1–3 working days
Note	As these viruses are frequently found in feeder insects, virus detection in pharyngeal or cloacal samples or in the intestine needs to be interpreted very carefully.

14.1.28 Lentiviruses

Lentiviruses are retroviruses and can cause so-called **slow virus diseases** in small ruminants, namely **caprine arthritis encephalitis** (CAE) in goats and maedi/visna in sheep.
CAE is a viral disease in goats which causes encephalitis, arthritis and/or mastitis, depending on the age of the animals affected. The clinical course is slowly progressive. Neurological changes and interstitial pneumonia may lead to ataxia, lameness, paralysis and respiratory distress. Only about one third of the seropositive animals will contract the disease.
The main transmission route is transmission to newborns via the colostrum. Horizontal and intrauterine transmission is possible, but of secondary importance.
Maedi and visna are two different diseases caused by lentivirus infection in sheep. Maedi (meaning dyspnoea) disease is characterised by shortness of breath and cough, which are caused by chronic progressive interstitial pneumonia.
Visna (meaning decay) is a slightly contagious but progressive disease of the central nervous system. The animals show paralysis because of a demyelination of the CNS as well as progressive wasting.
Maedi and visna are not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Lentiviruses (CAE/Maedi-Visna) – Antibody Detection	
Material	S 0.5 ml
Method	ELISA
Species	Sheep, goat
Duration	1–3 working days
Note	▪ In goats and sheep, the ELISA detects antibodies against lentiviruses, which can cause CAE in goats and maedi/visna in sheep. ▪ Particularly in affected herds, detection serves to eliminate positive carrier animals. Positive animals are considered to be infected and potentially shedding. Negative animals should be checked every six months since recent infection or low antibody titres may lead to false-negative results. ▪ Eradication of affected flocks is carried out by doing serological tests every six months and culling of reactants. In farms that are approved as free from suspected infection, monitoring is performed by serological tests at yearly intervals.

14.1.29 Lymphocytic Choriomeningitis Virus (LCMV)

The main reservoir of LCMV, which belongs to the arenaviruses, is the house mouse. Cells infected with LCMV express antigens and are recognised by cytotoxic T lymphocytes. This lymphocyte activity also makes the blood-brain barrier permeable resulting in meninges and neurons being damaged.

Infection of adult **mice** leads to choriomeningitis. In contrast, an intrauterine or neonatal infection generally causes an asymptomatic chronic carrier state in mice, with such animals forming immune complexes in the course of their lifetime that lead to glomerulonephritis. In **guinea pigs** and **hamsters,** LCMV infections often progress subclinically, however, conjunctivitis, blepharitis, respiratory signs, tremor, seizures and paralysis have been described. LCMV is transmitted diaplacentally and with all secretions and excretions. In humans, LCMV rarely leads to choriomeningitis; the infection is usually asymptomatic or shows mild, flu-like symptoms. An infection in the second part of pregnancy can cause severe foetal damage.

Lymphocytic Choriomeningitis Virus (LCMV) – Antibody Detection	
Material	EP, S, HP 0.5 ml
Method	IFAT
Species	Guinea pig, mouse, hamster
Duration	3–5 working days
Note	▪ Zooanthroponosis! – Be careful when collecting the sample! ▪ This service may not be available in some countries.

14.1.30 Myxoma Virus

Myxomatosis is caused by the myxoma virus (Leporipox myxoma), an enveloped DNA virus which belongs to the family Poxviridae and is very stable in the environment. The virus is very host-specific and is mainly isolated in rabbits. Transmission occurs through all secretions and excretions and via vectors (mosquitoes and fleas). The incubation period is 4 to 10 days. There are three clinical forms: subclinical, chronic nodular and acute. The acute form is characterised by severe systemic signs, primarily swelling (myxoedema) and nodules on the eyes, ears and genitals, as well as pneumonia and hepatopathy, which are often fatal. Mortality ranges from 25% (Australia) to 90% (Europe).
Since 2004, there has been an increase in the number of infections reported in hares, with mass deaths in southern Spain and Portugal in 2018 and, since 2024, in Germany as well. The cause is a new recombinant virus derived from myxoma virus and another poxvirus (ha-MYXV). The differentiation between rabbit and hare myxoma virus is currently still reserved for specialised laboratories (as of December 2025). Cases in hares should be notified to the competent authority in accordance with national legislation. For rabbits, vaccines are available as a preventive measure.

Myxoma Virus – Pathogen Detection	
Material	Swab without medium (conjunctiva, nose or pharynx), tissue (e.g. conjunctiva, lung or kidney)
Method	Realtime PCR
Species	Rabbit
Duration	1–3 working days

Note	The hare myxoma virus variant (ha-MYXV) is also detected by our PCR test – differentiation between classic myxoma virus and this variant is not yet possible (as of December 2025), but will be available from spring 2026 onwards.

Myxoma Virus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Rabbit
Duration	3–5 working days
Note	This service may not be available in some countries.

Newcastle Disease Virus ➢ **see Paramyxoviruses, p. 183**
Nidoviruses ➢ **see Serpentoviruses, p. 196**

14.1.31 Orthopoxviruses

The genus Orthopoxvirus belongs to the family Poxviridae. Poxviruses are able to mature into infectious viruses in the cytoplasm of the host cell without the cell nucleus being involved. They have a relatively large genome with a double-stranded linear DNA. Orthopoxviruses have a broad host spectrum and can therefore be called cowpox, catpox, elephantpox or ratpox. Cattle, carnivores, rodents and humans are particularly susceptible. Orthopox infections are not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Cat

An infection with cowpox virus can cause catpox in both cats and humans. Cats are usually infected by their prey animals such as mice and rats. The virus penetrates the skin through bite or scratch injuries, which are usually located on the head, neck or forelimbs. To some extent, necrotising, extremely itchy smallpox appears at these sites. In most cases, self-healing occurs after a few weeks, but in immunocompromised people and cats (e.g. FIV infection), a systemic infection with severe to fatal pneumonia can develop. The vaccination against human pox administered until the 1970s does not provide any protection against an infection, but seroconversion with the vaccinia virus used for vaccination can probably lead to an attenuated clinical picture. These vaccinations were discontinued in the mid-1970s and a more frequent occurrence of this infection becomes more likely. A PCR analysis of skin crust material can provide a quick and reliable diagnosis.

Rat and other small mammals

The occurrence of Orthopoxvirus bovis infections in pet rats and the resulting transmission to humans has also been described. The rats show necrotising lesions on the limbs and in the head and tail area. Other small mammals (rabbit, guinea pig, mouse) are also susceptible.

Poxvirus (Orthopoxvirus) – Pathogen Detection	
Material	Scurf
Method	Realtime PCR
Species	Cat, rabbit, guinea pig, rat, mouse, cattle, others on request
Duration	1–3 working days
Note	Zoonosis – be careful when collecting the sample!

Pacheco's Virus ➢ see Herpesviruses, p. 170

14.1.32 Papillomaviruses

Dog/Cat

Papillomatosis is a rare viral disease in dogs and cats characterised by numerous benign warts (papillomata) in the head area. Although papillomaviruses occur in many animal species and in humans, they are strictly host-specific, so they do not pose a risk to humans or other animals. PCR detects canine and feline papillomaviruses. Papillomata are mainly observed in the oral cavity and are less frequent on the conjunctiva, the cornea and the eyelids. Warts are benign and usually heal without treatment within one to five months. If feed intake is severely affected by them, surgical excision might be indicated. A study has attested a good effectiveness to the administration of azithromycin.

Horse

Equine sarcoid is one of the most common skin tumours in horses (about 2–12% of all horses are affected). The causative agent is bovine papillomavirus (BPV) – especially type 1, more rarely type 2. The tumour cells are modified fibroblasts; the skin and subcutaneous tissue are affected. Equine sarcoids are considered semi-malignant tumours, i.e. they do not metastasise, but have a strong tendency to recur if surgical removal is incomplete. It is presumed that transmission mainly occurs through direct contact as well as flies and horseflies, but also indirectly through wound sites, saddles, blankets and cleaning utensils. The entire skin surface as well as certain blood cells are infected; moreover, the infection remains throughout life. The initial diagnosis is made at the age of 3–12 years.
Equine papillomavirus (Equus caballus papillomavirus, EcPV) causes benign skin tumours in the genital area or at the ears ("**aural plaques**"). Different viral types are responsible, with nine types described to date. In rare cases, aural plaques can develop into squamous cell carcinoma. Transmission probably occurs through direct contact.

Papillomaviruses (dog, cat) – Pathogen Detection	
Material	Tissue (skin)
Method	PCR
Species	Dog, cat
Duration	1–3 working days

BPV (Bovine Papillomavirus 1 and 2, Equine Sarcoid) – Pathogen Detection	
Material	Scurfs, hair roots, tissue (tumour)
Method	Realtime PCR
Species	Horse
Duration	1–3 working days
Note	▪ Positive PCR results confirm the suspected clinical diagnosis. Gold standard for the diagnosis of equine sarcoid is the examination by histopathology. ▪ Papillomatosis in cattle is also caused by bovine papillomaviruses. Six types have been described to date. This PCR does not detect types 3–6.

EcPV (Equine Papillomavirus) – Pathogen Detection	
Material	Tissue (skin)
Method	Realtime PCR
Species	Horse
Duration	1–3 working days

14.1.33 Parainfluenza Viruses

Dog

Canine parainfluenza virus 2 (CPiV-2) plays a crucial role in acute infections of the upper respiratory tract in dogs, which are referred to as kennel cough. In kennels or similar facilities, antibodies can be detected in up to 70% of all animals.
Infections solely with CPiV-2 usually only lead to a mild or clinically inapparent course of the disease. Only if secondary infections with other viruses (mainly canine adenovirus 2/ canine herpesvirus 1), bacteria (Bordetella bronchiseptica, streptococci, staphylococci, etc.) or mycoplasma occur and if husbandry and/or hygiene conditions are poor, the known severe courses of the disease develop.

Cattle

Bovine parainfluenza virus 3 (PI-3, BPIV-3) plays an important role in acute respiratory tract diseases in cattle, especially in the development of the multifactorial disorder **enzootic bronchopneumonia**. Monoinfections cause only mild symptoms or are clinically inapparent. Only secondary infections with other viruses (e.g. bovine adenovirus), bacteria (pasteurella, mycoplasma) and factors that reduce resistance (cold weather, stress, poor stable hygiene) lead to the development of severe symptoms in the form of endemic bronchopneumonia. The virus is shed with the nasal secretion and the transmission is airborne. The clinical picture is characterised by fever, breathing difficulties and salivation. About 5% of the animals die within 3–4 days. Various vaccines are available, but reinfections can occur after a few months.

CPiV, Canine Parainfluenza Virus – Pathogen Detection	
Material	Swab without medium (nose, pharynx), lavage (BAL)
Method	Realtime PCR
Species	Dog
Duration	1–3 working days

BPIV-3, Bovine Parainfluenza Virus – Pathogen Detection	
Material	Swab without medium (nose or pharynx), lavage sample, tissue (e.g. trachea or lung)
Method	Realtime PCR
Species	Cattle
Duration	1–3 working days
Note	This test can be ordered individually and it is also part of the PCR tests Bovine Respiratory Profile 1 and 3 (see Chapter 14.5.4, p. 288).

BPIV-3, Bovine Parainfluenza Virus – Antibody Detection	
Material	S, HP 1 ml
Method	ELISA
Species	Cattle
Duration	2–4 working days
Note	This test is part of the serological Bovine Respiratory Profile.

14.1.34 Paramyxoviruses

Paramyxoviruses see also
- ➢ *BRSV, p. 153*
- ➢ *Distemper Virus, p. 163*
- ➢ *Parainfluenza Viruses, p. 182*

Paramyxoviruses are enveloped, single-stranded RNA viruses. They mainly cause respiratory disorders in humans and many animal species, but are also the causative agents of severe systemic diseases.

Birds

Avian Paramyxovirus 1 (aPMV-1, Newcastle Disease Virus)

Newcastle disease virus is an avian paramyxovirus which can infect many different avian species. In fowl, Newcastle disease is also called atypical fowl pest. There are different pathogenic strains which produce clinical signs of varying severity, from subclinical to peracute diseases. Most notably, affected animals can develop respiratory and CNS signs; loss of performance, diarrhoea and sudden deaths are also possible. Newcastle disease virus is zoonotic and can cause conjunctivitis, fever, headache and aching limbs in humans. However, it is rarely transmitted from animals to humans and does not spread from person to person.

aPMV-1 is considered the cause of Newcastle disease once it exceeds a certain pathogenicity index. Infection with Newcastle disease virus is listed under the **EU Animal Health Law (AHL)**. In Germany, poultry must be vaccinated.

Reptiles

Paramyxoviruses/Ferlaviruses

Ferlavirus infections most notably occur in snakes. These infections are rarely found in lizards and chelonians. Vipers, elapids, colubrids, boas and pythons are particularly affected. Signs of the disease include nasal discharge, breathing with open mouth and breath sounds. In addition to respiratory changes, CNS signs are often observed. They include poor muscle tone, compulsive movements, head tremor and opisthotonus. Cases of sudden death also occur. Transmission can occur horizontally from one animal to another, by aerosols or through faeces.
In live animals, the virus can best be detected by obtaining a tracheal wash sample or through a combined pharyngeal and cloacal swab. The most suitable organ samples are lung, followed by brain, pancreas as well as liver, intestine and kidney.

Avian Paramyxovirus (aPMV-1) – Pathogen Detection	
Material	Swab without medium (cloaca, trachea), tissue (trachea, lung, brain, liver, spleen)
Method	Realtime PCR
Species	Birds
Duration	4–8 working days

Avian Paramyxovirus (aPMV-1) – Antibody Detection	
Material	EP, S, EB 0.2 ml
Method	HAH
Species	Birds
Duration	7–10 working days
Note	This service may not be available in some countries.

Paramyxoviruses/Ferlaviruses – Pathogen Detection	
Material	Swab without medium (pharynx, cloaca), tracheal lavage, tissue (e.g. brain, lung, liver, kidney, pancreas, intestine)
Method	PCR
Species	Reptiles (especially snakes, but also lizards and chelonians)
Duration	1–3 working days

Paramyxoviruses/Ferlaviruses – Antibody Detection	
Material	S, HP 0.2 ml
Method	HAH

Species	Reptiles
Duration	5 working days
Note	This service may not be available in some countries.

14.1.35 Parvoviruses

Parvovirus is a very small, non-enveloped DNA virus with extreme environmental stability. It can persist in the environment for up to a year and is also very temperature-resistant. Animals become infected oronasally with parvoviruses. First, virus replication occurs in the mucous membranes, then followed by viraemia. The lymphatic system and organs become infected.

Dog

In dogs, **parvovirus infection** usually progresses as a cyclic systemic disease with a manifestation in the intestinal epithelium.
Different clinical forms of parvovirus infection can develop. Particularly in puppies, a peracute cardiac form with myocarditis may develop and sudden death can occur. The acute form is characterised by severe, uncontrollable haemorrhagic diarrhoea, high fever and vomiting. Due to the high affinity of the virus to tissues with high mitotic activity, severe leukopenia occurs simultaneously. If the leucocyte count falls below 2000 cells/µl, prognosis must be made carefully. Subclinically infected animals represent the pathogen reservoir as they shed the virus via the faeces.

Cat

Feline parvovirus infection – **panleukopenia** – is a highly contagious systemic disease of felids. The mortality rate among unvaccinated animals is over 80%.
Clinically, the disease is characterised by fever, diarrhoea, vomiting and dehydration. The blood count shows extreme leukopenia. A special case is the intrauterine infection. The mother cat is infected without showing any symptoms, but it leads to the abortion or death of the kittens. If kittens are born alive, there is often a cerebellar hypoplasia, which leads to ataxia and tremor, usually without any impairment of consciousness.

Ferret

Aleutian mink disease is caused by Carnivore amdoparvovirus 1, a highly contagious parvovirus of the genus Amdoparvovirus. This single-stranded DNA virus is non-enveloped and therefore, like canine and feline parvoviruses, extremely resistant. Minks, but also ferrets, skunks, otters, raccoons, foxes, etc. can be affected by this disease.
The virus triggers an immune complex-mediated disease which is mainly characterised by hypergammaglobulinaemia.
The signs vary: Young animals tend to develop pneumonia, adult animals develop glomerulonephritis, arteritis, and/or meningoencephalitis. Bloody diarrhoea, hind leg paresis and fertility disorders have further been described. The outcome is often lethal.

There is no vaccine available against Carnivore amdoparvovirus 1. Vaccination with other parvovirus vaccines has proven ineffective in ferrets because, unlike minks, they are not susceptible to canine or feline parvoviruses and cross-protections are unlikely. Transmission can be both direct and indirect.

Horse

Equine serum hepatitis, formerly referred to as **Theiler's disease**, is caused by infection with **equine parvovirus-hepatitis virus (EqPV-H)**. EqPV-H is a hepatotropic single-stranded DNA virus that can cause hepatitis in infected horses. Asymptomatic infection is common. Approximately 2% of infected horses develop clinical hepatic disease, ranging from mild disease to acute fulminant liver failure. Clinical signs may include one or more of the following: lethargy, anorexia, jaundice, neurological signs associated with hyperammonaemic encephalopathy, death usually within 72 hours. EqPV-H should be suspected in horses with signs of illness and/or liver disease. Horses between 3–6 years of age have a seroprevalence of about 14%, for the age group of 11–15 years even a value of about 43% has been reported. EqPV-H-positive horses have often received a blood product 4–8 weeks before.

Pig

Porcine parvovirus (PPV) can be detected in almost all pig populations worldwide. In Germany, a prevalence of 60–80% can be assumed.
In an infection with PPV, fertility disorders and embryonic infections with subsequent fetal death (**SMEDI:** stillbirth, mummification, embryonic death, infertility) are the main clinical symptoms. The sows usually show no clinical signs.

Parvovirus – Pathogen Detection	
Material	**Dog:** qualitative PCR: faeces, EB, tissue (e.g. intestine or heart) quantitative PCR: faeces **Cat:** faeces, EB **Ferret:** rectal swab without medium, EB (viraemia), tissue (e.g. spleen, lymph node or bone marrow), (faeces – lower sensitivity than rectal swab) **Horse (EqPV-H):** EB, serum, tissue (liver) **Pig:** swab without medium (genital tract), EB, tissue (e.g. abortion material)
Method	Realtime PCR Ferret: PCR
Species	Dog, cat, ferret, horse, pig
Duration	1–3 working days
Note	▪ PCR can be positive up to four weeks after vaccination with live vaccine. ▪ Direct detection of parvoviruses in the blood is possible approx. 1–5 days post infection.

- In **dogs**, differentiation between vaccine strain (CPV-2) and field strains (CPV-2a, CPV-2b, CPV-2c) is possible on request. Please note that when using parvovirus vaccines containing CPV-2b as vaccine antigen (e.g. Zoetis Versican Plus, Virbagen Puppy 2b), we cannot differentiate between vaccine strain and field strain.
- If vaccination was carried out using a vaccine with field strains or if the vaccine or vaccination status of the dog is unknown and vaccination was carried out shortly (less than 4 weeks) before the onset of the symptoms, quantitative PCR is recommended and can be requested following qualitative PCR. A very high pathogen load indicates an acute infection. If the infection has subsided, it is not possible to differentiate between the field strain and the vaccine strain even by qPCR; in both cases, only a low pathogen load is detectable.
- **Horse:** This test is also part of the PCR profile Hepatotropic Viruses (horse), see Chapter 14.5.3, p. 286.

Parvovirus – Antigen Detection

Material	Faeces
Method	EIA
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	A faecal sample at least the size of a cherry is required. False positive reactions may occur 5–12 days post vaccination with live vaccine!

Parvovirus – Antibody Detection

Material	**Dog, cat:** S, EP, HP 0.5 ml **Pig:** S 1 ml
Method	**Dog, cat:** IFAT **Pig:** ELISA
Species	Dog, cat, pig
Duration	Dog, cat: reporting of results on the day the sample is received (Mon–Fri) Pig: 5 working days
Note	Seroconversion occurs 4–7 days after infection; vaccination- and infection-induced titres can only be differentiated by testing serum pairs.

PBFD ➢ **see Circoviruses, p. 157**
Pestiviruses ➢ **see BVDV/BDV, p. 154**

14.1.36 Picornaviruses/Torchiviruses (Virus "X")

Picornaviruses see also ➢ *Sacbrood Virus, p. 194*

Picornavirus, also known as virus "X", which occurs in tortoises, is the only member of the genus Torchivirus. It is often detected in association with other pathogens, particularly herpesviruses and mycoplasmas.
Clinically, picornavirus in young animals is associated with a softening of the carapace. In adult tortoises, infections are manifested as rhinitis, stomatitis, ascites and sudden death.
Picornaviruses/torchiviruses can best be detected by PCR in pharyngeal swabs.
Suitable organ samples include intestine, tongue, kidney, liver and other organs.

Picornaviruses/Torchiviruses (Virus "X") – Pathogen Detection	
Material	Swab without medium (pharynx), tissue (e.g. intestine, tongue, kidney, liver)
Method	PCR
Species	Tortoise
Duration	1–3 working days

Picornaviruses/Torchiviruses (Virus "X") – Antibody Detection	
Material	S, HP 0.2 ml
Method	VNT
Species	Tortoise
Duration	5–10 working days

14.1.37 Polyomaviruses

Polyomaviruses are non-enveloped DNA viruses. They are latently present in mammalian cells and mostly cause persistent infections there. They usually form typical intranuclear inclusions in infected cells and after infection of heterologous cells lead to their transformation. They are therefore regarded as oncogenic. Polyomaviruses have a circular double-stranded DNA.

The highly contagious **budgerigar fledgling disease virus (BFDV)** causes an infection that may be fatal for psittacine nestlings; in adult birds, septicaemia and hepatitis are observed. In chronic cases, feather malformation and inability to fly occur; affected animals usually hop or run around. Budgerigars are particularly affected, but other psittacine species can also be infected. The disease is also called **French moult.**

Polyomavirus – Pathogen Detection	
Material	2–3 recently plucked feather shafts, blood (EB or 1–2 drops on a filter paper), faeces, swab without medium (cloaca)
Method	Realtime PCR
Species	Psittacines
Duration	1–3 working days

Polyomavirus – Antibody Detection	
Material	S, HP 0.2 ml
Method	IFAT
Species	Psittacines
Duration	5–10 working days

14.1.38 Porcine Respiratory and Reproductive Syndrome Virus (PRRSV)

Today, PRRS – also called swine infertility and respiratory syndrome (SIRS), porcine epidemic abortion and respiratory syndrome (PEARS), mystery swine disease (MSD), or blue ear disease – is among the world's most important diseases in pig production. In Germany, the disease first occurred in the winter of 1990/91.
The virus can spread very quickly through droplet and airborne infection. The disease is characterised by late abortions around the 110th day of gestation. Dead or weak piglets can be born. In addition, there may be respiratory tract infections.
PRRSV is listed under the **EU Animal Health Law (AHL).**

PRRSV – Pathogen Detection	
Material	Swab without medium (nose or pharynx), EB, tissue (e.g. abortion material, lung, trachea or lymph node), lavage (BAL), sperm
Method	Realtime PCR
Species	Pig
Duration	1–3 working days
Note	Detection by PCR allows for a reliable diagnosis and the differentiation between EU and US strains (NA/HP-NA).

PRRSV – Antibody Detection	
Material	S 1 ml
Method	ELISA
Species	Pig
Duration	5–6 working days

14.1.39 Rabbit Haemorrhagic Disease Virus (RHDV)

Rabbit haemorrhagic disease (RHD, synonyms: **rabbit calicivirus disease** or **viral haemorrhagic disease**) is a highly contagious, usually fatal viral disease affecting European wild and domestic rabbits. RHD is caused by caliciviruses (non-enveloped RNA viruses), mainly the variants RHDV-1 ("classic" variant, 1984 from China) and, since 2010, RHDV-2 (France), which has spread worldwide. RHDV-2 also affects very young rabbits (from the 7th day of life onwards) and, in some cases, hares. It has a slightly lower but highly variable mortality rate.

Since 2019, a new, highly virulent virus variant (RHD2hv) has been present in Belgium and France. So far, no cases have been reported in Germany.
Transmission mainly occurs orally via contaminated feed and contact, as well as through vectors (mosquitoes and, for RHDV-2, flies). The incubation period is short (1–3 days). The course of the disease is usually peracute with sudden death and is characterised by necrotising hepatitis and coagulation disorders. Clinical signs include anorexia, lethargy, neurological signs, dyspnoea, nasal discharge and, sometimes, haemorrhages. In rare chronic cases, jaundice develops. Differentiation between RHDV-1 and RHDV-2 is routinely done, while it is not yet done for RHD2hv (as of December 2025).
Treatment is symptom-based. The most important measure is vaccination against both variants, as RHDV-2 is currently the most prevalent strain in Germany, but classic strains are still present as well.

RHDV 1 + 2 – Pathogen Detection	
Material	Swab without medium (conjunctiva), urine, faeces, EB, bone marrow, tissue (e.g. liver)
Method	Realtime PCR
Species	Rabbit
Duration	1–3 working days

14.1.40 Rabies Virus

Rabies virus **(RABV)** belongs to the genus Lyssavirus of the family Rhabdoviridae and is globally distributed. Infection with rabies virus is listed under the **EU Animal Health Law (AHL)**. After intensive control measures, Germany has been considered free of terrestrial **rabies** (RABV) since 2008.
When travelling, some countries demand proof of the antibody titre.

Rabies Virus – Antibody Detection	
Material	S 1 ml
Method	FAVN
Species	Dog, cat
Duration	10 working days
Note	▪ Only for **control of vaccine titres**, for export, too, **not** for suspected infection ▪ Please request an **extra submission form** if the test result is required for export. ▪ To issue a rabies vaccination certificate for export, the time between vaccination and blood sampling must be at least 30 days. ▪ This service may not be available in some countries.

14.1.41 Ranaviruses

Ranaviruses are enveloped double-stranded DNA viruses and belong to the family Iridoviridae. They are found worldwide and have a very wide host range infecting different animal species and even classes. Transmission is by direct contact, environmental contamination or cannibalism (or eating infected animals).
In **amphibians,** ranaviruses can cause systemic disease and mass mortality. A distinction is made between the haemorrhagic and the cutaneous form. Clinically, erythema, especially on abdomen and upper legs, ulceration on the toes, and increased tendency to bleed are seen. Some animals die without having appeared ill, while others can be inapparent carriers.
In **reptiles,** ranaviruses occur especially in chelonians, where they are associated with stomatitis, rhinitis, pneumonia and liver disease. In lizards, ranaviruses seem to have a role in skin lesions, stomatitis, granulomatous changes and mass mortality. In snakes, changes in the mouth and liver have been described.
Ranavirus is also found in **fish.** In fish, the infection can extend from clinically inapparent to systemic disease with mass mortality.

Ranaviruses – Pathogen Detection	
Material	**Chelonians:** swab without medium (pharynx, cloaca), tissue (liver, tongue, kidney, intestine, possibly skin), possibly EB in box turtles **Lizard:** swab without medium (pharynx, cloaca), tissue (above all skin, liver) **Snake:** swab without medium (pharynx), tissue (above all liver) **Amphibians:** biopsy (toe clips, tail clips), EB or drops of blood on filter paper, tissue (above all liver, kidney), perhaps swab without medium (cheeks/mouth, skin) **Fish:** biopsy (gills), blood, tissue (above all liver, kidney), perhaps swab without medium (skin)
Method	PCR
Species	Reptiles, amphibians, fish
Duration	1–3 working days

14.1.42 Reoviruses

Reoviruses are non-enveloped, double-stranded RNA viruses.

Birds

Reoviruses are regularly found in various bird species. They can cause inapparent infections but are also associated with various clinical changes. Liver and intestine are often affected. Respiratory infection also occurs. Especially in Old World parrots, lethal infections can be seen.

Reptiles

Reoviruses are often found in snakes and lizards, but occasionally also in chelonians. In snakes and lizards, they are associated with respiratory signs, particularly pneumonia. In lizards, they are also involved in skin lesions (papillomatous changes) and enteritis. In turtles, reoviruses are associated with respiratory signs and stomatitis.

Reoviruses – Pathogen Detection		
Material	**Birds:**	swab without medium (cloaca), faeces, tissue (intestine, liver, heart, kidney, lung)
	Reptiles:	swab without medium (pharynx, cloaca), lung lavage, tissue (lung, intestine; in chelonians also tongue)
Method	PCR	
Species	Birds, reptiles	
Duration	2–4 working days	

14.1.43 Reptarenaviruses

Inclusion body disease of boid snakes (IBD) is caused by reptarenaviruses and particularly affects **boas and pythons.** Clinical signs can vary greatly. CNS disorders are common, e.g. tremor, opisthotonus and loss of the righting reflex. In young animals, it is often an acute infection with a mortality rate of nearly 100%. In adult animals, the course of the disease is usually chronic and protracted.

Progression of the disease is often faster in pythons than in boas. Many times, regurgitation is the first clinical sign in boas. Skin lesions, pneumonia, general weakness and neoplasms have been described in connection with reptarenavirus infections and IBD. Over the past years, an increase in the incidence of the disease has been observed in boas, whereas it does not occur as often in pythons anymore. To date, little is known about the transmission in reptiles. Transmission through close contact as well as through mites is being discussed. In some cases at least, a vertical transmission from infected parents to young animals seems to occur.

Diagnosis is either made through the detection of the characteristic intracytoplasmic inclusions in the tissues of affected animals or through the detection of reptarenaviruses using PCR. In both cases, detection is easier in boas; in pythons, inclusions as well as the virus are often only found in the brain. Particularly in boas, inclusions can be detected histologically, most notably in the pancreas, liver, kidneys, oesophageal tonsils and the brain. The same organs are suitable for PCR detection of the virus. In live animals, inclusions and viral RNA can be detected through blood smears or whole blood as well as through biopsies of the liver, kidney or the oesophageal tonsils. Especially in boas, oesophageal swabs are very useful for PCR detection of the virus.

Reptarenaviruses/IBD – Pathogen Detection	
Material	EB, tissue (e.g. liver, pancreas, kidney, brain), swab without medium (oesophagus)
Method	PCR, cytology, histology
Species	Snake (boa, python)
Duration	1–3 days
Note	▪ The PCR detects different reptarenaviruses. These viruses of the family Arenaviridae are associated with the inclusion body disease (IBD) in boid snakes (boas, pythons). ▪ A negative test result does not completely rule out IBD, as there may be other virus variants, which have not yet been described, leading to this disease.

14.1.44 Rotaviruses

Group A rotaviruses are one of the most important pathogens of nosocomial gastroenteritis in veterinary and human medicine. In Germany, human rotavirus infections are among the most common gastrointestinal diarrhoeal diseases and are a notifiable infection. Rotaviruses are non-enveloped and therefore very environmentally stable viruses. They are transmitted both via the faecal-oral route and aerosol transmission. The destruction of enterocytes and electrolyte imbalances lead to diarrhoea and dehydration.

Rotaviruses A – Pathogen Detection	
Material	Faeces, intestinal tissue
Method	Realtime PCR
Species	All mammals
Duration	1–3 working days

Rotavirus – Antigen Detection	
Material	Faeces (at least the size of a cherry)
Method	ELISA
Species	cattle, camelids
Duration	1–3 working days
Note	Rotavirus antigen detection is part of the Calf Faecal Profile – Large, Calf Faecal Profile and Camelid Faecal Profile and can only be requested via these profiles.

14.1.45 Rustrela Virus (RusV)

In a recent publication (Matiasek et al., 2023), Rustrela virus (RusV) is associated with staggering disease in cats, a non-purulent, lymphohistiocytic meningoencephalomyelitis. Clinical signs include hind-leg ataxia with generally increased muscle tone as well as other neurological abnormalities: abnormal posture, stiff gait, weakness of the hind legs, tetraparesis, tremor, seizures, etc. In some cases, fever, salivation, hyperaesthesia, behavioural changes, opisthotonos and reduced spinal reflexes are also observed. The disease is progressive and most cats have to be euthanised within 2 months of the onset of clinical signs. Mice probably play a role as pathogen reservoir. Infected cats do not seem to shed the virus. So far, the virus has only been detected in the CNS (and in peripheral nerve fibres in a few cases).

Rustrela Virus (RusV) – Pathogen Detection	
Material	Preferably brain tissue (fresh, frozen, FFPE material), possibly CSF
Method	Realtime PCR
Species	Cat
Duration	1–3 working days

14.1.46 Sacbrood Virus

Sacbrood virus is an RNA virus of the family Iflaviridae (order Picornavirales). This virus only affects bee brood; infected adult animals do not show any signs. Transmission occurs through the bees that take up the virus when removing dead larvae and afterwards excrete it again through the hypopharyngeal glands when feeding. In addition, beekeepers can also act as transmitters. The virus can survive winter dormancy in the salivary glands. Infected larvae die shortly before pupation and become small, fluid-filled "sacs" which later dry out and become scab. The brood pattern shows sunken caps. Sacbrood is considered a so-called secondary infection, since the disease usually only takes on a severe course if the colony has been weakened by a primary infection, such as varroosis. For the therapy of the swarm, affected combs can be removed and melted.

Sacbrood Virus – Pathogen Detection	
Material	Bee larvae
Method	PCR
Species	Bees
Duration	1–3 working days

14.1.47 SARS-CoV-2

Respiratory coronavirus, first detected in 2019 and then temporarily referred to as "2019-nCoV", is now better known as **SARS-CoV-2** (severe acute respiratory syndrome coronavirus 2) or **"COVID-19 virus"**. According to current knowledge, all mammals can be infected with this virus, and cats, lagomorphs, hamsters and ferrets are particularly susceptible to infection with SARS-CoV-2 and have a higher probability of developing clinical signs.
Signs of SARS-CoV-2 infection can range from nasal discharge to sneezing, extensive inflammation of the respiratory tract up to diarrhoea. However, non-specific signs such as lethargy or weight loss have also been described.
SARS-CoV-2 infections are not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

SARS-CoV-2 – Pathogen Detection	
Material	Swab without medium (deep nasal/pharyngeal swab), BAL faeces (only great apes)
Method	Realtime PCR
Species	All species, particularly cat, ferret, hamster
Duration	1–3 working days
Note	for animal samples only

14.1.48 Schmallenberg Virus

Schmallenberg virus is transmitted by blood-sucking insects (primarily biting midges and mosquitoes) as well as vertically from dam to the foetus. Acute infections therefore mostly occur between April and November when the vectors are active. In cattle, it can cause fever, diarrhoea and reduced milk yield, whereas adult sheep rarely show any clinical signs. Primary infections that occur during the vulnerable phase of gestation (cattle: days 75–175; sheep: days 30–50) result in congenital malformations of the foetuses (arthrogryposis-hydranencephaly syndrome), which are associated with abortions, stillbirths or the birth of weak offspring.
Schmallenberg virus is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Schmallenberg Virus – Pathogen Detection	
Material	Tissue (brain, spleen), placenta, EB (viraemia), S, sperm
Method	PCR
Species	Ruminants, South American camelids
Duration	1–3 working days

Schmallenberg Virus – Antibody Detection	
Material	S 1 ml
Method	ELISA
Species	Ruminants
Duration	3–5 working days

14.1.49 Sendai Virus

Sendai virus, also known as **murine parainfluenza virus 1,** causes infections in rabbits, guinea pigs, hamsters, rats and mice as well as in humans. Detection is particularly relevant in laboratory animals. An introduction into a population leads to severe respiratory disease (focally ulcerative/necrotising rhinitis/tracheitis, pneumonia and pleuritis) and mortality rates of up to 100%, especially in mice. If the infection persists in a population, the course of infection is milder or subclinical. Once the infection is overcome, antibodies are detectable throughout life.

Sendai Virus – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Rabbit, guinea pig, rat, mouse, hamster
Duration	3–5 working days
Note	This service may not be available in some countries.

14.1.50 Serpentoviruses (Nidoviruses)

Viruses of the order Nidovirales are large, enveloped, single-stranded RNA viruses. The nidoviruses detected in reptiles (especially snakes) are classified in the family Tobaniviridae, subfamily Serpentovirinae.
They are mainly found in pythons and boas, where they cause systemic disease that is primarily characterised by pneumonia and stomatitis. Infections can range from asymptomatic to fatal. Serpentoviruses have also been found in other reptiles.
Shingleback nidovirus 1 (genus Tiruvirus) has been detected in shingleback lizards and other Tiliqua spp., and infection is associated with respiratory disease.

Serpentoviruses – Pathogen Detection	
Material	Swab without medium (pharynx or trachea), tracheal lavage, tissue (e.g. lung or trachea)
Method	Realtime PCR
Species	Snake (python, boa)
Duration	1–3 working days

Serpentovirus (Shingleback Nidovirus) – Pathogen Detection	
Material	Swab without medium (pharynx)
Method	Realtime PCR
Species	Tiliqua spp. (skinks)
Duration	1–3 working days

14.1.51 Sunshine Virus

Sunshine virus is an enveloped ssRNA virus, which was first detected in pythons in 2012 in Australia.
Sunshine virus has been found in animals with respiratory and/or neurological signs, but can occasionally be detected even in clinically healthy animals.

Sunshine Virus – Pathogen Detection	
Material	Swab without medium (pharynx, cloaca), tissue (lung, brain)
Method	PCR
Species	Python
Duration	1–3 working days

14.1.52 Tick-borne Encephalitis Virus (TBEV)

Tick-borne encephalitis (TBE) is caused by an arbovirus. Arboviruses are an inhomogeneous group of viruses whose common feature is the transmission by blood-sucking arthropods. The TBE virus (TBEV) belongs to the genus Flavivirus and is transmitted by ticks.
Seroepidemiological studies have shown that **dogs** have relatively frequent contact with TBEV (up to 30% in certain areas) without contracting the disease. If disease develops, clinical signs in dogs are typically multifocal. The disease usually begins acutely to peracutely with a highly elevated body temperature (up to over 41 °C) and a further rapidly progressive course. Changes in behaviour, from being apathetic to overexcited or aggressive, gait disorders up to tetraparesis/tetraplegia and seizures can occur. Various brain nerve deficits have been observed. Hyperalgesia in the head and neck area as well as a generally increased painfulness are characteristic. A large part of the disorders ends lethally or by euthanasia. Recent literature reports describe chronic progression of the disease in dogs, with some of them recovering completely.
Diagnosis should be confirmed serologically by antibody detection using ELISA. However, it must be taken into account that the antibodies could be the result of a previous subclinical infection. Antibodies may also appear in the CSF within the first week after infection and can be detected by ELISA.
In the peracute form, PCR can be used to try to detect the virus in the CSF. Due to the very rapid virus elimination from the brain, however, this is only possible in the early phase of infection. **Virus detection** by PCR from a collected **tick** is possible and especially useful if a person is affected by a tick.

TBE is also increasingly detected in neurologically affected **horses**. The clinical picture is similar to the disease caused by the West Nile virus.

Tick-borne Encephalitis Virus – Pathogen Detection	
Material	CSF, S, tick
Method	Realtime PCR
Species	Dog, horse, others on request
Duration	1–3 working days
Note	Detection in serum (before seroconversion) or cerebrospinal fluid is only possible in the early phase of the infection.

Tick-borne Encephalitis Virus – Antibody Detection	
Material	S, HP 0.5 ml, CSF 0.2 ml
Method	ELISA
Species	Dog, cat, horse
Duration	2–4 working days
Note	▪ Three different tests are offered: detection of IgM in serum or detection of IgG in serum or detection of IgG in CSF. ▪ Performing the analysis is advisable if animals have been to endemic areas and show neurological signs.

14.1.53 Usutu Virus

Like West Nile virus (WNV), Usutu virus is a flavivirus. Similar to WNV, it primarily infects birds (mainly passerines, but also birds of prey and owls). Birds also serve as the reservoir. There have been repeated outbreaks of enzootic "blackbird die-offs" (e.g. in 2018). The virus is transmitted by mosquitoes.
Usutu virus is zoonotic and can cause fever, skin rash and meningitis in humans. However, the course of the disease is generally milder than with WNV.

Usutu Virus – Pathogen Detection	
Material	EB, S
Method	Realtime PCR
Species	Birds
Duration	1–3 working days

14.1.54 West Nile Virus

West Nile virus **(WNV)** is an RNA virus of the family Flaviviridae, which is endemic in various, mainly tropical regions of the world. The virus has been spreading northwards for years and has been found in Germany since 2018.
The virus is transmitted by blood-sucking insects. Horses, reptiles, humans and other mammals are dead-end hosts (not infectious), while birds can become ill themselves and serve as the pathogen reservoir.
West Nile fever is listed under the **EU Animal Health Law (AHL)**.

Horse

Affected horses show signs of encephalitis, but also ataxia, tremors and paralysis can occur. Around 10% of infected horses develop neurological signs. Approximately 30% of these affected horses suffer a relapse after initial improvement of the signs, with the mortality rate then being high (30–50%).

Birds

In birds, infections vary from asymptomatic to fatal, depending on the species. Passerine birds, birds of prey and owl species are particularly susceptible to the disease. They may develop severe epidemics with central nervous signs (e.g. vertigo, tremor, inability to fly) and death rates may increase.

West Nile Virus – Pathogen Detection	
Material	Birds: swab without medium (oropharynx, cloaca), EB, serum, tissue (e.g. brain, heart, kidney) Horse: CSF, EB, serum, tissue (e.g. brain, spleen, tonsils)
Method	Realtime PCR
Species	Birds, horse
Duration	1–3 working days
Note	Detection of the pathogen is complicated by the very short viraemic phase (approx. 1–3 days). Furthermore, this phase occurs before the onset of the first clinical signs.

Flaviviruses/West Nile Virus – Antibody Detection	
Material	Birds: S 0.5 ml; horse: S 1 ml
Method	ELISA
Species	Birds, horse
Duration	2–3 working days
Note	▪ **Birds:** Flavivirus IgG, e.g. West Nile virus and Usutu virus ▪ **Horse:** Flavivirus IgG + West Nile virus IgM ▪ Due to the high cross-reactivity of antibodies against flaviviruses, flavivirus IgG ELISA detects a broad range of flaviviruses such as West Nile virus, Usutu virus, TBE virus, etc. Positive IgG

antibodies therefore indicate flavivirus-specific antibodies. Further differentiation into antibodies specific to the West Nile virus cannot be done using the ELISA method. If IgM results are positive, which must be reported to the authorities in many countries and indicates a recent infection, a confirmatory test (e.g. virus neutralisation tests, VNT) is recommended to differentiate between antibodies against closely related flaviviruses.

14.2 Bacteria

Please note: If the detection of a bacterial pathogen is exclusively done by **PCR**, it is **not possible to create an antibiogram**.

14.2.1 Actinobacillus pleuropneumoniae (APP)

Actinobacillus pleuropneumoniae is a gram-negative bacillus. It produces exotoxins that can destroy erythrocytes and lung macrophages. The clinical picture of APP infection is characterised by severe respiratory signs and significant impairment of the general condition (body temperature may rise up to 42 °C). In intensive pig farming, pleuropneumonia caused by A. pleuropneumoniae is one of the most important infectious diseases. In peracute courses of the disease, it can lead to the death of the animals within 24 hours.

APP – Pathogen Detection	
Material	(1) Swab with medium, tissue (lung, tonsils) (2) Swab without medium (nose), nasal flush, tissue (lung, tonsils)
Method	(1) Bacterial culture (2) PCR
Species	Pig
Duration	(1) 2–3 working days (2) 1–3 working days

APP – Antibody Detection	
Material	S, HP 0.5 ml
Method	ELISA
Species	Pig
Duration	5–6 working days
Note	This service may not be available in some countries.

Actinomyces ➢ see Chapter 15.4, p. 297

14.2.2 Anaplasma

Anaplasma are gram-negative, obligate intracellular bacteria. Based on genetic analyses, the former species Ehrlichia phagocytophila, Ehrlichia equi and the causative agent of human granulocytic ehrlichiosis (HGE) were unified in the species Anaplasma phagocytophilum. In addition, infection with Anaplasma platys, the causative agent of infectious canine cyclic thrombocytopenia, plays an increasingly important role in Europe, too.

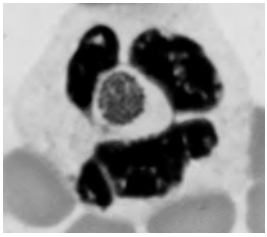
Anaplasma phagocytophilum

Anaplasma phagocytophilum primarily infects neutrophil, rarely eosinophil granulocytes, and forms, when multiplying within the granulocytes, typical inclusion bodies, so-called morulae. In Europe, the main vector is Ixodes ricinus. Deer, mice and other rodents are reservoir hosts.

Infection can be asymptomatic, can cause non-specific signs (fever, inappetence, lethargy) or severe signs (CNS disorders). In **dogs**, orthopaedic signs are also frequently described in association with Anaplasma infection.

In **horses,** fever, lethargy, limb oedema and reluctance to move are initially dominant. Horses older than 4 years show more obvious signs than younger animals. Once the infection is overcome, a resilient immunity is acquired for about 2 years.

In **ruminants,** Anaplasma phagocytophilum can cause **tick-bite fever.** Most infections progress subclinically, but fever and productivity loss or abortions are also possible. Severe cases occur when non-immune animals are introduced into endemically contaminated areas.



Neutrophil granulocyte with Anaplasma phagocytophilum (morula) in the middle of the segmented nuclei (Diff-Quik, 1000x magnification)

Anaplasma phagocytophilum – Pathogen Detection	
Material	EB, bone marrow, synovia, CSF, tick
Method	Realtime PCR
Species	Dog, cat, horse, ruminants, South American camelids, others on request
Duration	1–3 working days
Note	▪ PCR is positive in blood smears 6 to 8 days before and 3 days after the formation of morulae. ▪ A negative PCR result does not completely rule out an infection.

Anaplasma phagocytophilum – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT; dog: ELISA (IFAT only on specific request)
Species	Dog, cat, horse, cattle
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Positive titres can be expected from 7 days post infection.

Anaplasma platys

Anaplasma platys multiplies in platelets and causes cyclic thrombocytopenia and bacteraemia in dogs with intervals of approximately 14 days. The disease is called **infectious canine cyclic thrombocytopenia.** Descriptions of this species of Anaplasma come from overseas, but the pathogen is also detectable in the Southern Mediterranean (North Africa, southern Portugal, Andalusia, Sicily, southern Italy, southern Greece). It is probably transmitted by ticks (Rhipicephalus sanguineus). After the initial infection, there is a decrease in the platelet count within 7 days p.i.; the lowest values are reached between days 14 and 24 p.i.

Basophil inclusions (morulae) in the platelets can particularly be detected 7–10 days p.i. The phase of bacteraemia extends approximately over a period of 4–14 days p.i., followed by a phase in which the pathogen cannot be detected in the peripheral blood. Subsequently, these phases alternate cyclically. In the bacteraemic phase, the pathogen can be detected in blood samples by means of PCR.

Anaplasma platys – Pathogen Detection	
Material	EB, tick
Method	Realtime PCR
Species	Dog
Duration	1–3 working days
Note	A negative PCR result does not completely rule out an infection.

Anaplasma ovis

Anaplasma ovis is a haemotropic bacterium in small ruminants. It is a gram-negative, obligate intracellular, coccoid or pleomorphic bacterium from the order Rickettsiales, which infects erythrocytes. Morphologically, it cannot be distinguished from the closely related Anaplasma marginale.

Anaplasma ovis infection is a vector-borne disease; the pathogen is probably transmitted by ticks of the genus Dermacentor, Rhipicephalus and Hyalomma. Clinical signs include anaemia, anorexia and weight loss.

Anaplasma ovis – Pathogen Detection	
Material	EB
Method	Realtime PCR
Species	Sheep, goat
Duration	1–3 working days
Note	▪ A negative PCR result does not completely rule out an infection. ▪ Detection of Anaplasma ovis is only available in combination with PCR detection of Mycoplasma ovis (see p. 230).

14.2.3 Bartonella henselae

Bartonella are gram-negative, facultative intracellular bacteria which are transmitted by fleas and ticks. Bartonella henselae is mostly known as the causative agent of **"cat scratch disease"** in humans. Infections in cats are predominantly subclinical. Fever, muscular pain, local lymphadenopathy and, rarely, also neurological symptoms can occur, which usually disappear again after a few days. Recently, the involvement of Bartonella henselae in gingivitis and stomatitis in cats has been discussed more frequently. Pathogen detection and antibody detection often do not match and a definitive diagnosis is linked to the detection of the pathogen. A negative PCR result does not exclude an infection with B. henselae and should be repeated in case of clinical suspicion.
Dogs, too, can occasionally be affected by Bartonella infection. The disease can cause endocarditis, recurrent granulomatous lymphadenitis, systemic granulomatous processes and meningitis.

Bartonella henselae – Pathogen Detection	
Material	EB, CSF, flea
Method	Realtime PCR
Species	Dog, cat
Duration	1–3 working days

Bartonella henselae – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, cat
Duration	1–2 working days
Note	Antibodies can usually be detected from the second week p.i. onwards. Seroprevalence is particularly high in cats with flea infestation and is not indicative of a clinical condition.

14.2.4 Bordetella bronchiseptica

Bordetella are small gram-negative bacilli which can move by means of flagella. Bordetella (B.) bronchiseptica usually only survives for a rather short period of time outside the respiratory tract. Transmission takes place by direct contact or via aerosols. Because of its toxins, B. bronchiseptica particularly damages the cilia-bearing cells of the respiratory mucosa and it can persist in the respiratory tract for up to three months. The pathogen is not host-specific and can be transmitted from one animal species (e.g. dog) to another (e.g. cat) and also to humans (zoonosis!).
In dogs, bordetella are known as a component of kennel cough and they are also responsible for respiratory tract diseases in cats. Typical signs are fever, sneezing, nasal discharge, swelling of the submandibular lymph nodes and intensified breath sounds.

Usually, only mild symptoms occur which disappear again after about 10 days. However, life-threatening bronchopneumonia can develop in young kittens.
Numerous small mammals, especially rabbits (**upper respiratory tract disease/ "snuffles"**), guinea pigs, rats and mice, can also become infected with B. bronchiseptica and sometimes show severe respiratory signs.

Bordetella bronchiseptica – Pathogen Detection	
Material	(1) Swab must be with medium (Amies) (nose, pharynx) or bronchial secretion (2) Swab without medium (nose, pharynx), bronchial secretion, BAL
Method	(1) Bacterial culture (2) Realtime PCR
Species	Dog, cat, rabbit, guinea pig, rat, mouse, ruminants, pig, others on request
Duration	(1) 2–3 working days (2) 1–3 working days
Note	When requesting a culture test, please indicate the sampling site on the submission form.

14.2.5 Borrelia

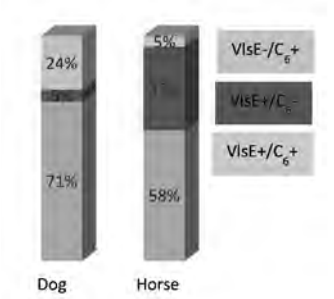
Borrelia are bacteria which belong to the family Spirochaetaceae. Spirochaetes are characterised by contractile axial filaments which are located under a multi-layered outer membrane and that give the spirochaetes their typical spiral shape as well as their motility. Borrelia species which are discussed in connection with Lyme borreliosis in dogs are included in the group Borrelia burgdorferi sensu lato, which currently comprises more than 20 different Borrelia species.
Borrelia are transmitted by vectors (ticks or lice). The main mode of transmission is a bite of the tick Ixodes ricinus (European castor bean tick). The bacteria are located in the intestine of the tick, are activated by the blood meal and migrate to the salivary glands. Therefore, transmission through saliva may take up to 24 hours. If the tick is properly removed within this period, the risk of infection can be greatly reduced.
In contrast to humans, the clinical signs of Lyme borreliosis (**Lyme disease**) in **dogs** are rather non-specific and can easily be overlooked. Subclinical infections also occur frequently. In dogs, there is rarely an erythema migrans. Lethargy, loss of performance, possibly fever and, after a symptom-free phase of several weeks, reluctance to move and shifting lameness occur. Occasionally, neurological deficits are also observed. A serious complication is the development of glomerulonephritis with subsequent kidney failure due to the deposition of immune complexes.
The main vector, Ixodes ricinus, occurs throughout Germany.
Infections and diseases in **cats** are reported more and more often. Furthermore, Lyme disease is classified as an emerging bacterial zoonosis.

Grazing animals are often used for blood meals by borrelia-infected ticks. There are both clinical disease as well as seropositive animals without any clinical signs, with the evaluation often being difficult.
In **horses,** a variety of signs are associated with borrelia: reduced performance, lameness, changes in the skin, eyes or heart up to neurological deficits and abortions. However, there is still controversy as to whether the infection in horses leads to any clinical signs at all.
In **cattle**, borreliosis may be associated with lameness, weight loss and abortion. Seroconversions after infection can be detected and pathogen can sometimes be isolated from clinical material (Borrelia burgdorferi sensu stricto, Borrelia afzelii).

Borrelia – Pathogen Detection	
Material	Tick, biopsy (skin), synovia, CSF
Method	Realtime PCR
Species	Dog, cat, horse, ruminants, South American camelids, others on request
Duration	1–3 working days
Note	The diagnostic value of a PCR is limited by the selection of the appropriate material and the concentration of pathogens. During a chronic infection, pathogen spread can be suspected in many sites, but the concentration of pathogen DNA can be very low and therefore the PCR produces a negative result. While a positive PCR is proof of infection, a negative PCR does not exclude an infection.

Borrelia – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT; dog: ELISA
Species	Dog, cat, horse, donkey, ruminants, South American camelids, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Simultaneous determination of IgG and IgM possible in dogs, cats, horses and donkeys; other species only IgG determination ▪ Positive IgG antibody titres are found in dogs after about 3–6 weeks, positive IgM antibodies 3–4 days after pathogen contact. ▪ The distinction between IgM and IgG is used to distinguish an acute infection from a pathogen contact that occurred a long time ago.

Borrelia Blot – Antibody Detection	
Material	S, HP 0.5 ml
Method	Line immunoassay
Species	Dog, horse
Duration	3 working days
Note	The Borrelia blot is used to clarify questionable antibody concentrations and to distinguish between vaccine-induced and infection-induced antibodies. The blot also detects antibodies against the VlsE protein and C6 peptide. VlsE (variable major protein-like sequence, expressed) and its subunit C6 are highly immunogenic surface antigens that express Borrelia during active reproduction. There is no recombination of the VlsE molecule in vitro or in the Borrelia residing in the tick, the detection of antibodies against the VlsE molecule therefore indicates an infection that has previously occurred. The blot can be carried out at the earliest from the 3rd week after infection onwards.



VlsE and C_6 antibodies in dogs and horses
(C_6- and/or VlsE-positive animals)
➔ No antibody detects all infections.

14.2.6 Brachyspira

Brachyspira are gram-negative anaerobic bacteria which, however, have a certain tolerance to oxygen. Reproduction takes place in the goblet cells of the large intestine where Brachyspira can persist after surviving infection (intermittent shedding!). **Pig dysentery,** which is caused by B. hyodysenteriae, is a highly contagious multifactorial diarrhoeal disorder that leads to high economic losses in pig production worldwide. The main sources of infection are infected pigs without clinical signs and rodents as reservoir hosts. B. pilosicoli causes a milder disease, **spirochete diarrhoea** in pigs, which usually occurs directly after weaning.

Brachyspira hyodysenteriae/pilosicoli – Pathogen Detection	
Material	Faeces, tissue (large intestine)
Method	Realtime PCR
Species	Pig
Duration	1–3 working days

Note	Differentiation between B. hyodysenteriae and B. pilosicoli is done by PCR.

14.2.7 Brucella

The causative agent of brucellosis are gram-negative, aerobic bacilli of the genus Brucella. The disease occurs in both animals and humans. Several Brucella species are known, including Brucella (B.) canis (canine brucellosis), B. abortus (bovine brucellosis), B. melitensis (ovine and caprine brucellosis), B. ovis (brucellosis in rams, infectious epididymitis) and B. suis (porcine brucellosis). Host-specificity of Brucella species is only limited. Brucella canis is transmitted genitally or orally by latently infected **dogs**. After 2 to 4 weeks, bacteraemia develops. In pregnant female dogs, there may be abortions in the last trimester of gestation or weak puppies are born. Male dogs suffer from inflammation of the testicles and epididymis and can become infertile. A rare sign of Brucella canis infection is discospondylitis, so if there is pain in the spine and lameness, especially in dogs from Southeastern Europe, this infection may be an important differential diagnosis. The main signs of brucellosis in **ruminants** and **pigs** are abortions, birth of weak animals, inflammation of the testicles and epididymis, and infertility. The occurrence of cases in humans is always related to the disease being present in domestic or wild animals. Apart from direct animal contact, routes of infection also include the consumption of insufficiently heated food (e.g. raw milk or raw milk cheese) obtained from infected animals.
B. abortus, B. melitensis, B. suis and B. ovis are listed under the **EU Animal Health Law (AHL)**.

Brucella canis – Pathogen Detection	
Material	Swab without medium (cervix, prepuce), EB, sperm, urine, (faeces, milk), tissue (abortion material)
Method	Realtime PCR
Species	Dog
Duration	1–3 working days

Brucella canis – Antibody Detection	
Material	S 1 ml
Method	(1) IFAT (2) Agglutination Test
Species	Dog
Duration	IFAT: reporting of results on the day the sample is received (Mon–Fri) Agglutination: 1–2 working days; for export testing, the processing time may be longer as the results are sent together with the final report.

Note

- The immunofluorescence antibody test (IFAT) is highly cross-reactive with antibodies against related bacteria, e.g. Yersinia enterocolitica, and positive results should be confirmed by a Brucella canis agglutination test.
- Agglutination tests are often required for entry into non-European countries.

14.2.8 Burkholderia mallei

Glanders is a disease of Equidae caused by Burkholderia mallei, which also has zoonotic potential: Apart from humans, wildcats (zoos!), camelids, bears, wolves and dogs are susceptible as well. Cattle, sheep and pig are resistant to natural infection. The course of the disease is either acute (especially in donkeys and mules) with high fever and respiratory signs and death after a few days. Or it is rather chronic, particularly in horses, with nodules and ulcerations on the skin, the mucous membrane and the inner organs. Chronically and subclinically infected animals represent a dangerous source of infection. All secretions of the respiratory tract and the skin are infectious; the incubation period ranges from a few days to many months.
In Europe, glanders is considered eradicated, but it does occur in different Asian, African and South American countries (export-relevant test).
Infection with Burkholderia mallei (glanders) is listed under the **EU Animal Health Law (AHL)**.

Burkholderia mallei (Glanders) – Antibody Detection	
Material	S 1 ml
Method	ELISA
Species	Horses and other Equidae
Duration	2–4 working days

14.2.9 Campylobacter

Several Campylobacter species could be detected in mammals, birds and also in humans. Some species are part of the normal gastrointestinal microbiota or their pathogenicity is still unclear.
In **cattle**, C. fetus subsp. veneralis causes epidemic abortions and fertility disorders (bovine genital campylobacteriosis, also called vibriosis in cattle), C. jejuni can lead to diarrhoea or mastitis. In **sheep**, C. fetus subsp. fetus is known as pathogen of the enzootic campylobacter abortion; occasional abortions caused by C. jejuni have also been described.
The importance of campylobacter infections in **birds** lies in the contamination of carcasses and the risk of food poisoning associated with it. Most frequently, birds are infected with C. jejuni. Diarrhoea or hepatitis are rare.

In **dogs and cats**, C. jejuni can often be isolated from healthy animals, but can cause diarrhoea especially in young animals. This diarrhoea is often self-limiting. Feeding a barf diet presents a risk of infection.
In **humans**, campylobacter (especially C. jejuni) is one of the most common causes auf bacterial diarrhoea and is usually food-associated (particularly insufficiently heated poultry meat, but also unpasteurised milk and raw minced meat). Rare complications which can occur are Guillain-Barré syndrome (polyradiculitis) and reactive arthritis.
Bovine genital **campylobacteriosis** is listed under the **EU Animal Health Law (AHL)**.

Campylobacter – Pathogen Detection	
Material	(1) Faeces, swab with medium (intestine, cloaca) (2) Faeces, swab without medium (intestine, cloaca)
Method	(1) Bacterial culture (2) Realtime PCR (only detection of **Campylobacter jejuni**)
Species	No limitations known
Duration	(1) 2 working days or 4 working days with antibiogram (2) 1–3 working days
Note	▪ Culture: Please send in a faecal sample with a diameter of at least the size of a cherry, otherwise use swab with medium. ▪ A combined detection by culture of Campylobacter and Yersinia is also available. ▪ Resistances are common; treatment should therefore only be carried out after an antibiogram has been performed. Preparation of an antibiogram is only possible after a culture test.

14.2.10 Chlamydia

Chlamydia are obligate intracellular, gram-negative pathogens. Extracellularly, chlamydia do not have their own metabolism and depend on the enzyme activity in the host cell. Chlamydia relevant in veterinary medicine belong to the family Chlamydiaceae. Some years ago, this family was split into the two genera Chlamydia (C.) and Chlamydophila. However, based on more recent genetic analyses, this classification is no longer considered justified. Because of this, the single term Chlamydia is used here.

Dog

In the literature, only little data is available on chlamydia infections in dogs. Yet in general, its occurrence must be expected in Europe. Respiratory signs up to bronchopneumonia seem to be dominating here. At the onset of the disease, only progressive loss of condition may appear. High fever can develop. When the disease progresses, central nervous disorders are possible. Other manifestations of chlamydiosis in dogs are conjunctivitis and keratitis.

Cat

Originally identified as the causative agent of "feline pneumonitis", C. felis is rather associated with conjunctivitis in cats nowadays. The cardinal symptom is serous conjunctivitis which begins unilaterally and then spreads to the other eye after some days. Especially when there is a secondary bacterial infection, the discharge can become mucopurulent. Chemosis and blepharospasm may also be present. In severe cases, follicular hyperplasia develops or even keratoconjunctivitis with corneal ulcerations. Conjunctivitis can last for 8 weeks or more. Other acute symptoms include slight rhinitis and fever. Animals between 5 weeks and 9 months of age are most affected, though conjunctivitis neonatalis has also been described. In that case, kittens already suffer from severe conjunctivitis when opening their eyes, often due to a chlamydia infection acquired intrapartum. Transmission occurs directly through conjunctival secretions. Persistent infections are possible, and in some animals also respiratory signs may last for several weeks. When the immune system is weakened, the infection can be reactivated.

Birds

In birds, infections with chlamydia are of particular significance. Infection rates of 10 to 40% may be prevalent in aviculture. As many birds have a carrier status, the disease can "suddenly" become clinically apparent under stress. Symptoms in birds are manifold and extremely non-specific. Ruffled feathers, apathy and lack of appetite must be mentioned. Basically, every "sick bird" could have a chlamydia infection. Respiratory signs with or without conjunctivitis are often seen, but central nervous disorders are also possible. The extent of clinical signs largely depends on the animals' condition; the type of symptoms also varies from one bird species to another. Sudden death without prior illness might happen. It is therefore not possible to make a diagnosis based on clinical signs. To make a reliable diagnosis, the identification of the pathogen is always necessary. C. psittaci is a zoonotic agent. Infections in humans are normally airborne, resulting in a flu-like disease. **Chlamydiosis** in poultry is listed under the **EU Animal Health Law (AHL)**.

Reptiles and amphibians

Various species of chlamydia are regularly detected in reptiles and amphibians. In reptiles, they have been associated with granulomatous changes in different tissues as well as with pneumonia, enteritis, hepatitis and myocarditis. In amphibians, they were found in cases of systemic disease.

Farm animals

In ruminants, C. abortus can cause abortions and fertility disorders. In sheep and goats, C. abortus is the most important infectious cause of abortion and can cause so-called "enzootic abortion" when introduced into a naive herd. Because of the massive shedding of the pathogen during abortions, the entire herd quickly becomes infected. Due to long-lasting immunity, abortions tend to occur sporadically in subsequent breeding seasons, especially in first-time mother animals.
It is also typical for C. abortus that non-pregnant animals usually show no clinical signs of the disease and that mother animals that abort show hardly any clinical signs apart

from placentitis. Abortion usually occurs in late pregnancy, and it is also possible that weak lambs are born. C. abortus is a zoonotic pathogen and can cause miscarriages in pregnant women and febrile systemic disease in immunocompromised persons. Chlamydiosis in poultry is listed under the **EU Animal Health Law (AHL)**.

Chlamydia – Pathogen Detection	
Material	**Dog, cat:** swab without medium (eye, pharynx, cervix, prepuce), abortion material, faeces **Small mammals:** swab without medium (eye, pharynx, cervix, prepuce) **Birds:** triple swab without medium (eye + pharynx + cloaca), tissue (liver, spleen, lung), faeces **Reptiles, amphibians:** swab without medium (pharynx), lung lavage, faeces, tissue (lesions, lung, liver, spleen, intestine, heart) **Ruminants:** swab without medium (eye, nose, cervix), urine, tracheal lavage, milk, faeces, tissue (lung, liver), abortion material
Method	Realtime PCR
Species	All
Duration	1–3 working days
Note	Pathogen detection identifies all chlamydia of the family Chlamydiaceae. In case of a positive result in **birds**, a PCR specific to C. psittaci is automatically performed.

Chlamydia – Antibody Detection	
Material	S, EP, HP 0.3 ml; ruminants: S 0.5 ml
Method	IFAT (dog, cat, birds, horse) ELISA (ruminants) ELISA (South American camelids, pig)
Species	Dog, cat, birds, horse, ruminants, South American camelids, pig
Duration	Dog, cat, birds, horse: reporting of results on the day the sample is received (Mon–Fri) Ruminants: 1–3 working days South American camelids, pig: 5–6 working days
Note	▪ Serology can determine whether an infection has occurred. However, evidence of active shedding can only be provided by pathogen detection. ▪ In **ruminants**, the test is specific for antibodies against Chlamydia abortus.

14.2.11 Clostridia/Clostridioides

Clostridia are obligate anaerobic spore-formers. In small quantities and without toxin production, they are part of the physiological intestinal flora. Toxin (gene) detection is therefore essential for diagnosis. Clostridioides difficile, formerly classified within the genus Clostridium and named Clostridium difficile, has been reclassified to the genus Clostridioides.

Clostridium botulinum

Botulism is regarded as pure intoxication, in which only the toxin is absorbed, absorbed via the intestine and spread haematogenously. If, in exceptional cases, botulism progresses as a toxin infection, the toxins are formed in the intestine (visceral botulism) or in wounds (wound botulism). The absorption of botulinum toxin leads to paralysis of the motor nerves.

Clostridioides difficile

Various predisposing factors play a role in causing rapid proliferation and clinical disease by C. difficile: antibiotic treatment, hospitalisation, dysbiosis, etc. In **dogs**, the exact role of C. difficile is still unclear, but there are several reports of digestive disorders. In **horses**, C. difficile is associated with necrotising colitis in foals, post-antibiotic colitis in adults and "duodenitis-proximal jejunitis syndrome". The signs are often non-specific (diarrhoea, colic, fever). Diarrhoea caused by C. difficile has also been described in **pigs, calves, cats, rabbits** and **hamsters**.

Clostridium perfringens

Clostridium perfringens is categorised into toxovars based on the presence of different toxins, which in turn are associated with specific clinical pictures in different animal species. These include mainly dogs and horses, but also rabbits, ruminants, pigs, chickens and others. Various predisposing factors, especially all types of dysbiosis, cause rapid proliferation and clinical disease. Alpha toxin is produced by all toxin-producing C. perfringens and is a microbial exotoxin. The enterotoxin binds to the intestinal epithelium and forms pore-like structures there, which lead to cell membrane damage and to cell death. NetE and NetF are also pore-forming toxins.

Clostridium perfringens enterotoxin can cause diarrhoea and vomiting of varying severity in carnivores, but enterotoxaemia is rare. Toxin production is induced by antibiotics, stress, co-infections or, in particular, an unbalanced diet rich in protein and connective tissue.

In **farm animals**, young animals, particularly calves, are susceptible to severe disease. Older animals, on the other hand, are often affected by clostridiosis (cattle) or sporadic catarrhal and haemorrhagic enteritis (pig).

NetF toxin is thought to be the main virulence factor in canine acute haemorrhagic diarrhoea syndrome (AHDS) and in necrotising enterocolitis in foals.

NetE toxin has also been described in association with AHDS in dogs.

Clostridium tetani

Infection with Clostridium tetani can occur through wound contamination. Under exclusion of air, the pathogen multiplies and produces toxins. This causes clinical signs which include stiff gait, contracted facial muscles ("risus sardonicus" in dogs) up to generalised contraction of the extensor muscles.

Clostridium botulinum Neurotoxin – Antibody Detection

Material	S 1 ml
Method	ELISA
Species	Dog, horse, ruminants, South American camelids, pig
Duration	5–7 working days

Clostridioides difficile Toxin A and B – Toxin (Gene) Detection

Material	Faeces
Method	(1) ELISA (detection of toxins) (2) PCR (detection of toxin genes)
Species	No limitations known
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ Determination is particularly indicated in case of colitis. ▪ For the ELISA test, a faecal sample at least the size of a cherry should be submitted. ▪ **Dog, cat, horse:** Detection of toxins/toxin genes can be requested as individual tests and is included in the species-specific faecal profiles (see Chapter 17.1.1, p. 308 ff.) and in the Foal Diarrhoea Pathogens profile (see Chapter 14.5.3, p. 286).

Clostridium perfringens Alpha Toxin – Gene Detection

Material	Faeces
Method	PCR (detection of toxin gene)
Species	No limitations known
Duration	1–3 working days

Clostridium perfringens Alpha Toxin – Antibody Detection

Material	S 1 ml
Method	ELISA
Species	Horse, ruminants, South American camelids, pig, others on request
Duration	5–7 working days

Clostridium perfringens Enterotoxin – Toxin (Gene) Detection	
Material	Faeces
Method	(1) ELISA (detection of toxin) (2) PCR (detection of toxin gene)
Species	No limitations known
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ Determination is particularly indicated in case of colitis. ▪ For the ELISA test, a faecal sample at least the size of a cherry should be submitted. ▪ **Dog, cat, horse, piglet:** Detection of toxins/toxin genes can be requested as individual tests and is included in the species-specific faecal profiles (see Chapter 17.1.1, p. 308 ff.) and profile Foal Diarrhoea Pathogens (see Chapter 14.5.3, p. 286).

Clostridium perfringens netE/netF – Gene Detection	
Material	Faeces
Method	Realtime PCR (detection of toxin gene)
Species	No limitations known
Duration	1–3 working days
Note	Detection of the netE-/netF gene can either be requested as an individual test or is included in the Haemorrhagic Diarrhoea profile for dogs and the Foal Faecal Profile (see Chapter 17.1.1, p. 308 ff.) as well as in the profile Foal Diarrhoea Pathogens (see Chapter 14.5.3, p. 286).

Clostridium tetani Neurotoxin – Antibody Detection	
Material	S 2 ml
Method	ELISA
Species	Dog, rabbit, horse, sheep, goat, others on request
Duration	1–3 working days
Note	For semi-quantitative determination whether a **horse has been sufficiently vaccinated.**

14.2.12 Corynebacterium pseudotuberculosis

Corynebacterium pseudotuberculosis is a gram-positive bacterium that belongs to the group of actinomycetes. It is the causative agent of pseudotuberculosis in sheep and goats, a chronic and incurable infectious disease associated with abscess formation in the superficial and/or internal lymph nodes. Pseudotuberculosis is becoming more and more clinically relevant in llamas and alpacas and can also be transmitted to other animal species (wild ruminants, cattle, horses, pigs) and to humans.

Corynebacterium pseudotuberculosis – Pathogen Detection	
Material	Swab with medium
Method	Bacterial culture
Species	Sheep, goat, South American camelids, others on request
Duration	2–3 working days
Note	▪ For this test, please order the service "Bacteriology". Please indicate your suspicion on the submission form, as special culture conditions (incubation in a CO2 atmosphere) accelerate the growth of the pathogen. ▪ Morel's disease is a differential diagnosis for pseudotuberculosis. It also results in large abscesses, particularly in superficial lymph nodes, and is caused by Staphylococcus aureus subsp. anaerobius. The pathogen requires anaerobic culture. To clarify both diagnoses, please request "Bacteriology (aerobic + anaerobic)" and note your suspicion on the submission form.

Corynebacterium pseudotuberculosis – Antibody Detection	
Material	EP, HP, S 0.5 ml
Method	ELISA
Species	Sheep, goat, South American camelids, others on request
Duration	2–4 working days

14.2.13 Coxiella burnetii

Coxiella burnetii is an obligate intracellular, gram-negative bacterium and the pathogen that causes **Q fever.** It is highly infectious, even a small amount of pathogens is sufficient to establish an infection.
Coxiella burnetii is spread worldwide and has a large host range, e.g. ruminants, dogs, cats, rodents and birds as well as humans (zoonosis!). An infection in humans is often subclinical but clinically non-specific severe influenza-like symptoms can occur. Furthermore, chronic forms with endocarditis, hepatitis or CNS involvement have been sdescribed. Especially persons who are in contact with ruminants are affected.
In ruminants, Coxiella burnetii replicates in the female genital tract and in the utter. Excretion is intermittent or persistent via uterine secretions, amniotic fluid and abortion material, but also in urine, faeces and milk. During replication, small spore-like permanent forms are produced, which can survive in the environment for a very long time. Transmission occurs mostly by inhalation of pathogenic dust, but also by direct contact with infected animals. Ticks have also been found to be vectors of Coxiella burnetii, with tick faeces being particularly infectious. If clinical signs are seen in animals, they include post-natal complications, metritis, foetal death, late abortions, stillbirths with subsequent infertility or birth of weak calves.
Q fever is listed under the **EU Animal Health Law (AHL)**.

Coxiella burnetii – Pathogen Detection	
Material	Swab without medium (reproductive tract), abortion material, milk, faeces, urine
Method	Realtime PCR
Species	Mainly ruminants, but also other species
Duration	1–3 working days
Note	As this is a zoonotic disease, the education of the animal owner and the practice staff on the zoonotic risk is advisable.

Coxiella burnetii – Antibody Detection	
Material	S, HP, milk, tank milk 0.5 ml
Method	ELISA
Species	Dog, cat, horse, ruminants, South American camelids, others on request
Duration	1–3 working days

14.2.14 Dermatophilus congolensis

Dermatophilus congolensis is the pathogen responsible for **rain scald** (also known as **mud fever**). This disease develops when previously damaged skin (microtraumata!) is exposed to prolonged moisture. It causes scaling, thick scabs and alopecia. Apart from horses, dogs and other animal species can also be affected by this disease.

Dermatophilus congolensis – Pathogen Detection	
Material	Scab, scales, skin scrapings, skin biopsy
Method	Realtime PCR
Species	Mainly horse, but also ruminants, South American camelids, dog and others
Duration	2–4 working days
Note	▪ Hair alone is not sufficient as sample material. ▪ The test can be requested individually or together with the PCR for dermatophytes as part of the profile Skin (horse).

14.2.15 Devriesea agamarum

The gram-positive bacterium Devriesea agamarum can cause dermatitis and cheilitis as well as septicaemia in **lizards**, predominantly in Uromastyx species, although other lizard species can also become infected. In the popular bearded dragons (Pogona vitticeps), asymptomatic courses are common, as Devriesea agamarum may be part of the oral microbiome in these animals. The potential transmission to susceptible animals should be taken into account when creating groups. Clinically, the disease often

presents with yellow, scabby lesions in affected animals. Outbreaks with high mortality have been described, especially if septicaemia develops. The bacterium has been detected in both wild lizards as well as lizards in captivity.

Devriesea agamarum – Pathogen Detection	
Material	(1) Scab, scales, skin scrapings, swab without medium (skin, oral cavity), tissue (skin biopsy, cheilitis material, subcutaneous granulomas, organs if septicaemia is suspected), suspicious pure culture of lizard skin (2) Swab with medium (skin, oral cavity), scab, scales, tissue (skin biopsy, cheilitis material, subcutaneous granulomas, organs if septicaemia is suspected)
Method	(1) Realtime PCR (2) Bacterial culture
Species	lizard, mainly Uromastyx as well as Pogona species
Duration	1–3 working days

E. coli, eae/enteropathogenic ➢ see Chapter 17.1.2, p. 313

14.2.16 Ehrlichia

Infections with ehrlichia occur worldwide. Ehrlichia are gram-negative, obligate intracellular bacteria belonging to the order Rickettsiales and are transmitted by ticks. Depending on the region, the tick species differ and thus also the species of **ehrlichia**. In Mediterranean countries and tropical regions, Rhipicephalus (R.) sanguineus is the most common vector of Ehrlichia (E.) canis. This tick species is not usually found in Germany. However, if R. sanguineus is introduced into Germany, it can survive in heated rooms. Infection with E. canis still rather presents a "typical" travel-related disease or can mainly be found in imported animals.
An infection with E. canis leads to an infection of the monocytes and thus to **canine monocytic ehrlichiosis (CME).** The incubation period is about 8–20 days, which then changes into an acute phase of 2–4 weeks. Clinical signs are mostly non-specific: fever, anorexia, dyspnoea, anaemia, lymphadenopathy. In rare cases, CNS disorders may occur. Subsequently, if untreated, it may become subclinical and last for months or years, or chronic infection may develop, often accompanied by hypergammaglobulinaemia as well as progressive thrombocytopenia or pancytopenia.
E. canis can also infect cats!

Ehrlichia canis – Pathogen Detection	
Material	EB, bone marrow, tick
Method	Realtime PCR
Species	Dog, cat
Duration	1–3 working days

Ehrlichia canis – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	ELISA (dog), IFAT (cat)
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Antibody levels do not correlate with disease severity. Cross-reactions with Anaplasma phagocytophilum and Rickettsia spp. are possible. ▪ Upon request, detection by IFAT is also possible in dogs.

ESBL ➢ see Chapter 15.4, p. 297

14.2.17 Flavobacterium columnare

Flavobacterium columnare is a gram-negative bacillus. Skin lesions and damage to the epithelium, e.g. due to osmotic skin injury caused by transferring the fish too quickly, are entry points for a so-called **columnaris disease** in aquarium and pond fish. Poor water quality, high ammonia concentrations, high pH values and low oxygen content promote infection.
It mainly occurs in summer when temperatures are warmer.
Initially, small, whitish spots form on the mouth, the edges of the scales and the fins. The edges of the fins begin to disintegrate, exposing the fin rays. Sometimes, there are secondary mycoses at the affected skin areas. The gills can also be affected. In young fish, the gill filaments stick together. This results in rapid breathing. Infections can be chronic or acute, and without appropriate treatment, they are often fatal.

Flavobacterium columnare – Pathogen Detection	
Material	tissue (gills), swab (skin or gills)
Method	PCR
Species	Fish
Duration	1–3 working days

14.2.18 Francisella tularensis

Francisella (F.) tularensis is a resistant, aerobic, gram-negative bacterium and the causative agent of the zoonosis **tularaemia (rabbit fever)**. There are four subspecies, two of which are clinically relevant: F. tularensis ssp. tularensis (only in North America, particularly virulent) and F. tularensis ssp. holarctica (entire northern hemisphere). Hares, rabbits and rodents are particularly affected, but many other animal species are also susceptible. Individual cases have also been reported in cats, dogs and sheep. Transmission occurs via blood-sucking insects, infected meat/carcasses or contaminated water. The infectious dose is low, except when transmitted via the gastrointestinal

tract. Signs in animals include lethargy, fever, tachypnoea and lymphadenomegaly, usually followed by fatal septicaemia within two weeks. In chronic cases, emaciation and skin ulcers may occur and, in dogs and cats, additionally organ enlargement, lingual ulcers and jaundice, sometimes resulting in death within 2–6 weeks.
Humans (risk groups such as hunters, veterinarians, etc.) are mainly infected through direct contact with infected wild animals.
It is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Francisella tularensis (tularaemia) – Pathogen Detection	
Material	Tissue (mainly spleen, liver, lung, kidney), lymph node aspirates, swab without medium (pharynx, tonsils)
Method	Realtime PCR
Species	(Dog, cat), rabbit, hare, mouse, others
Duration	1–3 working days
Note	The PCR detects F. tularensis ssp. holarctica.

14.2.19 Helicobacter

Helicobacter (H.) spp. are helical or curved, gram-negative bacteria. At least 35 species are known; some of them colonise the gastric mucosa, while others colonise the intestine and liver of humans and animals. Transmission occurs via the oral-oral or possibly also the anal-oral route. In humans, H. pylori is correlated with gastritis and gastric ulcers and can also be transmitted to animals.
Pathogenicity of Helicobacter spp. in animals has not yet completely been clarified. Infections do not always cause a disease; prevalence is very high in both healthy as well as infected animals. H. mustelae was detected in ferrets with gastritis and gastric ulcers, H. heilmanii was found in pigs with gastric ulcers. They are also associated with gastritis, vomiting and inappetence in dogs, cats and ferrets. In cats, Helicobacter spp. are associated with progressive lymphocytic cholangitis. In Muridae, helicobacter infection is often seen in association with typhlitis or rectal prolapse. In hamsters, the infection is often subclinical. In some cases, gastritis similar to that in humans may occur. Various Helicobacter spp. have been detected in reptiles. In turtles, Helicobacter infections have been described in connection with rhinitis.

Gastric Helicobacter spp. include H. heilmannii, H. felis, H. bizzozeronii, H. salomonis and others; the intestinal ones comprise, for example, H. canis, H. bilis, H. cinaedi as well as Flexispira rappini. Flexispira rappini, which is also assigned to the genus Helicobacter, is associated with abortions in sheep. Aborted lambs show multifocal hepatic necroses – similar to campylobacter infections.

Helicobacter – Pathogen Detection	
Material	Vomitus, gastric lavage, gastric biopsy, sheep: abortion material Chelonians: swab (without medium)
Method	PCR
Species	Dog, cat, hamster, mouse, ferret, chelonians, sheep, others on request
Duration	1–3 working days
Note	Positive PCR results from faecal samples do not necessarily indicate gastric involvement (gastritis, gastric ulcers, etc.), as PCR also detects intestinal Helicobacter spp. For this diagnostic task, gastric biopsies or vomitus are recommended as sample material.

14.2.20 Histophilus somni

Histophilus somni (formerly Haemophilus somnus) is a gram-negative bacillus of the family Pasteurellaceae. While some strains of H. somni are commensals of the mucosa of the upper respiratory and reproductive tract in cattle and other ruminants, pathogenic strains spread systemically and can cause severe diseases such as pneumonia, thrombotic meningoencephalitis, myocarditis, septicaemia, arthritis and abortions or, together with Mannheimia haemolytica, the multifactorial disease enzootic bronchopneumonia.

Histophilus somni – Pathogen Detection	
Material	(1) Swab with medium (indicate site, special culture medium required), BAL, tissue (2) Swab without medium, nasal lavage, BAL, tissue
Method	(1) Bacterial culture (2) Realtime PCR
Species	Ruminants
Duration	(1) 3–4 working days (2) 1–3 working days
Note	▪ **Culture**: Take a deep swab; request detection by culture via the service Bacteriology (Please specify the sampling site.). ▪ **PCR detection** is also part of the Bovine Respiratory Profiles 2 and 3 (see Chapter 14.5.4, p. 288).

14.2.21 Lawsonia intracellularis

Lawsonia (L.) intracellularis is an obligate intracellular, gram-negative bacterium.

Horse

In recent years, this bacterium has increasingly been identified as a significant pathogen in the differential diagnosis of foal diarrhoea. Foals at weaning age (6–7 months) are particularly affected, with L. intracellularis settling in the crypt cells of the ileum and causing **proliferative enteropathy**. This can result in intestinal malabsorption and/or (mostly) chronic diarrhoea. The disease usually occurs in individual animals, but multiple cases within a single herd have been reported. Abnormal findings on abdominal ultrasound and hypoalbuminaemia indicate a Lawsonia infection.

Pig

Porcine proliferative enteropathy (PPE) is widespread in pig herds, especially among weaners, store pigs and fattening pigs. Infected animals suffer from growth disorders and diarrhoea. Infection occurs via the oral route, the spread mainly through the purchase of infected animals. Often, the infection is subclinical.
PPE occurs in four clinically apparent forms: as acute and, if untreated, often fatal porcine haemorrhagic enteropathy (PHE) and as porcine intestinal adenomatosis (PIA), or less often as necrotic enteritis (NE) and as terminal regional ileitis (RI) with thickened and stiff ileum. While PHE mainly affects older fattening pigs and younger breeding pigs, the chronic forms PIA, NE and RI mainly occur in weaners and store pigs.

Small mammals

Infection with Lawsonia intracellularis presents with different clinical courses in small mammals. Ileitis is the typical manifestation. Haemorrhagic diarrhoea is a sign of acute disease, in the subacute form, there are reduced growth and diarrhoea as well. There may be no clinical signs in chronic Lawsonia infection. Young animals are often affected and contract the disease from their subclinically infected parents. A high population density, changes in food and other stress factors facilitate infections or worsen the clinical picture. L. intracellularis infections have primarily been described in hamsters, rabbits, ferrets and rats. It is important to be aware of the zoonotic potential.

Lawsonia intracellularis – Pathogen Detection	
Material	Faeces, tissue (intestine)
Method	Realtime PCR
Species	Horse (mainly foal), pig, small mammals
Duration	1–3 working days
Note	As very few pathogens are excreted in faeces, PCR is the method of choice here; however, false negative results are possible due to the low shedding rate.

14.2.22 Leptospira

Leptospira are gram-negative bacteria and zoonotic agents which belong to the spirochete group. Leptospira can actively move by twisting. Within the genus Leptospira interrogans sensu lato, there are various pathogenic and saprophytic species which cannot be differentiated morphologically, but only serologically or genetically.
Transmission of pathogens occurs directly through the urine or blood of infected animals or indirectly through inanimate vectors such as contaminated water, feed and sleeping places or living vectors like rodents. Leptospira best survive in a humid environment at temperatures of 0–25 °C.
Leptospirose is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Dog

Clinically, leptospirosis in dogs is initially manifested by anorexia, vomiting, dehydration and fever. Later, animals are apathetic and often show difficulty breathing. The mucous membranes are icteric, anaemia with haemoglobinuria appears and, in some cases, as a complication, disseminated intravascular coagulation (DIC). Toxic degradation products lead to haemorrhagic diathesis and necroses. This frequently results in acute nephritis with azotaemia. In some cases, hepatitis may also occur, which often has a highly acute course. Leptospira are fetotrophic.

According to our own research, there has been a shift in the types of serovars over the past years. In dogs, analysed serovars include L. Bratislava, L. Australis, L. Autumnalis, L. Icterohaemorrhagiae, L. Pomona, L. Canicola, L. Saxkoebing, L. Grippotyphosa, L. Copenhageni and L. Sejroe.

Cat

Cats seem to show a natural resistance. However, here too, the number of cases with clinical manifestation is increasing. The predominant serovars are L. Grippotyphosa and L. Bratislava, followed by L. Icterohaemorrhagiae, L. Sejroe, L. Autumnalis, L. Australis and L. Javanica.

Reptiles

In reptiles, leptospira antibodies can be detected quite often.

Horse

Leptospira infections, which are spread through the urine of rodents, are usually clinically inapparent in horses. Thus, seroprevalence in healthy horses is high (up to approx. 75%). The pathogen is ingested with feed or water and leads to rather non-specific signs in horses, like fever (often intermittent), icterus, inappetence and productivity loss. Abortions have been described as well. Transmission of the pathogen between horses practically does not occur.

Equine recurrent uveitis (ERU) – It is likely that persisting intraocular leptospiral infection contributes to the aetiology of ERU. The resulting autoimmune reactions lead to a progressive deterioration of the inner structures of the eye and may even lead to blindness.
Detection of antibodies (= most sensitive test) or pathogen detection using PCR can be carried out from aqueous humour or tissue of the vitreous body.

Ruminants

Cattle infected with leptospirosis suffer from fever, anorexia, icteric mucous membranes, anaemia with haemoglobinuria and a decline in productivity. Diarrhoea and mastitis can also occur. Leptospira infections can cause abortions and fertility disorders in cattle and small ruminants.
Predominant serovars in our own research are L. Icterohaemorrhagiae, L. Saxkoebing and L. Bratislava. The recently emerged serovar L. Hardjo was not detected in any of the samples we examined.

South American camelids

In South American camelids, too, leptospira infections can cause febrile systemic disease and lead to pregnancy loss and abortion in females that show no clinical signs.

Pig

Gravid pigs are especially susceptible to leptospira. The cardinal signs are birth of weak piglets or abortions. Aborted litters normally show different sizes and degrees of decay of the foetuses as the course of the disease is usually protracted.
When testing for antibodies in pigs, the following serovars relevant to this species are included: L. Canicola, L. Grippotyphosa, L. Saxkoebing, L. Bratislava, L. Sejroe, L. Pomona, L. Copenhageni and L. Tarrasovi.

Leptospira – Pathogen Detection	
Material	Urine + EB (bacteraemia only at the beginning of the infection!), tissue (kidney, abortion material) also: **farm animals:** milk, sperm **horse:** aqueous humour, vitreous body
Method	Realtime PCR
Species List	Dog, (cat), small mammals, horse, ruminants, South American camelids, pig
Duration	1–3 working days

Leptospira – Antibody Detection	
Material	S, EP, HP 0.5 ml, horse: also aqueous humour/vitreous body (if ERU signs are present)
Method	MAT
Species	Dog, cat, reptiles, horse, ruminants, South American camelids, pig, others on request

Duration	1–2 working days
Note	▪ Initially, antibody titres only confirm pathogen contact. Many animals are seropositive without showing any clinical signs. Generally, titres > 1:400 or a three- to fourfold titre increase in a paired serum sample at an interval of 14 days are considered positive. Peracutely infected animals only show low or even negative antibody titres. Furthermore, if animals have already been treated with antibiotics at a very early stage, the titre often does not increase as expected. ▪ For acutely affected animals, direct detection from urine and blood is recommended. ▪ **Horse:** Serum antibody titres have no relevance with regard to ERU.

14.2.23 Listeria

Listeriosis can affect many animal species as well as humans.
Listeria are relatively small gram-positive rods with a tendency to grow in chains. Within the genus, Listeria monocytogenes has the greatest significance. Listeria ivanovii has low virulence, but is pathogenic to humans and sheep.
Listeriosis is predominantly a disease in sheep that contract the disease through the ingestion of spoiled silage. Cattle, chickens, pigs, rabbits and goats are much less prone to the disease. Individual cases have been described in horses, dogs and cats.
In more than 80% of the cases of ovine listeriosis, the brain is affected and the characteristic clinical picture of this disease develops – the animals run in circles and show further signs up to recumbency due to a usually unilateral dysfunction of cranial nerves.
Other forms are septic listeriosis of newborn or young animals, organ listeriosis (e.g. mastitis) or gestation listeriosis with abortions.
Listeriosis is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Listeria – Pathogen Detection	
Material	(1) Faeces, swab with medium, CSF, abortion material, etc. (2) EB (ruminants only), abortion material, (faeces)
Method	(1) Bacterial culture (Listeria spp.) (2) Realtime PCR (specific to **Listeria monocytogenes**)
Species	(1) Dog, cat, horse, cattle, sheep, goat (2) Ruminants, (horse)
Duration	(1) 3 working days (2) 1–3 working days
Note	▪ For bacterial culture, please clearly indicate on the submission form that listeriosis is suspected, as special culture media are required. ▪ If pathogenic species are detected, an antibiogram will be performed additionally (subject to a charge).

- Detection of listeria is also part of the BARF Faecal Profile, p. 308.
- The PCR test is specific to L. monocytogenes.

Listeria – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, horse, ruminants, South American camelids
Duration	2–5 working days
Note	▪ Antibodies against serovars 1 and 4b are detected. ▪ Low titres may be non-specific (< 1:80), as there is an antigenic relatedness of L. monocytogenes with staphylococci and streptococci. ▪ Due to the widespread distribution of the pathogen, a significant titre increase over 2–3 weeks accompanied by acute signs may indicate listeriosis.

14.2.24 Mannheimia haemolytica

Mannheimia (M.) haemolytica is a gram-negative, facultative anaerobic bacillus of the genus Mannheimia and the family Pasteurellaceae. It is considered the primary causative agent of **enzootic bronchopneumonia** in cattle and sheep and, moreover, the pathogen of severe mastitis as well as septicaemia in sheep and goats. In ruminants, however, some of the serotypes described for M. haemolytica are part of the natural microflora of the upper respiratory tract.

Mannheimia haemolytica – Pathogen Detection	
Material	(1) Swab with medium, tissue (2) Swab without medium, nasal lavage, tissue
Method	(1) Bacterial culture (2) Realtime PCR
Species	Ruminants
Duration	(1) 2–3 working days (2) 1–3 working days
Note	**Culture**: Take a deep swab; request detection by culture via the service Bacteriology. **PCR detection** is also part of the Bovine Respiratory Profiles 2 and 3 (see Chapter 14.5.4, p. 288)

Mannheimia haemolytica – Antibody Detection	
Material	S, HP 1 ml
Method	ELISA
Species	Cattle

Duration	2–4 working days
Note	This test can only be requested via the serological Bovine Respiratory Profile.

14.2.25 Melissococcus plutonius

The gram-positive bacterium Melissococcus plutonius is the primary pathogen of **European foulbrood (EFB)/benign foulbrood** in bees. It mainly affects so-called coiled larvae, which then die at 4–5 days of age. The larvae are infected through the food and the pathogen multiplies in the gut. Infected brood changes colour and becomes a semi-liquid mass, which later on dries out to loose scales. Due to the partly sour smell, it is also referred to as sourbrood. After capping, the caps are sunken and perforated. The signs are very similar to those of American foulbrood, which is listed under the **EU Animal Health Law (AHL)**, thus, a precise diagnosis is of great importance. Transmission can either occur through the bees themselves (drifting, robbing) or by the beekeeper. By forming an artificial swarm, the brood can be separated from the healthy bees and then killed.

Melissococcus plutonius – Pathogen Detection	
Material	Bee larvae, bees
Method	PCR
Species	Bees
Duration	1–3 working days

14.2.26 Methicillin-resistant Staphylococci: MRSA/MRSP

In human medicine, diseases caused by methicillin-resistant Staphylococcus aureus **(MRSA)** are known and feared as so-called "nosocomial infections". These are infections with pathogens that have developed resistance to common antibiotics. The pathogens can enter the environment through hospital visitors, personnel, equipment, etc. As most of these infections in humans are zoonoses, pathogens can also be transmitted to animals as well as vice versa, because of the close contact between humans and animals. This probably also leads to an increase in MRSA cases in veterinary medicine.
MRSA is often detected in farm animals. In 2016, only about every fourth pig in Germany was MRSA-free. Approximately every fourth horse was an MRSA carrier (zoonoses monitoring 2019). In agricultural **livestock,** MRSA of a certain line are predominant, so that the term livestock-associated or laMRSA is used. laMRSA mostly belong to the clonality CC398 and were responsible for 8% of MRSA cases in humans in 2017 and for 5% in 2018. In regions with high livestock density, laMRSA cause increasing numbers of human MRSA cases. People with close animal contact, including veterinarians, are particularly at risk.
In small animals, we detect MRSP, methicillin-resistant Staphylococcus pseudintermedius, far more frequently than MRSA.

MRSA/MRSP	
Material	Swab with medium (skin, eye, pharynx, nose, etc.)
Method	Bacterial culture (on standard and special culture media) and optionally followed by realtime PCR
Species	Dog, cat, horse, farm animal, others on request
Duration	Culture + special culture medium: 2–3 working days after sample receipt Culture + PCR: 3–6 working days after sample receipt Culture + special antibiogram: 3–4 working days after sample receipt
Note	▪ Detection of methicillin resistance in Staphylococcus (S.) aureus or S. pseudintermedius is only possible after prior bacterial culture. This is followed by a screening for methicillin resistance using a special culture medium, or by detection using a special antibiogram or PCR (detection of the resistance gene mecA or mecC). ▪ From 1 July 2026 onwards, the service "MRSA Differentiation" (by special culture medium or antibiogram) will also include the preceding bacteriological examination. ▪ The test for MRSA is also part of the service "Analysis of Multidrug-resistant Bacteria" (see Chapter 15.4, p. 298).

14.2.27 Mycobacterium avium ssp. paratuberculosis

Mycobacteria see ➢ Chapter 17.1.2, p. 315, and Chapter 15.4, p. 298

Mycobacterium avium subsp. paratuberculosis (MAP) is the causative agent of **paratuberculosis,** also called **Johne's disease,** a chronic granulomatous enteritis in ruminants. The disease is globally distributed. In addition to domesticated ruminants (cattle, sheep, goat), also wild ruminants and camelids can be affected. MAP could also be isolated from other animal species, e.g. rabbits, mice, foxes and ferrets. The pathogen is very stable and can remain infectious in the environment for up to one year.
Normally, an infection already occurs orofaecally in calves through contact with faeces of infected animals, but it can also spread through the colostrum and milk, and intrauterine infections are possible as well.
The incubation period varies greatly and can take several years. The first clinical signs often tend to occur when the animals are already older than 2 years. Primary signs are continuous, profound, uncontrollable diarrhoea and progressive weight loss with regular appetite. Paratuberculosis is always fatal. Already prior to the onset of these signs, decreased milk production, reduced fertility, etc. lead to high economic losses. Not all infected animals develop clinical signs, subclinically infected carriers also (intermittently) excrete the pathogen. Animals suspected of being infected should be isolated and, in case of a positive result, should soon be eliminated from the population or slaughtered. Test results vary depending on the phase of infection, therefore, the use of repeated sampling is recommended if an infection is suspected!
This disease is listed under the **EU Animal Health Law (AHL)**.

Mycobacterium avium ssp. paratuberculosis – Pathogen Detection	
Material	Faeces, tissue (intestine, lymph node), milk
Method	Realtime PCR
Species	Cattle, sheep, goat, South American camelids
Duration	1–3 working days

Mycobacterium avium ssp. paratuberculosis – Antibody Detection	
Material	S, HP 1 ml or cattle also milk 1 ml
Method	ELISA
Species	Ruminants
Duration	2–4 working days

14.2.28 Mycoplasma

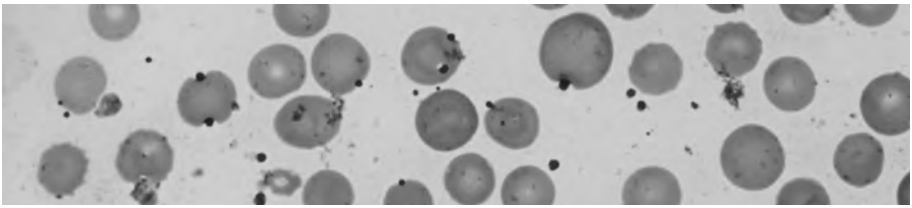
Mycoplasmas are bacteria that lack a cell wall; they belong to the family Mycoplasmataceae and are divided into haemotropic and non-haemotropic mycoplasmas. Outside the organism, mycoplasmas are very unstable. Recently, scientific literature has also used the genus name Mycoplasmopsis for some species, although the nomenclature is still under discussion. To ensure consistency, we use the term Mycoplasma.

14.2.28.1 Haemotropic Mycoplasma

Haemotropic mycoplasmas (formerly haemobartonella and eperythrozoon) are globally spread. They attach to the surface membrane of erythrocytes and can cause anaemia.

Dog

So far, **Mycoplasma haemocanis** and **Candidatus Mycoplasma haematoparvum** have been described in dogs. Both strains are found in Europe, especially in the Mediterranean area. Clinically, the course of the disease is often just chronic and asymptomatic. In contrast, acute infections with fever, anorexia, weight loss and lethargy are mainly seen in immunocompromised dogs, dogs that had splenectomy or those simultaneously infected with other pathogens. Deaths are also possible. Natural infection probably occurs through vectors, particularly the brown dog tick (Rhipicephalus sanguineus) is being discussed. Vertical transmission through the placenta and milk is also possible, and blood transfusions present a risk of infection as well.



Erythrocytes with mycoplasma on the membrane (dog, Diff-Quik, 1000x magnification).

Cat

Currently, three different types of haemotropic mycoplasmas with different pathogenicity have been described in cats. In addition to **Mycoplasma haemofelis** (known as the Ohio isolate) and the more commonly detected **Candidatus Mycoplasma haemominutum** (California isolate), another species, **Candidatus Mycoplasma turicensis**, has been known for several years. The latter was first detected in cats in Switzerland, but seems to occur relatively rarely in Germany. While Mycoplasma haemofelis can cause serious illness even in immunocompetent animals, an infection with Candidatus Mycoplasma haemominutum usually progresses subclinically in healthy animals. Co-infections are possible with clinical signs typically being more distinct than in mono-infections.
Natural infection probably occurs through vectors; particularly fleas, but also ticks and stinging insects are being discussed. Vertical transmission through the placenta and milk is also possible. Blood transfusions present a risk of infection, too, as well as direct transmission between animals through bite wounds.
Clinical signs in the acute phase are anaemia (haemolytic anaemia as cardinal symptom), fever, splenomegaly, general weakness and possibly polypnoea, tachycardia and icterus. The cause of haemolytic anaemia is damage of the erythrocyte membrane by haemotropic mycoplasmas. Because of the change in the erythrocyte surface, a secondary immune haemolytic anaemia can develop later on; in this case, the direct Coombs test will be positive. The main signs of a chronic infection include weight loss and intermittent fever. Studies have shown that a high percentage of the dog and cat population is infected without the animals showing any clinically relevant signs. These carriers present a particular risk for breeding and blood transfusions.

South American camelids

In its acute phase, an infection with **Mycoplasma haemolamae** can cause haemolytic anaemia in affected animals. However, infections can also primarily progress silently and lead to a chronic carrier state. The disease may fully break out in these animals in situations linked to stress and/or immunosuppression.

Pig

Porcine infectious anaemia (synonym: porcine eperythrozoonosis) is an infectious disease caused by **Mycoplasma suis** (formerly Eperythrozoon suis). The pathogens attach to the erythrocytes (adhesion, invasion) and provoke damage to and lysis of the erythrocytes due to the formation of autoantibodies. Below the normal body temperature ("cold antibodies"), they agglutinate the blood cells and result in anaemia. Once infected animals go through episodes of anaemia time and again. The disease becomes chronic. Older pigs are only latently infected and only suffer from another relapse when they are very weak. The pathogen remains in the body throughout life.

Small ruminants

Mycoplasma ovis is a haemotropic bacterium that can infect small ruminants. Infection with Mycoplasma ovis is a "vector-borne disease", the vectors are blood-sucking insects such as mosquitoes, lice and autumn flies as well as ticks of the genus

Rhipicephalus. Clinical signs include anaemia and weight loss. Anaemia can be so severe that it may lead to cardiovascular failure and death. Signs particularly manifest when there is also an infestation with gastrointestinal parasites.

Mycoplasma (haemotropic) – Pathogen Detection	
Material	EB, tissue (spleen)
Method	Realtime PCR
Species	Dog, cat
Duration	1–3 working days
Note	PCR detection should be preferred over microscopic detection as the sensitivity of the microscopic detection is low (around 30%). Species differentiation is included in the detection of haemotropic mycoplasma (dog: Mycoplasma haemocanis, Candidatus Mycoplasma haematoparvum; cat: Mycoplasma haemofelis, Candidatus Mycoplasma haemominutum, Candidatus Mycoplasma turicensis).

Mycoplasma haemolamae – Pathogen Detection	
Material	EB
Method	Realtime PCR
Species	South American camelids
Duration	1–3 working days

Mycoplasma (Eperythrozoon) suis – Pathogen Detection	
Material	EB, tissue (spleen)
Method	Realtime PCR
Species	Pig
Duration	1–3 working days

Mycoplasma ovis – Pathogen Detection	
Material	EB
Method	Realtime PCR
Species	Sheep, goat
Duration	1–3 working days
Note	Detection of Mycoplasma ovis is only available in combination with PCR detection of Anaplasma ovis (see p. 202).

14.2.28.2 Non-haemotropic Mycoplasma

Non-haemotropic mycoplasmas can be found on the mucous membranes of the respiratory and the urogenital tract **(mucosa-associated mycoplasmas)**, where they can escape from the immune response of the infected animal for a very long time.

Conjunctivitis and rhinitis are clinically apparent, disorders of the upper respiratory tract occur less frequently. Mycoplasma infections are multifactorial diseases.

Dog

Mycoplasmas often occur in dog populations and are sometimes considered as commensals in the literature. Yet, they are also associated with diseases of the urogenital region and with infertility. Clinically, an infection with canine mycoplasmas can cause prostatitis and/or orchitis in male dogs, and can, amongst others, lead to endometritis in female dogs. The main causative agent is usually **Mycoplasma canis**. However, mycoplasmas may also play a role in canine respiratory diseases, including the kennel cough complex. In this context, **Mycoplasma cynos** is particularly relevant. As it is difficult to cultivate mycoplasma, PCR detection is the method of choice.

Cat

In the cat common cold complex, not only viral components (FHV, FCV) play a role, but also **Mycoplasma felis**. Clinically, an infection is usually manifested by conjunctivitis and rhinitis. **Mycoplasma gatae** and **Mycoplasma feliminutum** are sometimes isolated from cats, nevertheless, their clinical relevance is questionable.

Rabbit, ferret

So far, no specific Mycoplasma species has been described in rabbits. However, Mycoplasma spp. has been detected in cases of conjunctivitis in rabbits. Mycoplasma may also be involved in upper respiratory disease in rabbits (so-called **snuffles**). Typical signs range from weight loss, apathy, nasal discharge, ocular discharge and dyspnoea to pneumonia. Mycoplasma infections also play a role in respiratory diseases in ferrets.

Guinea pig

Mycoplasma caviae has been detected in guinea pigs in cases showing various signs, mainly respiratory ones.
They range from mild rhinitis, sneezing, nasal discharge and dyspnoea to severe interstitial pneumonia. Conjunctivitis is possible. Non-specific signs such as anorexia and lethargy have also been described. In addition to lymphadenitis and metritis, Mycoplasma caviae also causes arthritis in guinea pigs.

Rat and mouse

Mycoplasma pulmonis is the causative agent of "murine respiratory mycoplasmosis" in rats and mice, a slowly progressing infection of the respiratory tracts associated with the formation of thick mucus. Clinical signs of infected animals are sneezing, mucopurulent nasal discharge, stertorous breathing sounds and dyspnoea. The infection can spread to the middle ear and lead to otitis media and head tilt.
In addition, especially in older female rats, Mycoplasma pulmonis can cause genital infection which leads to infertility or a small litter size. In rare cases, metritis or pyometra are also seen.
Latent infections without any clinical signs are common.
Transmission occurs through aerosols in close direct contact. Sexual or intrauterine transmission is also possible.

Reptiles

Several Mycoplasma spp. exist in tortoises. An infection with a virulent **Mycoplasma agassizii** strain causes the so-called upper respiratory tract disease (URTD), a disease clinically characterised by serous, mucous and purulent nasal discharge as well as ocular discharge, conjunctivitis and eyelid oedema. Furthermore, it can cause lethargy, dehydration, anorexia and fatal cachexia. An essential trait of mycoplasma infections is the fact that they can persist in the organism without triggering any symptoms. Often, the disease only breaks out if there are other microorganisms and environmental factors involved, combined with the genetic properties and immune reactions of the host. Mycoplasmas are also detected in turtles and other reptiles, especially pythons, but little is known about their clinical relevance.

Cattle

Mycoplasma bovis can cause mostly severe and often chronic pneumonia and occurs enzootically in calves and young cattle. In addition, joint inflammation and the typical ear infection in calves with hanging pinna and head tilt can occur. As mastitis pathogen, Mycoplasma bovis is highly contagious and can cause severe, treatment-resistant udder inflammation in cows. Within a few weeks, the inflammation often spreads gradually to neighbouring udder quarters.
Reservoirs of Mycoplasma bovis are the respiratory tract of clinically healthy calves and young cattle as well as the udder of cows with subclinical mastitis.

Pig

Mycoplasma hyopneumoniae is the primary causative agent of enzootic porcine pneumonia (EPP). EPP is one of the most significant causes of respiratory infectious diseases in pigs. The disease is globally distributed. However, the pathogen only causes high economic losses in pig production when combined with poor environmental conditions and secondary bacterial and/or viral infections.

Poultry

Infections with **Mycoplasma gallisepticum** cause the so-called chronic respiratory disease (CRD) in chickens and infectious sinusitis in turkeys. Infection occurs both horizontally through the air and direct contact as well as vertically through hatching eggs. The main signs include chronic inflammation of the upper respiratory tract and air sacs, accompanied by disorders of the joints, tendon sheaths and the genital tract. Central nervous disorders can also arise. In addition, laying performance and hatching rates decrease significantly. Mixed infections with viral pathogens, such as Newcastle disease virus (NDV) or infectious bronchitis virus (IBV) are not unusual and can severely aggravate the clinical picture (also as vaccine viruses).
Mycoplasma gallisepticum is listed under the **EU Animal Health Law (AHL)**.

In chickens and turkeys, **Mycoplasma synoviae** causes infectious synovitis and arthritis, which are clinically manifested by joint swelling and lameness. Inflammation of the air sacs, myocardium and pericardium also occurs. Especially after mixed infections, respiratory signs can be seen as well. Stunted growth, reduced laying performance and greenish diarrhoea are also due to the infection. Besides game birds, geese, too, are susceptible to this pathogen.

Mycoplasma – Pathogen Detection

Material	**Dog:** swab without medium (eye, nose, pharynx, genital tract), BAL, abortion material **Cat:** swab without medium (eye, nose, pharynx, genital tract), BAL, abortion material **Rabbit, guinea pig, ferret:** Swab without medium (conjunctiva, oropharynx), nasal lavage **Rat, mouse:** swab without medium (nose, pharynx), tissue (lung) **Chelonians, snake:** swab without medium (conjunctiva, mouth), nasal lavage **Cattle:** swab without medium (nose, pharynx), nasal lavage, BAL, milk, synovia, sperm, tissue (lung) **Pig:** swab without medium (trachea, nose), BAL, tissue (lung) **Poultry:** swab without medium (pharynx, cloaca), faeces, tissue (lung)
Method	PCR/realtime PCR
Species	Dog, cat, ferret, rabbit, guinea pig, rat, mouse, chelonians, snake, cattle, pig, poultry
Duration	1–3 working days
Note	▪ Mycoplasma (M.) spp. PCR in **dogs** detects at least the following species: M. arginii, M. gateae, M. spumans, M. cynos, M. molare, M. canis, M. edwardii, M. bovigenitalum, M. maculosum, M. opalescens, M. feliminutum. Detection of M. canis and M. cynos can be requested as individual tests. ▪ Mycoplasma PCR in **cats** detects M. felis. ▪ For animal species other than dogs and cats, detection of mycoplasmas can also be requested as an individual test and it is included in the Respiratory Profiles/Respiratory Tract Profiles (see Chapter 14.5, p. 280 ff.).

Mycoplasma bovis – Antibody Detection

Material	S, HP 1 ml
Method	ELISA
Species	Cattle
Duration	2–4 working days
Note	This test can only be requested as part of the serological Bovine Respiratory Profile.

Mycoplasma hyopneumoniae – Antibody Detection

Material	S 1 ml
Method	ELISA
Species	Pig
Duration	5–6 working days

Note
- This test can be ordered individually and is also part of the serological Porcine Respiratory Profile (see Chapter 14.5.5, p. 289).
- This service may not be available in some countries.

Nocardia ➢ **see Chapter 15.4, p. 299**

14.2.29 Neoehrlichia mikurensis

Officially named in 2004, Neoehrlichia mikurensis is an obligate intracellular, gram-negative bacterium. The pathogen is characterised by endotheliotropism but has not been cultivated in vitro so far and thus could not be completely described yet.
N. mikurensis was first found in common rats on the Japanese island of Mikura. It is assumed that small mammals, such as mice and rats, serve as reservoir; transmission most likely occurs through ticks. In recent years, N. mikurensis has been detected in about 2 to 25% of Ixodes ricinus ticks in Germany.
Since 2007, this pathogen has been associated with diseases in humans. Especially the elderly and immunocompromised people have been affected by neoehrlichiosis, including two patients from Germany. The symptoms are non-specific, with high fever and headaches as well as muscle and joint pain being the most common signs. The occurrence of vascular complications, like deep vein thromboses, pulmonary embolism and arterial aneurysms, was most noticeable. Laboratory findings particularly indicate an increased level of C-reactive protein, leukocytosis with neutrophilia and anaemia.
In dogs, so far only one single case has been reported in which this bacterium could be isolated. It was an eight-year old female Irish Setter after ovariohysterectomy and mastectomy. Postoperatively, she was lethargic and developed profuse subcutaneous bleeding (Diniz et al. 2011).

Neoehrlichia mikurensis – Pathogen Detection	
Material	EB, tick, tissue (e.g. spleen, kidney, liver)
Method	Realtime PCR
Species	Dog, tick
Duration	1–3 working days

Paenibacillus larvae ➢ **see Chapter 15.4, p. 299**

14.2.30 Pasteurella multocida

Pasteurella multocida is a gram-negative bacillus. Pasteurella are commensals of the mucous membrane of the upper respiratory tract. Factors that reduce resistance, such as overpopulation or a bad stable environment, provide a predisposition to infections with toxigenic strains. Co-infections with Bordetella bronchiseptica are common and lead to particularly severe signs.

In rabbits, members of the family Pasteurellaceae, in addition to other pathogens, are one of the main causes of the multifactorial disease **"upper respiratory tract disease"**. Due to the high infection rate, herd problems and relapses are common in immunocompromised animals.
In **pigs,** Pasteurella multocida toxin is the aetiological agent that causes progressive **atrophic rhinitis,** with especially the toxigenic pasteurella types A and D being involved. The cytotoxic toxin (PMT) inhibits the osteoblasts. With the activity of the osteoclasts being maintained, it leads to atrophy of the nasal conchae and deformation of the nasal septum. The importance of the toxin in pneumonia in cattle has not yet been clarified.

Pasteurella multocida (toxin producing) – Pathogen Detection	
Material	Swab without medium (nose, pharynx), BAL, NSP, tissue (lung)
Method	Realtime PCR
Species	Rabbit, pig, others on request
Duration	1–3 working days
Note	▪ The serogroups/types (A–F)/serotypes cannot be differentiated by PCR. ▪ Detection by culture of solely P. multocida is also possible; please indicate on the submission form that pasteurella is suspected. A possible toxin formation cannot be detected by culture. ▪ This test can be ordered individually and it is also part of the Respiratory Profiles/Respiratory Tract Profiles (see Chapter 14.5, p. 281 ff.).

14.2.31 Rhodococcus equi

Rhodococcus (R.) equi causes severe pneumonia in foals. Infection occurs through the inhalation of pathogens bound to dust particles during the first days of life. The course of the disease is insidious. Clinical signs appear at the earliest at 3–4 weeks of age, often only after several months. It leads to purulent bronchopneumonia and abscess formation in the lungs. When swallowed, the rhodococci also enter the intestinal tract, where the pathogens can multiply, leading to the formation of granulomas and to diarrhoea. R. equi is shed in the faeces, becoming a source of infection for other foals. Older animals also shed the pathogen but do not become ill. In addition, R. equi has an affinity for joints.

Rhodococcus equi – Pathogen Detection	
Material	(1) Swab with medium (nose, navel), BAL, tracheal lavage (preferred), faeces (2) Swab without medium (nose, navel), BAL, tracheal lavage, faeces
Method	(1) Culture (2) Realtime PCR
Species	Horse

Duration	(1) 2–3 working days (2) 1–3 working days
Note	▪ Because of the sensitivity of PCR, it is possible to also identify clinically healthy carriers. ▪ If PCR detection is positive, the virulence factor gene vapA will be automatically detected at no additional cost.

14.2.32 Rickettsia

Rickettsia are obligate intracellular coccoid, rod-shaped or pleomorphic gram-negative bacteria that parasitise in reticuloendothelial cells or erythrocytes. They are usually transmitted by arthropods.
Rickettsia are divided into the categories "spotted fever group", thyphus group and "others", which includes Coxiella burnetii.
In the USA, Rickettsia rickettsii, the causative agent of **Rocky Mountain spotted fever**, and in the Mediterranean area, Rickettsia conorii, the causative agent of **Mediterranean spotted fever**, play a central role in animal infections. Infected dogs may remain asymptomatic or show signs ranging from lymphadenopathies, fever, hyperesthesia, peripheral oedema up to lameness.

Rickettsia spp. – Pathogen Detection	
Material	Tick, EB, tissue (skin)
Method	Realtime PCR
Species	Dog, cat, others
Duration	1–3 working days

Rickettsia conorii – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	R. conorii is found in the Mediterranean, Africa, South West Asia and India. Serological studies suggest a high prevalence in asymptomatic dogs.

Rickettsia rickettsii – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Rickettsia ricketsii infection causes Rocky Mountain spotted fever. It is found in North and South America.

14.2.33 Salmonella

Salmonella belong to the family Enterobacteriaceae and are found in the intestines of animals and humans. In most cases, infection occurs faecal-orally or by feeding raw meat. Salmonella infections affect almost all animal species. Compared to herbivorous pets, dogs and cats are more resistant to salmonella infections. Under favourable conditions, salmonellosis causes diarrhoea with vomiting and fever; in young animals, the disease can also become septicaemic.
Together with predisposing factors such as immunodeficiency or stress, salmonellosis can cause diarrhoea and fever in horses; septicaemia often occurs in young horses. Asymptomatic carriers have been described as well. They do not fall ill, but are a source of infection for animals and humans.
In reptiles and amphibians, salmonella can be part of the normal intestinal flora. In these animals, clinically relevant salmonellosis is associated with immunodeficiency.
According to the Robert Koch Institute (RKI), about 10% of all human salmonella infections, which cause diarrhoea, are related to direct contact with excreting dogs, cats and particularly reptiles.
For some time now, ESBL producers have also been detected among salmonella, especially in livestock. Because of the **ESBL problem, creating an antibiogram** is essential.
In Germany, it is an **epizootic disease** in cattle that is **notifiable upon suspicion**. In other species, it is **notifiable upon diagnosis**. For commercial poultry in Germany, there is also an obligation to notify and inform the authorities, but this is strictly monitored and can result in official measures being taken in the flock.
Salmonella (S.) pullorum, S. gallinarum and S. arizonae are listed under the **EU Animal Health Law (AHL)**.

Salmonella – Pathogen Detection	
Material	(1) Faeces, swab with medium (intestinal or cloacal swab) (2) Faeces; in birds also swab without medium (cloaca), eggs, tissue
Method	(1) Bacterial culture with enrichment (2) Realtime PCR
Species	No limitations known
Duration	(1) 2–3 working days (2) 1–3 working days
Note	Culture with enrichment is the most sensitive test method. After successful culture growth, a serological pathogen differentiation is carried out (subject to a charge).

Salmonella Abortusequi – Antibody Detection	
Material	S 1 ml
Method	Slow agglutination
Species	Horse
Duration	3–6 working days; for export tests, the processing time may be longer as the results are sent together with the final report.

Note	▪ Export-relevant test ▪ In the host-adapted serotype Abortusequi, pathogen transmission occurs orally, rarely through mating. With regard to miscarriages, this pathogen does not currently play a role in Germany anymore. ▪ This service may not be available in some countries.

14.2.34 Staphylococcus

Staphylococci are gram-positive and extremely resistant bacteria. They normally reside on the skin and the mucous membranes, where they are part of the physiological microbial flora.
Inflammation caused by staphylococci is usually locally limited. Only in cases of decreased resistance, septicaemia and pyaemia can occur. In ruminants, staphylococci are of major importance as causative agents of mastitis.
Nowadays, special attention should be paid to whether methicillin-resistant strains of Staphylococcus pseudintermedius (MRSP) or Staphylococcus aureus (MRSA) are present (see Chapter 14.2.26, p. 226). In case of repeated wound healing problems in patients visiting the practice, which are caused by MRSA or MRSP, it should be considered testing the staff of the practice, too, whether they carry this type of pathogen on their nasal mucosa.
Detection can be done through culture examination of clinical samples, e.g. swabs of pustules, mucosal swabs and other body secretions and excretions.

Staphylococcus – Pathogen Detection	
Material	Swab with medium, milk (ruminants)
Method	Culture with enrichment
Species	All
Duration	2–3 working days
Note	Further differentiation can be made if MRSA/MRSP is suspected.

Staphylococcus – Antibody Detection	
Material	S 0.5 ml
Method	MAT (IgG)
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	To recognise animals sensitive to Staphylococcus in cases of pyoderma.

14.2.35 Streptococcus equi

The globally spread and highly infectious equine disease **strangles** is caused by an infection with **Streptococcus equi subsp. equi** and is characterised by purulent lymphadenitis and pharyngitis. It used to be a typical disease in young animals which induces long-lasting immunity. Over the past years, however, an increasing number of affected adult horses has been described, with the disease showing a rather atypical progression (mainly fever, respiratory disorders). PCR provides faster results than a culture, but it can also detect non-viable pathogens. It may therefore be advisable to confirm a positive result by culture.
Clinically, an infection with Streptococcus equi subsp. equi cannot always be distinguished from an infection with **Streptococcus equi subsp. zooepidemicus.** Streptococcus equi subsp. zooepidemicus can be found in all domestic animals and in humans. In horses, it is a facultative pathogenic commensal; infections can cause, amongst others, respiratory disorders and purulent bronchopneumonia. Especially foals and young horses are affected.

Streptococcus equi – Pathogen Detection	
Material	(1) Swab with medium (nose, abscess, lymph node), guttural pouch lavage sample (gold standard, highest sensitivity), pharyngeal lavage sample (2) Swab without medium (nose), lavage sample (guttural pouch, BAL), TBS, lymph node aspirate/lymph node pus, tissue (lymph node)
Method	(1) Bacterial culture (2) Realtime PCR
Species	Horse
Duration	Culture: 2–3 working days, PCR: 1–3 working days
Note	▪ In culture, both subspecies (Streptococcus equi equi and Streptococcus equi zooepidemicus) are determined and differentiated by MALDI-TOF. ▪ If detection is to be done by means of PCR, it can be chosen between the single detection of Streptococcus equi equi or the detection of both subspecies mentioned above.

Streptococcus equi subsp. equi – Antibody Detection	
Material	EP, HP, S 0.5 ml
Method	ELISA
Species	Horse
Duration	2–4 working days
Note	▪ Detection of specific antibodies against the surface antigens A and C of Streptococcus equi subsp. equi ▪ No cross-reaction with Streptococcus equi subsp. zooepidemicus ▪ Identification of infected horses, including asymptomatic carriers

- Detection of antibodies in symptomatic and asymptomatic horses as early as 2 weeks post infection
- Detection of seroprevalence in exposed animals as part of outbreak management
- Confirmation that individual animals are free of infection prior to transport or sale
- The titre level does not correlate with the protective effect of the antibodies or with vaccine protection.

14.2.36 Taylorella

Taylorella asinigenitalis

Taylorella (T.) asinigenitalis, an non-motile, gram-negative bacillus, is closely related to T. equigenitalis and occurs on the genital mucosa of equids (mainly donkeys, more rarely horses). The pathogen is more often detected in male animals than in female ones. Donkeys and horses can act as asymptomatic carriers of T. asinigenitalis, particularly male animals. Transmission occurs via mating. T. asinigenitalis is usually described as apathogenic, but there are also pathogenic strains that can cause severe purulent endometritis in mares. In female donkeys, the infection is usually asymptomatic. For a comprehensive breeding soundness examination, it is recommended to do the additional PCR test for T. asinigenitalis – along with the PCR for T. equigenitalis – to detect future outbreaks at an early stage.

Taylorella asinigenitalis – Pathogen Detection	
Material	Swab with or without medium (males: penile sheath, urethra, fossa glandis; females: fossa clitoridis, sinus clitoridis, cervix), sperm
Method	Realtime PCR
Species	Horse, donkey
Duration	1–3 working days

Taylorella equigenitalis

Contagious equine metritis (CEM) is caused by the gram-negative bacillus Taylorella equigenitalis. Transmission particularly occurs during mating; stallions latently carry the pathogen on the mucous membrane of the penis, especially in the Fossa urethralis and in the smegma of the prepuce. Transmission from infected mares to stallions is also possible. In mares, an infection leads to endometritis/cervicitis with mucopurulent vaginal discharge and to reduced fertility. Stallions show no clinical signs of the disease. For exports, a bacteriological examination is required; within the EU, however, detection by PCR is now also recognised as a suitable test method. Contagious equine metritis is listed under the **EU Animal Health Law (AHL)**.

Taylorella equigenitalis/CEM – Pathogen Detection	
Material	(1+2) Swab with medium (Amies with charcoal, not older than 48 hours) Stallion: penile sheath, urethra, fossa glandis (optional: prepuce or semen) Mare: fossa clitoridis, sinus clitoridis (optional: cervix)
Method	(1) Bacterial culture (2) Realtime PCR
Species	Horse
Duration	(1) Reporting of results **one week** after the sample is received (Mon–Fri); for export tests, however, the processing time may be longer depending on the specific requirements of the respective export country. (2) 1–3 working days
Note	▪ Detection by PCR is offered as an individual service for one sample or as a CEM profile for the examination of several sites. The CEM Profiles stallion 1 and mare 1 are suitable as PCR detection before export to another EU country (see Chapter 14.5.3, p. 285). ▪ Even after successful bacterial cultivation, it is not possible to create an antibiogram for Taylorella equigenitalis.

14.2.37 Treponema paraluiscuniculi

"**Rabbit syphilis**" (Spirochaetosis cuniculi, venereal spirochaetosis) is caused by the bacterium Treponema paraluiscuniculi. Only rabbits are affected; transmission to humans is not possible. The pathogen causes persistent infections that are usually subclinical or mild and self-limiting, but can also be accompanied by severe pasty, oedematous swelling and crusty inflammation in the genital and oral region, abortions, reduced conception and increased susceptibility to infection. If there is an acute clinical manifestation, direct detection from scabs is the most promising method, as antibodies often cannot be detected.

Treponema paraluiscuniculi (syphilis) – Pathogen Detection	
Material	Tissue (mainly skin lesions/scabs; possibly regional lymph nodes), swab without medium (vagina, prepuce)
Method	Realtime PCR
Species	Rabbit, hare
Duration	1–3 working days

Treponema paraluiscuniculi (syphilis) – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	Treponema pallidum haemagglutination test
Species	Rabbit
Duration	3–5 working days
Note	▪ Antibody detection can sometimes be false negative in acute clinical phases, but it is suitable for herd screening. ▪ This service may not be available in some countries.

14.2.38 Yersinia

Yersinia belong to the order Enterobacterales. Yersinia (Y.) pseudotuberculosis is the causative agent of **pseudotuberculosis/rodentiosis**, an infectious disease many mammalian and bird species can contract. For instance, rodents and cats are predisposed. Cats, however, rarely show any clinical signs, which are often non-specific. The pathogen has a high tenacity. In the soil, the pathogen remains infectious for months. Y. enterocolitica causes enterocolitis in humans and animals. Immunopathological reactions can lead to arthritis, arthrosis and skin diseases. Animals, especially pigs, sheep and poultry, often act as pathogen reservoir. Dogs rarely become ill, if at all, puppies are mainly affected. The infection manifests itself as enteritis, resulting in mucous to bloody diarrhoea. Especially in Y. pseudotuberculosis infections, abscesses can occur in various organs. Y. pseudotuberculosis can also play a role in wild ruminants (game enclosures!).
Just like Y. enterocolitica, Y. pseudotuberculosis is a **zoonotic agent**!

Yersinia – Pathogen Detection	
Material	Faeces
Method	(1) Bacterial culture with cold enrichment (2) Realtime PCR (Y. enterocolitica only)
Species	No limitations known
Duration	(1) Up to 4 weeks (2) 1–3 working days
Note	▪ A faecal sample of at least the size of a cherry is required. ▪ In exceptional cases, a swab with transport medium can also be used for detection by culture. ▪ The Campylobacter/Yersinia culture test is available as a single service and is also included in the BARF Faecal Profile and the Faecal Profile Pathogenic Bacteria. (see Chapter 17.1.1, p. 308). ▪ After successful culture growth, a serological pathogen differentiation is carried out (subject to a charge).

14.3 Fungi

14.3.1 Aspergillus

Aspergillus is a genus of moulds with approximately 200 species worldwide. In the environment, Aspergillus is particularly found in soil, organic waste, but also in animal feed. Parrots often get infected through unpeeled peanuts.
Aspergillosis is often caused by the species Aspergillus fumigatus and preferably affects the skin, nose, paranasal sinuses and the lung. Aspergillosis frequently occurs in birds, especially if the animal is predisposed by improper keeping, the administration of antibiotics or stress. This very often results in severe respiratory disorders. Other organs (e.g. CNS) can also be affected.

Aspergillus – Pathogen Detection	
Material	Swab with medium, BAL, nasal lavage, tracheal lavage, faeces
Method	Culture, mycology
Species	All
Duration	1 week
Note	Order via the Mycology service.

Aspergillus-Galactomannan – Antigen Detection	
Material	S 0.5 ml
Method	ELISA
Species	Birds, others on request
Duration	5 working days
Note	Galactomannan is a polysaccharide found in the cell wall of Aspergillus spp. In animals affected by aspergillosis, it can be detected in the blood. For birds, the detection of galactomannan in the blood can help to diagnose aspergillosis. However, galactomannan is only released during active infection, i.e. during growth and spread of the fungus. In inactive older granulomas, the polysaccharide cannot be detected in the blood. Antibody and antigen detection can complement each other when making a diagnosis, in addition to medical imaging.

Aspergillus spp. – Antibody Detection	
Material	S 0.5 ml
Method	MAT
Species	Dog, cat, birds, cattle, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Culture detection of Aspergillus is often very difficult due to the site of infection. Antibody detection may be used to support the diagnosis.

14.3.2 Batrachochytrium

Batrachochytrium spp. are fungi which are being held responsible for large losses in **amphibians**.

Batrachochytrium dendrobatidis

The chytrid fungus Batrachochytrium (B.) dendrobatidis is one of the causative agents of chytridiomycosis (along with B. salamandrivorans). B. dendrobatidis can infect anurans and salamanders and is thought to be partly responsible for population declines and the global extinction of > 200 amphibian species.
In many cases, infections with B. dendrobatidis are associated with very high mortality rates (up to 100% in the laboratory), especially during metamorphosis. Other factors such as stress or co-infections with other pathogens also seem to play a role.
B. dendrobatidis multiplies in keratinised tissue and therefore affects primarily the outer skin of adult animals. In larvae, the keratinised mouthparts are affected. The clinical signs are often non-specific and may affect the skin (often macroscopically unchanged or "dull" or depigmented; hyperkeratosis and excessive episodes of skin shedding) as well as the behaviour (atypical behaviour, ataxia and CNS problems). Spontaneous deaths without previous clinical manifestation are also observed.
Six genetically distinct lineages of B. dendrobatidis (Bd lineages) are currently known. Fungi of the lineages BdCAPE and BdGPL (= Global Pandemic Lineage) seem to be the most pathogenic ones. BdCAPE is mainly found in Africa, while BdGPL occurs worldwide and is the most frequently detected Bd lineage.

Batrachochytrium dendrobatidis – Pathogen Detection	
Material	Swab without medium: skin swabs of the ventral body surface (adult animals) or of the keratinized skin at the mouth (tadpoles), tissue (sloughed skin of infected animals)
Method	Realtime PCR
Species	Amphibians
Duration	1–3 working days
Note	▪ Specific detection of BdGPL to aid differentiation is available after a positive PCR result for B. dendrobatidis. ▪ Detection of Batrachochytrium dendrobatidis is also included in the PCR profiles Skin Profile (amphibian) and Quarantine (anura) and Quarantine (caudata) (Chapter 14.5, p. 284).

Batrachochytrium salamandrivorans

Batrachochytrium salamandrivorans is a highly contagious and deadly chytrid fungus that has been described for some years and which mainly infects salamanders. Fire salamanders are particularly susceptible. Infected animals show anorexia, apathy and ataxia as well as skin lesions with superficial erosions and deep ulcerations all over the body. This pathogen is listed under the **EU Animal Health Law (AHL).**

Batrachochytrium salamandrivorans – Pathogen Detection	
Material	Swab without medium and tissue (also ventral body surface and lesions)
Method	Realtime PCR
Species	Amphibians (mainly salamander)
Duration	1–3 working days
Note	Detection of the pathogen Batrachochytrium salamandrivorans is also included in the PCR profiles Skin Profile Large (amphibian) and Quarantine (caudata) (Chapter 14.5, p. 284).

14.3.3 Cryptococcus

Cryptococcus is a yeast and mainly found in bird faeces and contaminated soil and dust. Cryptococci are potential causative agents of systemic infections in humans, domestic and wild animals. Direct transmission from vertebrates to humans has not yet been observed. Clinical disease occurs more frequently in cats than in dogs. It is possible to differentiate between nasal, central nervous, cutaneous or systemic forms of the disease. In dogs, nasal or cutaneous infection is less common; instead, systemic or central nervous signs are more frequently seen. In both species, the lungs can be affected as well. As Cryptococcus neoformans infection can lead to serious diseases, early detection is important.

Cryptococcus – Pathogen Detection (Antigen)	
Material	(1) S 0.5 ml (2) Swab with medium
Method	(1) Agglutination (2) Culture, mycology
Species	Dog, cat, others on request
Duration	(1) Reporting of results on the day the sample is received (Mon–Fri) (2) 2–7 calender days

14.3.4 Dermatophytes

Dermatophytes are filamentous fungi that can cause skin lesions in humans and animals. The disease is called dermatophytosis. The fungi use keratin as a carbon source and colonise keratinised tissue, such as hair, skin or claws.
Dermatophytes are highly contagious. Infection is direct or indirect. Favourable factors are, for example, immunosuppression, reduced immune response (e.g. high age) or previous damage of the skin (e.g. by ectoparasites). Moreover, spores as form of propagation can remain infectious in the environment for years.
The clinical signs are diverse and depend on the virulence of the fungal strain, the infection period and the immune status of the host. Typical patchy alopecia may appear on the face, ears and front legs. Pruritus may be missing or may range from mild to severe. In case of skin diseases, dermatophytosis must always be considered in the differential diagnosis.

Especially guinea pigs from pet shops are (asymptomatic) carriers of Trichophyton benhamiae. Most zoonotically transmitted dermatophytoses in humans are now caused by this pathogen. Before introducing guinea pigs into a household, particularly if there are children or immunocompromised persons, the animals should be examined for dermatophytes. Hedgehogs are also often carriers (Trichophyton erinacei).

Dermatophytes – Pathogen Detection	
Material	Hair with roots, deep skin scraping, scales, scabs, claws
Method	(1) Culture, mycology (2) Realtime PCR
Species	Dog, cat, rabbit, guinea pig, hedgehog, horse, cattle (and other species)
Duration	(1) 3 working days to 3 weeks (2) 2–4 working days
Note	▪ Zoonosis! ▪ Culture also detects Malassezia; a false negative result is possible with previous treatment. ▪ PCR, including species differentiation, is validated for the detection of the following dermatophyte species: Microsporum canis, Nannizzia gypsea (formerly: Microsporum gypseum), Nannizzia persicolor (formerly: Microsporum persicolor), Trichophyton (T.) mentagrophytes, T. benhamiae, T. equinum, T. verrucosum, T. erinacei. Further types of skin fungus might also be detected by the PCR. ▪ PCR is not suited for therapy monitoring (dead dermatophytes are detected as well).

14.3.5 Emydomyces testavorans

Emydomyces testavorans was first described in 2019 and is a keratinophilic fungus of the order Onygenales. So far, it has only been documented in aquatic turtles and terrapins, both in captive and in wild animals. Infection has been described in connection with various shell lesions (mainly ulcerative), osteonecrosis, but also space-occupying epithelial inclusion cysts.

Emydomyces testavorans – Pathogen Detection	
Material	Swab (shell, skin, triple swab: oral cavity-cloaca-shell), skin, shell material
Method	Realtime PCR
Species	Chelonians (mainly aquatic turtles and terrapins)
Duration	1–3 working days

14.3.6 Macrorhabdus ornithogaster

Macrorhabdus ornithogaster is a yeast which is found in many different **avian** species, especially in budgerigars. Macrorhabdiosis is also called **megabacteriosis** or **going light syndrome.** Infected animals may develop maldigestion and lose weight even though there is no change in appetite. Undigested seeds can be excreted in the faeces, sometimes there is also blood in the faeces. Choking and vomiting as well as a general weakness can also be found in macrorhabdiosis. Inapparent carriers are frequent. Transmission presumably occurs through billing and feeding as well as through contaminated feed and water.

Macrorhabdus ornithogaster – Pathogen Detection	
Material	Faeces, crop lavage, proventriculus, smear on slide
Method	Stain, microscopy
Species	Birds
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	A faecal sample at least the size of a cherry is required.

14.3.7 Nannizziopsis

Fungi of the genus Nannizziopsis belong to the order Onygenales. They are keratinophilic fungi that can cause various skin changes, especially in lizards. The ascomycete fungus Nannizziopsis guarroi is one of the most frequently described species within this genus. Other species of this genus include N. dermatitidis, N. chlamydospora, N. vriesii, N. crocodili and N. barbatae.
Infections have been reported worldwide and occur in both wild and captive animals. Infections are most commonly seen in central bearded dragons (Pogona vitticeps), but other reptile species can be affected as well. Infected animals often develop ulcerative to scabby dermatitis. Discolouration may occur, particularly a yellowish discolouration, which is why the disease used to be called "**yellow fungus disease**". However, the term **nannizziomycosis** is preferred now. Granulomas are common. Infections can range from mild to severe, and dissemination to organs is possible. If left untreated, chronic infections often develop progressively and can lead to the death of the animal. Transmission mainly occurs through direct contact, but indirect transmission through a contaminated environment might also be possible.

Nannizziopsis spp. – Pathogen Detection	
Material	(1) Scabs, skin, swab without medium (skin), tissue (2) Swab with medium (skin), skin scraping
Method	(1) Realtime PCR (2) Culture, mycology
Species	Lizard

Duration	(1) 1–3 working days (2) 1–3 weeks
Note	The PCR test is to be preferred over the culture test.

14.3.8 Nosema

Nosemosis is the most common disease of adult honey bees. The genus Nosema belongs to the microsporidia, which are parasitic fungi. It is spread through spores that are viable for several years. Two species can be differentiated: Nosema apis and Nosema ceranae, which can only be distinguished by PCR, but differ in pathogenicity. The pathogens infect the midgut cells and thus lead to yellowish diarrhoea. Affected animals are often unable to fly and the abdomen is bloated. Many times, signs are rather non-specific, the bees are weak. Nosemosis is a multifactorial disorder, which means outbreaks of the disease only occur when there are other adverse conditions involved, such as cold, other illnesses, etc. Hence, nosemosis is potentially curable by resolving the other factors. Due to the resistance of the spores, it is often difficult to completely eliminate the pathogens. As with many bee diseases, transmission occurs through the bees themselves (drifting or robbing) or through the beekeeper.

Nosema – Pathogen Detection	
Material	30–40 dead bees
Method	(1) Microscopy (2) PCR (differentiation) – only possible after positive microscopy
Species	Bees
Duration	(1) 2–3 working days (2) 1–3 working days
Note	If the result of the microscopic examination is positive, we recommend PCR differentiation between Nosema apis and Nosema ceranae.

14.3.9 Ophidiomyces ophidiicola

Ophidiomyces (O.) ophiodiicola is a dermatophyte found in snakes. Infections with O. ophidiicola are associated with skin lesions, pustules, nodules and swelling of the skin. Lesions primarily occur on the ventral scales, but can also spread to the whole body.

Ophidiomyces ophidiicola – Pathogen Detection	
Material	(1) Swab without medium (skin), tissue (skin) (2) Swab with medium (skin), skin scraping
Method	(1) Realtime PCR (2) Culture, mycology
Species	Snake

Duration	(1) 1–3 working days (2) 1–3 weeks
Note	PCR is used for precise species differentiation of cultured fungi from snake skin. PCR testing is preferred over detection by culture.

14.3.10 Paranannizziopsis

Fungi of the genus Paranannizziopsis (P.) are closely related to Ophidiomyces (O.) ophidiicola, but have been studied much less extensively. Several species have been described: P. australasiensis, P. californiensis, P. crustacea, P. longispora and P. tardicrescens. Infection can be accompanied by scabby-ulcerative, sometimes necrotic dermatitis and discolouration in affected areas, which can also spread to deeper tissue. Moulting problems have been described as well. Infection can also be associated with high mortality. Paranannizziopsis spp. has already been detected on different continents (North America, New Zealand, Australia, Europe) and in various wild and captive reptile species (snakes, lizards, tuataras). Co-infections with O. ophidiicola are possible.

Paranannizziopsis spp. – Pathogen Detection	
Material	Swab with medium (skin), scabs, tissue (skin)
Method	Realtime PCR
Species	Reptiles
Duration	1–3 working days

14.4 Parasites

14.4.1 Aelurostrongylus abstrusus

The adults, which are 0.5 to 1.5 cm in size, live in the bronchioles and alveoli of cats and wild felids. They release eggs into the alveoli and terminal bronchioles. The larvae hatch there, enter the pharynx through coughing, are swallowed and excreted in the faeces. Various snails and slugs serve as intermediate hosts in which the development into infective L3 larvae takes place. Transport hosts such as mice and rats, but also birds, amphibians and reptiles play an important epidemiological role. In cats, the L3 larvae reach the lungs through the lymphatic system and the bloodstream when the intermediate or transport host is eaten.
Egg or larvae production usually lasts for 5–6 months, after that the infection is self-limiting and the cat remains immune to further infections with L3. Therefore, mainly young animals or immunocompromised cats are affected.
Lungworm infections can be asymptomatic; detection of lungworm larvae is often an incidental finding during routine coproscopic examinations. Mild to severe respiratory signs are also possible, including coughing, nasal discharge, tachypnoea and dyspnoea. Young animals are more frequently affected and usually suffer more severely.

Aelurostrongylus abstrusus – Pathogen Detection	
Material	(1) Faeces (3-day pooled sample; as fresh as possible) (2) Faeces, BAL, tracheal lavage, lung tissue
Method	(1) Baermann technique (2) PCR
Species	Cat
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ False negative results cannot be excluded due to prepatency, intermittent shedding and limited sensitivity of the test methods. Tests should therefore be repeated if there is a clinical suspicion. ▪ It is difficult to differentiate the L1 larvae microscopically from the L1 larvae of Troglostrongylus brevior. ▪ PCR detection of Aelurostrongylus abstrusus is included in the Lungworm Profile Cat (see Chapter 14.5.1, p. 279).

14.4.2 Angiostrongylus vasorum

Angiostrongylus vasorum is a globally distributed nematode that parasitises the pulmonary arteries and, less frequently, the right heart of dogs and wild canids. At 7.4% (2009), prevalence in Germany is higher than generally assumed. Thus, an infection with this lungworm should always be considered the differential diagnosis if respiratory and/or cardiovascular signs are present.

Dogs as definitive hosts get infected by ingesting L3 larvae when eating infected snails or slugs (intermediate hosts). L3 invade the lymphatic and blood system through the wall of the small intestine of the dog and enter the pulmonary arteries. Six to eight weeks p.i., the females begin to lay eggs. Via the blood, the eggs reach the fine pulmonary capillaries where they develop into L1 larvae and enter the pulmonary alveoli. From here, they are carried up by the ciliated epithelium or are coughed up, swallowed again and finally excreted in the faeces. L1 are taken up with the faeces by intermediate hosts and the infectious L3 then develop within them.

Especially young dogs between the age of one and two years are affected by canine angiostrongylosis. Besides clinically inapparent infections, the course of the disease may be mild to life-threatening. Clinical signs are highly variable, however, the main symptoms include cardiopulmonary signs such as dyspnoea and cough. The second most common manifestations are coagulopathy with epistaxis, haemoptysis, haematoma and anaemia. Subsequently, DIC, circulatory insufficiency and death can occur. Vomiting or neurological signs like muscle tremor, ataxia, dizziness and epileptiform seizures are also possible.

Angiostrongylus vasorum – Pathogen Detection	
Material	(1) Faeces (3-day pooled sample; as fresh as possible) (2) EB, BAL, faeces (3-day pooled sample), tissue (lung, brain)
Method	(1) Baermann technique (2) Realtime PCR
Species	Dog
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ If blood should be examined, a combination of PCR and ICA is recommended as it increases sensitivity. ▪ False negative results cannot be excluded due to prepatency, intermittent shedding and limited sensitivity of the test methods. Tests should therefore be repeated if there is a clinical suspicion. ▪ PCR detection of Angiostrongylus vasorum is included in the Lungworm Profile Dog (see Chapter 14.5.1, p. 279).

Angiostrongylus vasorum – Antigen Detection	
Material	S 0.5 ml
Method	ICA
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Fri)

14.4.3 Anoplocephala

Anoplocephala perfoliata is the most common type of tapeworm in horses. It is globally distributed; in Germany, focal prevalences of up to 30% have been described. The moss mite acts as intermediate host; mites infected with tapeworm larvae are ingested by the horse while grazing. Within 6–10 weeks, the larvae develop into adult tapeworms. The adult worms colonise the mucosa of the small and large intestine, mainly the ileocecal valve, and cause local erosion and ulceration. Colic-like symptoms may occur.

Anoplocephala perfoliata (tapeworm) – Antibody Detection	
Material	S 0.5 ml
Method	ELISA
Species	Horse
Duration	2–5 working days
Note	▪ The test is suitable for herd screening and targeted treatment. ▪ As Anoplocephala only releases eggs at intervals of several weeks, antibody detection is superior to pathogen detection in faeces (flotation/SAFC, microscopic detection of eggs) because of the higher sensitivity and specificity.

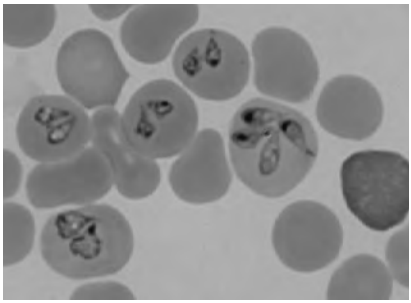
14.4.4 Babesia (Piroplasms)

Babesiosis in mammals has become one of the most important parasitic diseases. The pathogens, which belong to the order Piroplasmida, are transmitted by ticks.
In *peracute or acute* infections, non-specific clinical signs such as fever, apathy and loss of appetite appear between the 5th and 28th day p.i. Anaemia, icterus and haemoglobinuria may occur. Especially acute Babesia (B.) canis infections often lead to pancytopenia, typically characterised by severe thrombocytopenia as the main finding, usually mild anaemia, usually mild to moderate leukopenia. A *chronic* infection, especially with B. vulpes (= B. microti-like = Theileria annae), is characterised by fatigue and emaciation of the animals over months, anaemia and intermittent periods of fever. Without treatment, dogs can also develop a *subclinical form,* especially when infected with B. canis and B. vogeli, with the blood count being normal again. Especially imported dogs from Eastern Europe may be subclinically infected with B. canis and thus represent a reservoir of infection. Cattle and horses can also remain carriers of Babesia for many years.

Dog

Babesia canis
Distribution: north and east Mediterranean area, Western Europe, Central Europe, Eastern Europe

B. canis is mainly transmitted by Dermacentor reticulatus (meadow tick or ornate dog tick) and is more virulent than B. vogeli.
Depending on the geographical region, strains with varying degrees of virulence seem to be present.



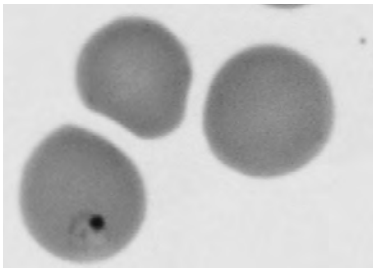
Erythrocytes with 2–4 Babesia (B. canis) (dog, Diff-Quik, 1000x magnification)

Babesia vogeli
Distribution: North Africa, the whole Mediterranean area, Portugal

B. vogeli is transmitted by Rhipicephalus sanguineus (brown dog tick) and often only leads to low antibody titres.

Babesia gibsoni
Distribution: Asia, USA, Europe

In Europe, cases are mainly imported.



Erythrocytes with small Babesia (B. gibsoni) (dog, Diff-Quik, 1000x magnification)

Babesia vulpes (formerly Babesia microti-like, Theileria annae)
Distribution: north west Spain, Central Europa including England

Vector unknown, assumed are: Ixodes hexagonus (hedgehog tick), I. ricinus (European castor bean tick), I. canisuga (dog tick) und Dermacentor reticulatus (ornate dog tick).

Cat

Babesia canis
Distribution: Thailand, Brazil, France, Poland, Germany

Very rare, only known in combination with other chronic underlying disease.

Babesia felis
Distribution: in parts of Africa

Babesia cati
Distribution: India

Cytauxzoon
Taxonomically, Cytauxzoon belongs to the family Theileriidae. This family differs from Babesiidae in the fact that reproduction does not only take place in erythrocytes but also in other tissues. In Cytauxzoon, the erythrocytic stages are preceded by meronts in lymphoid cells. Transmission occurs through the bite of different species of soft ticks. While feline babesiosis is a very rare but well-known disease in Europe, cytauxzoonosis in felids is one of the "emerging diseases". Cytauxzoon spp. found here differ genetically and pathogenetically from the species Cytauxzoon felis found in America. In recent years, there have been case reports in domestic cats from Italy, France, Spain, Switzerland, Germany and other countries.
In our own analysis of over 600 blood samples from anaemic cats from Germany, no piroplasms were detected by PCR. They therefore seem to play a minor role as causative agent of anaemia in Germany.
Morphologically, Babesia and Cytauxzoon cannot be differentiated in blood smears.

Horse, Donkey

Babesia caballi and Theileria equi (formerly Babesia equi)
Distribution: from the tropics and subtropics to the temperate zones (e.g. France and Spain)

Ticks are the vectors. Due to transport and the expanded range of the vectors, clinical cases and seropositive animals can now also be expected in Germany. The clinical signs are often non-specific and may include fever (also intermittent), inappetence, increased respiratory and heart rate, depression, anaemia, icterus and haemoglobinuria as well as weight loss. The course of the disease varies from peracute to chronic. Infected animals often remain carriers for a long time and thus present a source of infection for the vectors.

Cattle

Babesia divergens

Distribution: in Europe from Finland down to the Mediterranean

Vectors are Ixodes ricinus (European castor bean tick) and Ixodes persulcatus (taiga tick). Babesia divergens is also pathogenic to humans.

Babesia major

Distribution: Central Europe in small endemic areas; in Germany, only on the North Sea islands Amrum, Norderney and Juist

Haemaphysalis punctata (red sheep tick) is the vector.

Babesia bigemina

Distribution: tropics and subtropics; in Europe: the Balkans, coastal areas in the Mediterranean, Portugal

Babesia (Piroplasms) – Pathogen Detection	
Material	(1) EB 1 ml + blood smear (2) EB, tick
Method	(1) Microscopy (2) Realtime PCR
Species	Dog, cat, horse, cattle
Duration	(1) Reporting of results on the day the sample is received (Mon–Fri) (2) 1–3 working days
Note	(1) Microscopic detection is possible from the 5th day p.i. onwards. It is preferable to collect capillary blood (edge of the ear) and spread it onto a glass slide. The detection from capillary blood significantly increases sensitivity! (2) PCR detects Babesia spp., Cytauxzoon spp. (cat) and Theileria (horse). Species differentiation is done automatically and free of charge after a positive PCR result. PCR detection is far more sensitive than the detection in a blood smear. In case of a chronic infection, it is likely that pathogens have spread to many sites. However, the concentration of pathogen DNA in the blood may be very low and thus lead to a negative PCR result.

Babesia – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	(1) IFAT (horse, donkey only when leaving the country) (2) ELISA (dog, Babesia canis) (3) cELISA (horse, donkey – export to the USA, most sensitive test)
Species	Dog, horse, donkey

Duration	(1) 4–5 working days; as this is an export test, the processing time may be longer as the results are sent together with the final report. (2) Reporting of results on the day the sample is received (Mon–Fri) (3) 2–3 working days
Note	▪ Seroconversion from the 2nd week p. i., maximum titre after 4 weeks ▪ False negative results can occur in young dogs under 6 months and in the early phase of infection.

14.4.5 Capillaria aerophila

The lungworm Capillaria aerophila has a low host specificity and has zoonotic potential. The adult stages are embedded in the submucosa of the trachea, bronchi and bronchioles. They lay eggs there, which are coughed up, swallowed and excreted in the faeces. These eggs become infectious in the environment after 30–45 days (embryonated eggs). Earthworms play an important role in the development cycle of C. aerophila, but their role (intermediate host or only transport host) has not yet been fully clarified. Definitive hosts (e.g. dogs and cats) become infected by ingesting an infectious stage. The larvae penetrate the intestinal wall and reach the lungs via the lymphatic and/or the bloodstream, where they develop into adults and become sexually mature. Infections can be asymptomatic, but mild to severe respiratory signs are also possible.

Capillaria aerophila – Pathogen Detection	
Material	(1) Faeces (3-day pooled sample; as fresh as possible) (2) Faeces, BAL, tracheal lavage, lung tissue
Method	(1) Baermann technique (2) Realtime PCR
Species	Dog, cat, hedgehog
Duration	(1) 1–2 working days (2) 1–3 working days
Note	PCR detection of Capillaria aerophila is included in the Lungworm Profile Dog and the Lungworm Profile Cat (see Chapter 14.5.1, p. 279)

14.4.6 Coccidia

Coccidia are unicellular intestinal parasites found in a variety of domestic and farm animals. In many animal species, different species of coccidia occur with varying pathogenicity. They range from apathogenic species to highly pathogenic ones, which can lead to watery and haemorrhagic diarrhoea if there is a heavy infestation. Young animals are particularly affected here. In dogs and cats, especially puppies and kittens at 3 to 4 weeks of age can fall ill.

Coccidia have different predilection sites in the intestine, so that dissection may also provide an indication of coccidiosis and the respective coccidia species. Eimeria species are found in **ungulates, ruminants, South American camelids, poultry, rabbits** and other **small mammals**. Isospora is a parasite in **dogs and cats**, and in **pigs**, both Eimeria and Isospora occur, with Isospora suis often causing diarrhoea in piglets.

Testudine intranuclear coccidiosis (TINC) is a severe disease in tortoises with high morbidity and mortality rates. TINC has already been detected in different tortoises and box turtles in North America and Europe. Clinical signs include lethargy, significant weight loss, erosive rhinitis, dyspnoea and occasionally skin lesions. Infections are generally systemic. These coccidia are most frequently detected in the intestine, pancreas, liver and kidneys. However, they can also be found in the Eustachian tube, in macrophages of the spleen, in the middle ear, lungs and stomach. In live animals with rhinitis, they can also be detected in nasal lavage samples.

Coccidia – Pathogen Detection	
Material	Faeces
Method	Flotation
Species	No limitations known
Note	Testing for coccidia is part of the service "Endoparasites" (see Chapter 16.1, p. 302) and should be ordered via this service.

Intranuclear Coccidians (TINC) – Pathogen Detection	
Material	Swab without medium (nose, possibly cloaca), nasal lavage, tissue (nasal mucosa, intestine, pancreas, kidney, liver)
Method	Realtime PCR
Species	Chelonians
Duration	1–3 working days

14.4.7 Crenosoma vulpis

The adult nematodes, which are 0.4 to 1.5 cm in size, are found in the bronchi and trachea of wild canids, occasionally also in dogs. The females lay eggs there, from which the L1 larvae hatch. These L1 larvae are coughed up, swallowed and later excreted in the faeces. They then infect various snail and slug species in which they develop into the infective third-stage larvae (L3). Definitive hosts in turn become infected by ingesting these intermediate hosts or transport hosts (small amphibians and reptiles). After penetrating the intestinal wall, L3 migrate through the portal vein, liver and right heart into the lungs, where they mature into adults.
Lungworm infections can be asymptomatic; detection of lungworm larvae is often an incidental finding during routine coproscopic examinations. Mild to severe respiratory signs are also possible, including coughing, nasal discharge, tachypnoea and dyspnoea. Young animals are more frequently and usually more severely affected.

Crenosoma vulpis – Pathogen Detection	
Material	(1) Faeces (3-day pooled sample; as fresh as possible) (2) Faeces, BAL, EB, tracheal lavage, lung tissue
Method	(1) Baermann technique (2) Realtime PCR
Species	Dog
Duration	(1) 1–2 working days (2) 1–3 working days
Note	PCR detection of Crenosoma vulpis is included in the Lungworm Profile Dog (see Chapter 14.5.1, p. 279).

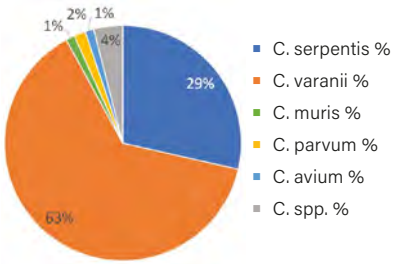
14.4.8 Cryptosporidia

Cryptosporidia are very small, unicellular parasites of the gastrointestinal tract. They are classified as coccidia. Different species are described with very similar morphology. Some of these are host-specific, others (e.g. Cryptosporidium (C.) parvum) can infect various animal species and humans (zoonosis).
Infections occur after intake of sporulated oocysts. The infectious dose is very low (approx. 100 oocysts). Subsequently, the released sporozoites infect the intestinal epithelial cells, followed by a development cycle over trophozoites, meronts, merozoites, gamonts, zygotes, ultimately resulting in the formation of new oocysts. The oocysts excreted in the faeces show a high tenacity, are resistant to many disinfectants and can remain infectious for months. Therefore, e.g. contaminated pens or terrariums are frequent sources of infection.
In **cattle,** cryptosporidiosis is a very common endoparasitosis. A large proportion of calves go through an infection with C. parvum. Clinically apparent courses with enteritis and diarrhoea occur especially in calves up to 3 weeks of life, often related to co-infections. Quite often **lambs, piglets** and **foals** (especially 2nd–4th week of life, < 6 months) are also affected.
A much lower prevalence is seen in **dogs and cats,** with usually asymptomatic infections. However, oocysts are excreted in the faeces here, too, for about 2 weeks. Manifest infections can be seen in puppies and kittens or immunocompromised animals (e.g. FeLV, FIV, distemper, neoplasia, etc.).
In **reptiles,** cryptosporidiosis is a serious disease that can cause severe losses, especially in snake and lizard stocks. C. serpentis is an important parasite in snakes and infects the gastric mucosa. Due to the chronic inflammation, a subsequent swelling and hardening of the connective tissue in the gastric area can occur. A typical sign is the regurgitation of food days after ingestion. C. varanii (previously also referred to as C. saurophilum), on the other hand, destroys the lining of the intestinal walls of affected lizards and snakes. Clinically, malabsorption with excretion of undigested food, profound weight and fluid loss are observed. Both pathogens are not pathogenic to humans. Quite often, C. muris and C. parvum are found in reptile faeces as intestinal passengers (origin: infected feeder animals). Therefore, further differentiation is absolutely necessary if the result is positive.

In laboratory diagnostics, several **methods** are available for detection. Already during the microscopic examination after specific enrichment (SAFC) oocysts can be found. As with all parasitological faecal examinations, sensitivity is relatively limited at approximately 60%.
In **cattle,** ELISA testing, which detects C. parvum, is recommended. The immunofluorescence test includes a wider range of Cryptosporidium species and is therefore suitable for **dogs, cats,** but also **small rodents** (guinea pig: C. wrairi).
In case of positive test results in **reptiles**, differentiation between pathogenic agents and intestinal passengers is of interest. For this, PCR with subsequent differentiation is recommended.

Cryptosporidia – Pathogen Detection

Material	Faeces; in **snakes** also: regurgitated material, gastric lavage, stomach biopsy
Method	(1) Antigen detection: EIA (mammals), IFAT (reptiles) (2) PCR (3) Modified Ziehl-Neelsen staining
Species	Dog, cat, small mammals, reptiles, ruminants, South American camelids, others on request
Duration	(1) IFAT: reporting of results on the day the sample is received (Mon–Fri), EIA: 1–2 working days (2) 1–3 working days (3) Reporting of results on the day the sample is received (Mon–Fri); reptiles: 2 working days
Note	▪ As the pathogen is shed intermittently, a single negative test result does not completely rule out a Cryptosporidium infection. ▪ If the PCR yields positive results in **reptiles**, it is possible to perform a differentiation of the Cryptosporidium species to distinguish between harmless intestinal passengers (origin: infected feeder animals) and pathogenic agents.



Prevalence of different Cryptosporidium species in snakes

14.4.9 Demodex

Demodex mites are strictly host-specific ectoparasites of numerous mammals and of humans. So far, there have been three species each described in dogs and cats (dogs: particularly Demodex (D.) canis, rarely D. injai and D. cornei; cats: especially D. cati, but also D. gatoi and an unnamed species).
The entire development of demodex mites takes place in the hair follicles, the sebaceous and apocrine glands of the host. They cannot survive very long in the environment. Transmission mainly occurs postpartum while nursing. Demodex mites belong to the physiological skin fauna, but are facultative pathogenic. In dogs, there is often alow number of mites present without any clinical signs (prevalence up to 85%), but demodicosis is rare. Nevertheless, it is one of the most frequent dermatoses in dogs (especially young dogs), in cats, however, it is very rare.
In **dogs,** lesions generally start in the face or on the forelegs and spread from there. The *localised form* affects a few well-defined skin areas and most notably occurs in young dogs. The skin areas are often hairless and may also be scaly. Comedones are typical as well. In general, itching only occurs in case of secondary bacterial infections.
If more than four lesions are present, an entire body region or at least two paws are affected and if it continuously worsens without treatment, it is referred to as *generalised demodicosis*. There are usually secondary bacterial infections present and alopecia appears with follicular papules up to furunculosis, focal ulcerations and fistula tracts. Most of the time, there is no itching, but sometimes intense pain. Fever, anorexia, lethargy, lymphadenopathy and sepsis may occur and it might be fatal if not treated. Special forms are *podo-* and *otodemodicosis.* There is a genetic predisposition in young dogs (juvenile generalised demodicosis). These dogs should be excluded from breeding.
In **cats,** demodicosis particularly occurs if systemic diseases, such as diabetes mellitus, FIV, FeLV or neoplasia, are present, and most notably causes alopecia and crusts on the head and neck. Itching is also possible. **D. gatoi** is a mite that dwells rather on the surface and lives in the stratum corneum (not in the hair follicles). D. gatoi is considered a primarily pathogenic parasite and is highly contagious. D. cati, in contrast, lives in the hair follicles and is part of the cutaneous fauna of cats.
It seems that hypersensitivity to the mites can cause severe pruritus even if only a few D. gatoi mites are present (similar to sarcoptic mange in dogs). How intense the itching is varies between cats; asymptomatic carriers have been described as well.
Demodicosis caused by D. gatoi should be included in the differential diagnosis of any cat with pruritus.

Demodex spp., Demodex gatoi – Pathogen Detection	
Material	Dog, horse: deep skin scraping Cat: superficial skin scraping, (hairs)
Method	(1) Microscopy (2) Realtime PCR (Demodex spp., semi-quantitative; Demodex gatoi)
Species	Dog, cat, horse (microscopy)
Duration	(1) 1 working day (2) 1–3 working days

Note

- Demodex spp. PCR is used to detect 3 species each in dogs (D. canis, D. injai, D. cornei) and cats (D. cati, D. gatoi, unnamed species). PCR for D. gatoi can also be requested separately as an individual test.
- **Cat:** Because the density of infestation of D. gatoi is sometimes low, it is recommended to perform several superficial skin scrapings.
- D. gatoi is a mite that dwells rather on the surface and lives in the stratum corneum (not in the hair follicles) of the cat. It is considered a primarily pathogenic parasite and is highly contagious.
- Since Demodex mites belong to the normal skin fauna in **dogs** and only an excessive increase leads to demodicosis, a positive PCR result should always be interpreted in connection with clinical and epidemiological data.
- **Horse:** Demodicosis is a rare skin disease caused by D. caballi (around the eyelids and muzzle) and D. equi (over the entire body).

14.4.10 Echinococcus

Echinococcus (E.) multilocularis does not only infect foxes as definitive hosts, but also dogs and cats; it is present in Central Europe (particularly southern Germany, northern Switzerland and western Austria), West and East Europe and focally in Scandinavia. Definitive hosts of E. granulosus are dogs and other canids. E. granulosus is mainly detected in the Baltic States, Eastern and Southern Europe, including the Mediterranean, and is very rare in other places.
For the definitive hosts, echinococci are harmless intestinal parasites, whereas in intermediate hosts (herbivores and omnivores), metacestode cysts are mainly formed in the liver and lungs, even in humans as accidental hosts. In cystic **echinococcosis** caused by E. granulosus, encapsulated lesions are formed. In alveolar echinococcosis caused by E. multilocularis, in contrast, cysts show invasive growth with metastasis, so that the disease will lead to death if untreated.
There is a higher risk of echinococcus infestation and excretion of tapeworm eggs in dogs that eat rodents or that are used for fox hunting in dens. Infection with E. multilocularis is listed under the **EU Animal Health Law (AHL)** (as of December 2025).

Echinococcus multilocularis/granulosus – Pathogen Detection	
Material	Faeces, tissue
Method	Realtime PCR
Species	Dog, cat, fox
Duration	1–3 working days

Note

- This PCR test differentiates between E. multilocularis and E. granulosus.

- In contrast to this species-specific PCR, microscopy after enrichment can only detect morphologically indistinguishable Taenia eggs.

Echinococcus – Antibody Detection	
Material	S, HP 0.5 ml
Methode	ELISA
Species	Dog
Duration	2–4 working days

14.4.11 Encephalitozoon

Encephalitozoon cuniculi (E. cuniculi)

E. cuniculi, a spore-forming, intracellular protozoan (Cryptomycota), is the causative agent of **encephalitozoonosis** (**torticollis, wry neck, head tilt**), which is particularly common in rabbits. The disease is a zoonosis with a wide host range (mammals, birds, etc.) and four genotypes (rabbit, mouse, dog and human strains). Infection mainly occurs orally, but also, for example, by horizontal, vertical and transplacental transmission. Spore formation takes place intracellularly throughout the body and is accompanied by multifocal granulomatous inflammation and the formation of pseudocysts. The infection can remain asymptomatic throughout life (approx. 40% of rabbits are serologically positive) or be acute, primarily accompanied by CNS signs (vestibular syndrome, ataxia, paresis, etc.), kidney and/or eye diseases. The detection of antibodies does not indicate symptomatic infection; only a positive PCR test is conclusive. Despite the low zoonotic potential, the aim should be to ensure that stocks are free of encephalitozoonosis.

Encephalitozoon cuniculi – Pathogen Detection	
Material	Urine, CSF, (faeces), tissue (e.g. kidney, brain or eye/lens)
Method	PCR
Species	Rabbit, guinea pig, others on request
Duration	1–3 working days

Encephalitozoon cuniculi – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	IFAT
Species	Dog, cat, rabbit, guinea pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Positive titres can be expected from day 14 p.i. onwards. Subclinical infections are possible. ▪ IgG are detected. On request, there is an additional test available for the detection of IgM and IgG in rabbits and possibly in other animal species.

Encephalitozoon pogonae

Encephalitozoon pogonae has been described in bearded dragons (Pogona spp.; Agamidae) and belongs to the microsporidia.
Infections can be associated with non-specific signs such as lethargy, anorexia, weight loss and polydipsia. Multiplication takes place in macrophages of different organs, especially the kidneys, but also the gastrointestinal tract, liver, ovaries, spleen, lungs, the vascular endothelium and ventricular ependymal cells of the brain are affected, and granulomas are formed. Co-infections with agamid adenovirus 1 and coccidia have been described and may lead to a more severe clinical picture.
The pathogen can be excreted through the cloaca and transmission is likely via the faecal-oral route. Diagnosis is made by PCR and/or histopathology of the affected tissue or by PCR from a cloacal swab or faeces.

Encephalitozoon pogonae – Pathogen Detection	
Material	Swab without medium (cloaca), faeces, tissue
Method	PCR
Species	Bearded dragon
Duration	1–3 working days

14.4.12 Entamoeba

Entamoeba are protozoan parasites and go through a direct life cycle. In reptiles, species of this genus can cause non-specific signs like diarrhoea, anorexia and lethargy. Organs such as the liver and the intestine are primarily affected, but other organs may also be involved. Infection can lead to severe inflammation with necrosis and abscesses. Acute death has been described as well. Entamoeba invadens is a pathogenic species in reptiles that mainly affects animals under human care. Symptomatic courses have mainly been described in snakes and carnivorous lizards, but also occur in different chelonian species. There may also be asymptomatic carriers, especially in herbivorous turtles and tortoises. However, these animals can also develop clinical amoebiasis. E. invadens should therefore be considered pathogenic for all reptiles.
This protozoan is transmitted by the faecal-oral route, through the ingestion of infectious cysts. Diagnostic testing can be done by PCR and/or histology of affected tissue or faeces, or by microscopic examination of faeces.

Entamoeba invadens – Pathogen Detection	
Material	(1) Faeces, tissue
	(2) Faeces
Method	(1) PCR
	(2) Microscopy after enrichment by SAFC method
Species	Snake
Duration	(1) 1–3 working days
	(2) Reporting of results on the day the sample is received (Mon–Fri)

Note	▪ It could be necessary to repeat testing as the amount excreted may vary or be low. ▪ Differentiation of the apathogenic species Entamoeba coli from the pathogenic species Entamoeba histolytica in warm-blooded animals and Entamoeba invadens in snakes can be done microscopically based on the number of nucleoli.

Entamoeba spp. – Pathogen Detection	
Material	(1) Faeces, tissue (2) Faeces
Method	(1) PCR (2) Microscopy after enrichment by SAFC method
Species	Reptiles
Duration	(1) 1–3 working days (2) Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ It could be necessary to repeat testing as the amount excreted may vary or be low. ▪ E. invadens, E. ranarum and E. terrapinae can be reliably detected. After a positive PCR result for Entamoeba spp. in reptiles, species differentiation can be requested separately.

14.4.13 Fasciola hepatica

The large liver fluke parasitises the bile ducts of different mammals. The eggs are excreted in the faeces and undergo a development cycle in which the dwarf pond snail serves as an intermediate host. The metacercariae are then ingested by the definitive host. There, they penetrate the intestinal wall, migrate through the liver and reach the bile ducts, where they develop into mature liver flukes.
In **horses**, infection is rare. Risk factors include grazing on damp pastures or access to natural water sources, especially when grazing together with sheep or cattle. The infection is often asymptomatic. The following signs are associated with liver fluke infection: diarrhoea, apathy, anorexia, emaciation, poor performance. Elevated hepatic enzyme activity is possible.
Ruminants are the typical definitive hosts of the large liver fluke. Regular checks should be carried out when grazing on typical "liver fluke habitats" (damp meadows, meadows with access to water). Clinical signs can range from chronic loss of performance, emaciation and diarrhoea to acute hepatic failure, peritonitis, jaundice and sudden death. Laboratory findings include anaemia, hypoproteinaemia, possibly eosinophilia, and increased activity of GLDH, AST and GGT.
South American camelids, pigs and humans can also be definitive hosts of the liver fluke.

Fasciola hepatica (large liver fluke) – Pathogen Detection	
Material	Faeces 20 g (3-day pooled sample; as fresh as possible)
Method	Sedimentation
Species	Horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ In **horses**, egg excretion may be low or absent. ▪ Detection can be requested via the printed submission form under "Further requests" (liver flukes sedimentation or tapeworm eggs). This test will also be available as an individual service directly on the printed submission form from 1 July 2026 onwards.

Fasciola hepatica (large liver fluke) – Antibody Detection	
Material	S, HP, milk, tank milk 0.5 ml (ruminants) S 1 ml (horse, South American camelids)
Method	ELISA
Species	Horse, ruminants, South American camelids
Duration	1–3 working days (ruminants) 5–7 working days (horse, South American camelids)
Note	Antibody detection is well suited for diagnosing acute fasciolosis, as eggs are often not yet detectable in the faeces when clinical signs appear (prepatent period).

14.4.14 Filaria

In Europe alone, five different filarial species are known to cause filariasis in dogs: Dirofilaria immitis, Dirofilaria repens as well as Acanthocheilonema (Dipetalonema) reconditum, Acanthocheilonema (Dipetalonema) dracunculoides and Cercopithifilaria grassi. Dirofilaria immitis causes cardiovascular dirofilariasis (heartworm disease), Dirofilaria repens causes cutaneous dirofilariasis. Both types of dirofilariasis are zoonoses and are transmitted by mosquitoes, including the common house mosquito (Culex pipiens) which is very common in Germany. The mosquito genera Aedes and Anopheles are also competent intermediate hosts and vectors in Europe.

Dirofilaria immitis – Pathogen Detection (Dirofilaria Antigen)	
Material	S, EP, HP 0.5 ml
Method	ELISA
Species	Dog, cat, ferret, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ The serological examination detects the proteins of female, parturient filariae (macrofilariae), which are parasites in the heart or in larger vessels.

- The earliest time for a positive result is half a year p.i., but it can be delayed if infected dogs receive heartworm prevention. Examination of puppies under the age of six months is therefore not appropriate. Therapy monitoring should be done at the earliest 4–5 months after completing therapy. For the detection of microfilariae see below.
- Dirofilaria **Antigen Detection incl. Heat Pre-treatment** can be requested as a separate service.

Microfilaria – Pathogen Detection	
Material	EB 0.5 ml
Method	Microscopy, Knott test, filtration test Realtime PCR; quantitative PCR (dog)
Species	Dog, cat Ferret (PCR)
Duration	1–3 working days
Note	▪ Accumulation of the microfilariae of Dirofilaria immitis in the peripheral blood takes place in the evenings (adaptation to the piercing behaviour of vector mosquitoes). This behaviour has not been documented for other filarial species, but it is advisable to possibly take the blood sample in the evening hours. ▪ For export or travel abroad, the filtration test is often required. ▪ In case of a positive PCR result, differentiation of the filarial species can be done on request and is recommended in order to initiate treatment adapted to the type of filaria. ▪ **Dog:** Quantitative PCR is used for both to decide on suitable treatment and for therapy monitoring. It also provides information on the development of resistance. It can be requested directly or following qualitative PCR.

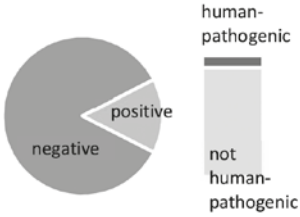
14.4.15 Giardia

Giardia is a flagellate that can be found in the intestine of mammals, birds, reptiles, amphibians and humans. There are some well-differentiated species, such as G. intestinalis (lamblia, duodenalis). Giardia is ingested orally (food, water) or through smear infection as cysts, excystates in the intestine and attaches as trophozoites to the intestinal wall where it replicates. Damage to and detachment of the intestinal epithelium cause chronic intermittent catarrhal to mucous-bloody diarrhoea. The cysts that are excreted in the faeces remain infectious for many months in cold water and a humid environment.
Except for Giardia in birds and amphibians, Giardia is partially of zoonotic nature. Seven variants have been identified through genetic characterisation of which variants (assemblages) A and B mainly occur in humans, variants C and D are primarily detected

in dogs and variant F can mostly be found in cats. Across species, however, isolates of different subtypes of A as well as those of B can be detected in different animal species, so that a transmission from humans to animals and from animals to humans cannot be excluded. In dogs and cats, Giardia is the predominant type of intestinal parasites. In our own examinations, Giardia infections were detected in 15% of cats; 3.5% of these animals contained the human-pathogenic assemblage A.

Giardia – Pathogen Detection

Material	Faeces
Method	(1) Microscopy after enrichment by SAFC method (2) EIA (antigen detection) (3) IFAT (microscopic detection of cysts) (4) Realtime PCR
Species	Dog, cat, small mammals, reptiles, large animals
Duration	(1, 2 and 3) Reporting of results on the day the sample is received (Mon–Fri) (4) 1–3 working days
Note	▪ Microscopic detection is less sensitive than PCR and ELISA, but serves to detect a patent infection. ▪ **Please note:** After treatment, false positive results are possible when using PCR or ELISA. A follow-up examination should therefore be carried out at the earliest after 3 weeks. ▪ In case of a positive PCR result, testing for the presence of humanpathogenic assemblages A and B can subsequently be conducted.



Giardia in cats:
15% of the animals are positive. 3.5% of the carriers are infected with human-pathogenic assemblage A.

14.4.16 Haemonchus contortus

Haemonchus contortus is also known as barber's pole worm. It parasitises the abomasum of sheep, goats and South American camelids, and rarely cattle. Adult females can reach a length of up to 30 mm. Clinically, young animals in their first year of grazing are particularly affected. The animals show inappetence, emaciation and weakness. Changes in faecal consistency are possible, but not typical of **haemonchosis**. Massive damage to the abomasal mucosa leads to severe blood loss (anaemia and hypoalbuminaemia). Sudden deaths are common, as the parasites can reproduce explosively.

Haemonchus contortus – Pathogen Detection	
Material	Faeces
Method	(1) Microscopy (special staining) after enrichment by flotation and SAFC method (2) Realtime PCR
Species	Ruminants, South American camelids
Duration	(1) 1 working day (after prior parasitological examination) (2) 1–3 working days
Note	Microscopy: The differentiation of strongyle eggs using fluorescence staining for Haemonchus contortus can be requested via a separate service ID – Haemonchus contortus (special staining) – or as a combined service together with the parasitological examination.

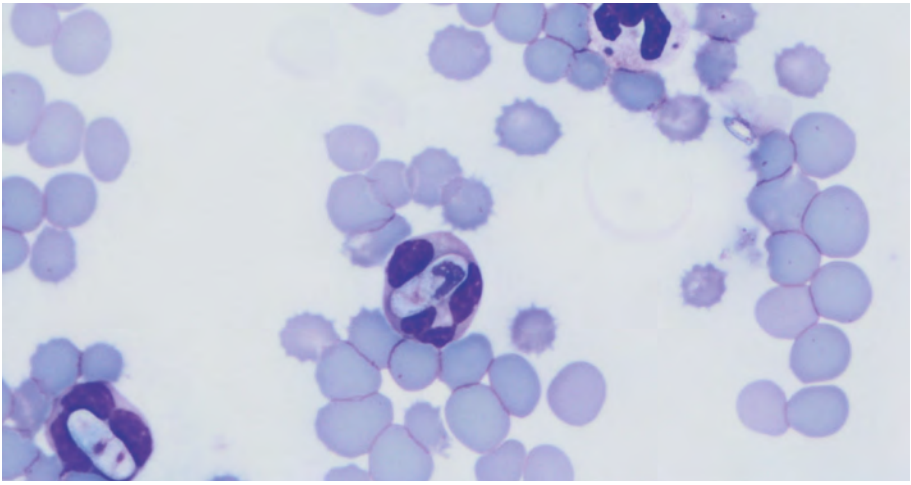
14.4.17 Haemosporidia (avian)

Haemosporidia are common blood parasites in European songbirds and birds of prey (prevalence in blackbirds, for example, is close to 100%). The most important genera of these parasites include Plasmodium and Haemoproteus, which both produce malarial pigment and therefore belong to the malaria parasites, and Leucocytozoon. These 3 genera can be detected by our PCR test.
These parasites are globally distributed and very diverse, with well over 200 species currently described. Depending on the parasite species, the host spectrum ranges from highly specific to generalised. Mixed infections are widespread in native songbirds.
The course of the disease ranges from peracute in susceptible bird species (e.g. penguins) to subclinical (e.g. blackbirds). The severity of the disease depends on the parasite species, the bird species as well as the age and the immune status of the host. Signs vary from reduced general condition, fatigue and anorexia to dyspnoea, anaemia, hepatomegaly, splenomegaly and pulmonary oedema. In penguins, sudden death is possible. Birds that survive the acute phase of infection may remain chronically infected for years. In these animals, the symptomatic phase of the disease can recur at any time if the animal is stressed or infected by another pathogen.

Avian Haemosporidia – Pathogen Detection	
Material	EB, tissue (spleen, liver, lung)
Method	Realtime PCR
Species	Birds (mainly songbirds and birds of prey (e.g. snowy owl), penguins)
Duration	1–3 working days

14.4.18 Hepatozoon

Hepatozoon canis (H. canis) belongs to the protozoa and goes through a typical coccidial life cycle with the dog as intermediate host. Asexual reproduction, schizogony, takes place in several generations in the endothelial cells of the spleen, liver and bone marrow. The merozoites formed here penetrate the leukocytes and differentiate into gamonts. The definitive host, the tick, ingests the gamonts during the blood meal. Gamogony and sporogony take place in the tick and oocysts with infectious sporozoites are formed. Infection with H. canis occurs by biting or swallowing an infected tick, primarily the brown dog tick (R. sanguineus), which is found in warm countries (mainly Southern Europe, South America, Africa and Asia). By now, the pathogen has also been detected in several regions of Germany. Vertical intrauterine transmission is possible as well.
Acute infections may be characterised by fever, lymphadenitis, anorexia, apathy, myositis and epileptiform seizures (bleeding in meninges). Massive lesions up to necrosis occur in the affected organs (spleen, liver, lung, brain). Chronic infections cause intermittent fever, lymphadenopathy, anaemia, diarrhoea and vomiting. Hyperaesthesia and muscular pain with stiffening of the neck muscles and the trunk muscles are possible. Periosteal bone proliferation can be seen and epileptiform seizures may also occur in chronic diseases. However, asymptomatic infections or infections with only mild clinical signs are common.



Neutrophil granulocyte with **Hepatozoon canis** (acidophilic capsule) (Diff-Quik, 1000x magnification)

Hepatozoon – Pathogen Detection	
Material	EB 0.2 ml, tissue (liver), tick
Method	(1) Microscopy: buffy coat smear (semi-quantitative) (2) Realtime PCR (Hepatozoon canis/felis)
Species	Dog, cat
Duration	1–3 working days

14.4.19 Leishmania

Leishmaniosis is an infectious disease transmitted by insects. The vectors of Leishmania are sand flies (Phlebotominae). Leishmania is taken up during the blood-sucking process. The promastigote stages, which are infectious 6–12 days after the blood-sucking process, multiply in the sand fly. In Europe, the pathogen is Leishmania infantum. South of the Bosporus and especially in North Africa, Leishmania tropica occurs additionally. Other species of Leishmania have been described worldwide. The main infection areas in Europe are Spain, Portugal, Italy and Greece.
In Germany, naturally occurring sand flies (mainly Phlebotomus mascittii; no transmission of Leishmania proven so far) have been found along the Rhine rift in Baden-Württemberg, in Rhineland-Palatinate in the Kaiserslautern region, and in Saarbrücken in Saarland.
Infected animals can be asymptomatic for many years. The beginning of the disease is mostly characterised by lymphadenopathy, anaemia; in the cutaneous form of leishmaniosis, skin lesions at the ear margins, the rhinarium and periorbital lesions are visible. Furthermore, the animals may show reduced resilience, weight loss, scaly, non-pruritic skin lesions and ocular changes.

Resistance of Leishmania to allopurinol
A reduced copy number of the METK gene has been described in cases of in-vitro allopurinol resistance (Yasur-Landau et al. 2018). In vivo, too, individual cases of suspected allopurinol resistance in dogs have been analysed, which correlate with a low copy number (Yasur-Landau et al. 2018, Sigel et al. 2025).
A positive Leishmania PCR with an adequate amount of pathogens is a prerequisite for testing allopurinol resistance. It is recommended to determine the METK copy number if **leishmaniosis has recently been diagnosed** in order to select the appropriate treatment, or in dogs with leishmaniosis that are being treated with allopurinol and have experienced **treatment failure with recurrence of clinical signs and/or changes in laboratory findings.**

Leishmania infantum – Pathogen Detection (qualitative) **Leishmania – Pathogen Detection (quantitative)**	
Material	Qualitative PCR: swab without medium (conjunctiva), bone marrow, tissue (skin, lymph node, spleen), possibly EB Quantitative PCR (dog): EB or bone marrow
Method	Realtime PCR, cytology, histology
Species	Dog, cat, others on request
Duration	1–3 working days
Note	▪ PCR detection is much more sensitive than microscopic detection and is specific for Leishmania infantum. ▪ Quantitative PCR in dogs has a high predictive value and is recommended in combination with serology, especially if titres are low or questionable. Quantitative PCR is also suitable for monitoring the course of infection and the treatment response,

whereby the same sample material needs to be used und tested by the same laboratory to ensure that the results are comparable.
- PCR sensitivity is much higher in bone marrow than in EB.

Leishmania – Antibody Detection	
Material	S, for IFAT also EP, HP 0.5 ml
Method	IFAT, ELISA
Species	Dog, cat, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Positive antibody titres appear at the earliest 2–3 weeks p.i. In asymptomatic dogs, ELISA is significantly more sensitive (approx. 90%) than IFAT (approx. 50–70%).

Leishmania – Resistance to Allopurinol	
Material	Bone marrow (preferred), tissue (lymph node aspirate, spleen, skin scabs), EB 1 ml
Method	Culture + realtime PCR (quantitative detection of Leishmania infantum) + droplet digital PCR (quantification of the METK gene, see text on p. 269)
Species	Dog
Duration	5–6 working days
Note	▪ **Indications:** Treatment failure in a dog with confirmed leishmaniosis that is being treated with allopurinol; immediately upon initial diagnosis to determine further treatment ▪ **Sample material: Bone marrow** is preferred, but **skin scabs (e.g. from lesions on the edge of the ear)** are also suitable as they often have high concentrations of the pathogen. The pathogen concentration in **EDTA blood** is usually lower. ▪ Culture enrichment is carried out in advance. However, if the pathogen concentration is low, it is still possible that the required amount of pathogens cannot be achieved despite growing a culture (especially in EDTA blood samples). ▪ Detection of allopurinol resistance is done by quantifying the METK gene. However, droplet digital PCR (ddPCR) to determine the copy number of the METK gene is only possible if Leishmania infantum has been detected in sufficient quantities in realtime PCR. If ddPCR cannot be performed, a lower price will be charged. ▪ An METK gene copy number < 3.0 is currently considered a strong indicator of resistance, while a copy number < 4.0 is considered suspicious.

14.4.20 Neospora caninum

Neospora caninum is the causative agent of **neosporosis** and was first described in Norway in 1984. Neosporosis has already been detected in many countries, it must therefore be assumed that it is spread worldwide. Natural infections have been found in dogs, cattle, horses, sheep, goats, red deer and cats. Numerous other animal species can be experimentally infected.
Clinically, dogs and cattle are particularly severely affected. In the latter, at every stage of gestation, the clinical picture is determined by abortions. In dogs, signs vary greatly, ranging from ascending paralysis of the hind legs to muscle weakness, heart failure or pneumonia. Young, congenitally infected dogs show more severe signs, sometimes with sudden deaths. Older dogs often show signs of disseminated infection with polyradiculitis, polymyositis and possibly multiple organ involvement. Thus, in older dogs with neurological signs, neosporosis should always be included as a differential diagnosis. However, due to the often high antibody prevalence in certain regions, it is assumed that only a small percentage of infected dogs actually develops a clinical disease.

Neospora caninum – Pathogen Detection	
Material	**Dog:** faeces, CSF **Cattle:** abortion material, foetal tissue (brain, lung, liver, kidney)
Method	Realtime PCR
Species	Dog, cattle
Duration	1–3 working days

Neospora caninum – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	ELISA, (IFAT on request)
Species	Dog, cat, horse, ruminants, South American camelids
Duration	ELISA: 1–2 working days IFAT: on request

Ostertagia ➢ see Chapter 16.2, p. 307

14.4.21 Sarcoptes

Sarcoptes (S.) scabiei is the only species of the genus Sarcoptes. The Sarcoptes mites that are found in the different hosts are considered varieties of S. scabiei. The varieties are mostly host-specific, yet these itch mites are able to spread to other hosts, but usually do not settle there permanently.
Sarcoptes scabiei varietas canis causes sarcoptic mange in dogs. Red foxes are considered reservoir animals. Occasionally, the mite is also transmitted to ferrets, rabbits, guinea pigs, cats and humans.

Transmission occurs by direct contact between animals, but also indirectly via the contaminated environment. In dogs, indirect transmission seems to be gaining more and more importance. The whole developmental cycle of itch mites takes place on the host animal. In abraded skin material, the mites can survive up to 3 weeks, if the environment is damp and cool.
The mites burrow their tunnels into the horny layer of the skin. They prefer skin areas that are only sparsely haired, so they are often found on ears, elbows, lower abdomen and ankles. If the disease spreads, larger areas of the body may be colonised. The main clinical sign is massive pruritus, which is often intensified by heat.
In pigs, the mites spread beginning from the inside of the pinna. Bovine sarcoptic mange especially affects the head and neck, but can also spread to the udder. Mange causes loss of performance.

Sarcoptes – Pathogen Detection	
Material	Skin scraping (superficial, large-scale)
Method	(1) Microscopy (2) Realtime PCR (Sarcoptes scabei var. canis)
Species	(1) Dog, cat, farm animal, South American camelids, others on request (2) Dog, (cat, rabbit, ferret, other canids and mustelidae)
Duration	(1) Reporting of results on the day the sample is received (Mon–Fri) (2) 1–3 working days
Note	▪ Often, the infestation in dogs cannot be diagnosed by performing a skin scraping. In this case, the diagnosis can only be made by antibody detection. ▪ In cats, localised infections are found in the head and neck area. ▪ Zoonosis (pseudoscabies) ▪ Microscopic detection can be ordered via the service Ectoparasites. This also detects, for example, Notoedres.

Sarcoptes – Antibody Detection	
Material	S 0.5 ml
Method	ELISA
Species	Dog
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Seroconversion only begins after 2–3 weeks p.i. and persists for weeks or months after successful treatment.

14.4.22 Strongyles

The most common endoparasite in horses. All age groups can be infected. Strongyles can be divided into two subfamilies: large strongyles and small strongyles. Nowadays, large strongyles are only found in isolated populations. Their larvae cause considerable

damage during their migration through the body. Small strongyles are found in every horse population.
In ruminants, strongyles usually only cause clinical signs when infestation is severe. Haemonchus contortus (see p. 266) is of particular importance in small ruminants (and South American camelids). High concentrations of gastrointestinal strongyle eggs in faeces may be an indication of this parasite and require clarification by means of differentiation.

Detection is carried out using flotation, the modified McMaster technique and the Egg Count Reduction Test. In horses, Larval Culture is used to differentiate between large and small strongyles (see Chapter 16.1, p. 302 ff .). In small ruminants and South American camelids, Haemonchus contortus is differentiated by staining or by PCR (see p. 267).

Large Strongyles ➢ see Larval Culture (see Chapter 16.1, p. 302)

Small Strongyles (larval cyathostominosis)

Larval cyathostominosis is a disease caused by the larvae of small strongyles. Beginning in autumn until the end of winter, the number of larvae encapsulated in the intestinal mucosa increases significantly. The larvae remain in this dormant state until spring. With the onset of spring, there is a synchronised mass migration of the larvae into the intestine, which causes severe damage to the intestinal mucosa, literally "punching holes" in it. Young horses up to 6 years of age are particularly susceptible. Affected horses mainly show severe diarrhoea and weight loss. It is not possible to distinguish between large and small strongyles based on their eggs; this requires Larval Culture (see Chapter 16.1, p. 302).

Small Strongyles (larval cyathostominosis) – Antibody Detection	
Material	S 1ml
Method	ELISA
Species	Horse
Duration	5–7 working days
Note	The test may still be false positive for up to 4 months after successful deworming.

14.4.23 Toxoplasma

Toxoplasma gondii is an obligate intracellular parasite which belongs to the class Coccidia. It is ubiquitous and causes clinical signs in all warm-blooded animals, including humans.
More than 1 billion people worldwide have antibodies against toxoplasma. In addition to fever and cold-like symptoms, congenital infection during pregnancy is feared. The intrauterine infection of the foetus occurs approximately 3–4 weeks after the first

infection of a seronegative mother, when the placental barrier is crossed and placentitis occurs. Miscarriages and severe neurological or ophthalmological diseases can occur in the newborn. The cat as the definitive host excretes oocysts for approx. 3 weeks, which sporulate and become infectious after approx. 2–4 days, depending on temperature (daily cleaning of the cat litter box!).
Another source of infection is meat contaminated with tissue cysts that has not been sufficiently cooked before consumption. However, the main source of infection is gardening, where oocysts may be absorbed via contaminated soil (aerosols).
Cats can also be intermediate hosts at the same time; they rarely fall ill, but the clinical signs depend on where the tissue cysts are located. For example, hepatitis, cholangitis, dyspnoea may occur, and in case of CNS involvement, there may be ataxia, motor deficits and epileptic seizures. Additionally, uveitis and chorioretinitis can occur. Similar signs can also be seen in dogs.
In sheep and goats, about 10% of the abortions worldwide are attributed to T. gondii.

Toxoplasma gondii is not yet listed under the EU Animal Health Law (AHL) (as of December 2025).

Toxoplasma gondii – Pathogen Detection	
Material	**Cat:** faeces (detection of excretion), CSF, ascites, BAL **Dog, small mammals:** CSF, tissue (e.g. brain) **Farm animals, South American camelids:** abortion material, tissue (brain, heart, lung and others)
Method	Realtime PCR
Species	Dog, cat, small mammals, farm animals, South American camelids, others on request
Duration	1–3 working days
Note	The pathogen can be detected by parasitological examination; confirmation by PCR is necessary, as morphological differentiation from Hammondia is not possible.

Toxoplasma – Antibody Detection	
Material	S, EP, HP 0.5 ml
Method	ELISA
Species	Dog, cat, rabbit, guinea pig, ruminants, South American camelids, pig, others on request
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Detection of IgG (all species) and IgM (all species except for goats) ▪ **Cat:** Increased titres of IgM may indicate the excretion of oocysts. IgG antibody titres indicate exposure.

14.4.24 Trichomonads

Birds

Trichomoniasis (also called **canker** or **frounce**) is a disease of the gastrointestinal tract, especially of the crop, which is caused by protozoa of the order Trichomonadida. In particular, the flagellates are transmitted through the crop milk or through contaminated drinking water. It is most notably pigeons and finches, but also budgerigars, cockatiels and sometimes other parrots and canary birds that become infected. In pigeons, older animals are often persistently infected, clinically inapparent carriers. Trichomonas gallinae is a pear-shaped flagellate of 5 to 18 µm in size that uses small lesions in the mucous membrane to penetrate into the tissue and triggers the characteristic focal, yellowish tumours there. Occurrence of the disease is often associated with stress, vitamin deficiency or other illnesses and in some cases it can lead to the colonisation of inner organs such as the liver and the heart. Clinical signs often include regurgitation of undigested food, but diarrhoea can be an indicator, too. In case of a longer duration of the disease, the animals lose weight and become apathetic. In young birds, the mortality rate can be up to 40%.

Trichomonas spp, – Pathogen Detection	
Material	Swab without medium (crop), crop lavage sample
Method	PCR
Species	Birds
Duration	1–3 working days

14.4.25 Tritrichomonas foetus/blagburni

Tritrichomonas (T.) blagburni (also known as T. foetus) is also a protozoan of the order Trichomonadida. It is characterised by three anterior flagella and one posterior flagellum. However, similar to Giardia, these are only microscopically visible in fresh faecal samples. Transmission between cats occurs by faecal-oral route. Transmission between cattle or pig to cat is not documented.

Affected animals show typical large intestinal diarrhoea with frequent defaecation in small portions, which may progress to faecal incontinence. Mucus and blood may be present in the faeces. Tenesmus is frequently observed. The general condition usually remains unaffected, increases in temperature are rare. T. foetus/blagburni should always be considered as differential diagnosis in cats suffering from chronic, intermittent diarrhoea. In cattle, Tritrichomonas foetus causes **trichomoniasis**, which is characterised by inflammation of the reproductive tract in cows leading to repeat breeding and abortion. Bulls transmit the disease but display no clinical signs.

Bovine trichomoniasis is listed under the **EU Animal Health Law (AHL)**.

Tritrichomonas foetus/blagburni – Pathogen Detection	
Material	**Cat:** faeces **Cattle:** swab without medium (cervix), preputial wash
Method	Realtime PCR
Species	Cat, cattle, others on request
Duration	1–3 working days
Note	PCR is considered the most sensitive and specific method for the detection of Tritrichomonas foetus. As T. foetus is excreted intermittently, it is recommended to send a pooled faecal sample (collected over a period of 3 days) for analysis.

14.4.26 Troglostrongylus brevior

Troglostrongylus brevior has been detected in cats in Italy, Bulgaria, Spain and Greece. This parasite is 0.6 to 1.7 cm in size and mainly infects wild felids such as lynx and wildcats, but also domestic cats. It has a life cycle similar to that of Aelurostrongylus abstrusus: The adults parasitise in the bronchi and bronchioles of the definitive hosts. There, females lay eggs from which the L1 larvae hatch. After they are coughed up, swallowed and excreted in the faeces, snails and slugs act as intermediate hosts. It is very likely that paratenic hosts are also involved in the transmission of the infective L3 larvae to cats.
Lungworm infections can be asymptomatic; detection of lungworm larvae is often an incidental finding during routine coproscopic examinations. Mild to severe respiratory signs are also possible, including coughing, nasal discharge, tachypnoea and dyspnoea. Young animals are more frequently affected and usually suffer more severely.

Troglostrongylus brevior – Pathogen Detection	
Material	(1) Faeces (3-day pooled sample; as fresh as possible) (2) Faeces, BAL, tracheal lavage, lung tissue
Method	(1) Baermann technique (2) PCR
Species	Cat
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ False negative results cannot be excluded due to prepatency, intermittent shedding and limited sensitivity of the test methods. Tests should therefore be repeated if there is a clinical suspicion. ▪ It is difficult to differentiate the L1 larvae microscopically from the L1 larvae of Aelurostrongylus abstrusus. ▪ PCR detection of Troglostrongylus brevior is included in the Lungworm Profile Cat (see Chapter 14.5.1, p. 279).

14.4.27 Trypanosoma

Trypanosoma equiperdum

Infection with Trypanosoma equiperdum, also known as **dourine**, is a chronic or acute infectious disease in equids, which is transmitted directly between animals during mating. Infected equids are the only natural reservoir; the pathogens are present in the genital secretions of both mares and stallions. Incubation period, severity and duration of the disease vary considerably. Subclinical infections are possible; donkeys and mules are more resistant to the pathogen. Clinically, affected animals show inflammation of the outer genitals with depigmentation of the mucosa up to peripheral-neurological disorders/paralysis. Particularly in Asia and Africa, Trypanosoma is still widespread; Central Europe is currently considered free from Trypanosoma equiperdum. Export-relevant test.
Dourine is listed under the **EU Animal Health Law (AHL).**

Trypanosma equiperdum (dourine) – Antibody Detection	
Material	S 1 ml
Method	CFT
Species	Horse
Duration	5 working days
Note	This service may not be available in some countries.

Trypanosoma evansi

Trypansoma evansi is present in North Africa, the Middle East, Latin America and Asia. Transmission mainly occurs mechanically through blood-sucking insects. Infections with Trypanosoma evansi cause a disease known as **surra** in various mammals, but primarily in camelids, cattle and horses. However, dogs can also be infected. In contrast to camels, clinical signs in dogs are often mild.
Surra is listed under the **EU Animal Health Law (AHL).**

Trypanosoma evansi – Pathogen Detection (Antigen)	
Material	EB 1 ml + blood smear
Method	Microscopy
Species	No limitations known, mainly dog, horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Fri) For export tests, the processing time may be longer as the results are sent together with the final report.
Note	If requested for travelling abroad, please order via the comment field or use service ID 8888 when ordering online.

Trypanosoma evansi – Antibody Detection	
Material	S 0.5 ml
Method	CATT (card agglutination test for T. evansi)
Species	No limitations known, mainly dog, horse, ruminants, South American camelids
Duration	Reporting of results on the day the sample is received (Mon–Fri)

14.5 Pathogen Detection Profiles (PCR)

An overview of all profiles, particularly those not listed in this chapter with a combination of clinical-chemical parameters and/or serological testing for pathogens with direct pathogen detection by PCR, can be found in the current **Catalogue of Prices and Services** or on the **Laboklin website** in a separate section under the tab "Products".

14.5.1 PCR Profiles Dog/Cat

Anaemia Small (dog)	
Material	EB
Parameter	Anaplasma phagocytophilum, babesia (incl. species differentiation)

Anaemia Vector-borne (dog)	
Material	EB
Parameter	Haemotropic mycoplasma (incl. species differentiation), babesia (incl. species differentiation), Ehrlichia canis, Anaplasma phagocytophilum

BAL Profile ➢ **see Cytology (Chapter 19.3, p. 326)**

Diarrhoea Pathogens (cat)	
Material	Faeces
Parameter	Coronavirus, Tritrichomonas foetus/blagburni, giardia, parvovirus, cryptosporidia

Diarrhoea Pathogens (dog)	
Material	Faeces
Parameter	Coronavirus, parvovirus, circovirus, giardia, cryptosporidia

Diarrhoea, Human Pathogenic Causes	
Material	Faeces
Parameter	Salmonella, Yersinia enterocolitica, Campylobacter jejuni

Dysbiosis Profile ➢ **see Chapter 17.1.1 Faecal Profiles, p. 309**

Eye (cat)

Material	Swab without medium (eye)
Parameter	FHV, chlamydia, Mycoplasma felis

Eye (dog)

Material	Swab without medium (eye)
Parameter	CHV, chlamydia, mycoplasma

Flea (cat)

Material	Flea, EB
Parameter	Haemotropic mycoplasma (incl. species differentiation), Bartonella henselae, rickettsia

Haemorrhagic Diarrhoea (dog) ➢ **see Faecal Profiles (Chapter 17.1.1, p. 309)**

Lungworms (cat)

Material	Faeces, BAL
Parameter	Aelurostrongylus abstrusus, Capillaria aerophila, Troglostrongylus brevior

Lungworms (dog)

Material	Faeces, BAL
Parameter	Angiostrongylus vasorum, Capillaria aerophila, Crenosoma vulpis

Neurology (cat)

Material	CSF
Parameter	Coronavirus, Toxoplasma gondii, FHV, rustrela virus

Neurology (dog) ➢ **see Catalogue of Prices and Services**

Reproduction (cat)

Material	Swab without medium (vagina, prepuce), abortion material
Parameter	FHV, chlamydia, Mycoplasma felis

Reproduction (dog)

Material	Swab without medium (vagina, prepuce), abortion material
Parameter	CHV, chlamydia, Mycoplasma canis, Brucella canis

Respiratory I (cat)

Material	Swab without medium (pharynx, nose, eye), BAL
Parameter	FCV, FHV, chlamydia, Mycoplasma felis, Bordetella bronchiseptica

Respiratory II (cat)

Material	Swab without medium (pharynx, nose, eye), BAL
Parameter	FCV, FHV, chlamydia, Mycoplasma felis

Respiratory III (cat)

Material	Swab without medium (pharynx, nose, eye)
Parameter	FCV, FHV, chlamydia

Respiratory IV (cat)

Material	Swab without medium (pharynx, nose, eye), BAL
Parameter	FCV, FHV

Respiratory I (dog)

Material	Swab without medium (pharynx, nose, eye), BAL
Parameter	CHV, CAV-2, CPiV, CRCoV, distemper virus, Bordetella bronchiseptica, Mycoplasma cynos

Respiratory II (dog)

Material	Swab without medium (pharynx, nose, eye), BAL
Parameter	CPiV, CRCoV, Bordetella bronchiseptica, Mycoplasma cynos

Canine and feline **Travel Profiles/Thrombocytopenia Profiles** (dog)/
Profile **Vector-borne Diseases** and **feline** Profile **Northern/Central Europe**

➢ **see Catalogue of Prices and Services**

Tick I – PCR

Material	Tick
Parameter	Borrelia, TBE virus

Tick II – PCR

Material	Tick
Parameter	Anaplasma phagocytophilum, piroplasms (babesia, cytauxzoon, theileria; incl. species differentiation), borrelia, TBE virus

Tick III – PCR	
Material	Tick
Parameter	Anaplasma phagocytophilum, Anaplasma platys, piroplasms (babesia, cytauxzoon, theileria; incl. species differentiation), borrelia, Ehrlichia canis, Hepatozoon

Tick IV – PCR	
Material	Tick
Parameter	Anaplasma phagocytophilum, piroplasms (babesia, cytauxzoon, theileria; incl. species differentiation), borrelia, TBE virus, rickettsia

14.5.2 PCR Profiles Small Mammals, Birds, Reptiles, Amphibians and Fish

Small Mammals

Ferret: Respiratory Profile	
Material	Swab without medium (pharynx, nose, eye), BAL, tissue
Parameter	Distemper virus, Influenza A virus, Mycoplasma spp.

Guinea Pig: Respiratory Profile	
Material	Swab without medium (oropharynx, conjunctiva), tissue
Parameter	Mycoplasma caviae, Bordetella bronchiseptica

Rabbit: Respiratory Profile	
Material	Swab without medium (pharynx, nose, eye), nasal lavage, tissue + swab with medium (pharynx, nose, eye)
Parameter	Bacteriology, PCR: Bordetella bronchiseptica, toxigenic Pasteurella multocida, Mycoplasma spp.

Rat/Mouse: Respiratory Profile	
Material	Swab without medium (pharynx, nose, eye), BAL, tissue
Parameter	Mycoplasma pulmonis, Bordetella bronchiseptica

Birds

Feather (parrots)	
Material	EB, feather, swab without medium (cloaca), faeces
Parameter	Circovirus (PBFD), polyomavirus

Pigeon	
Material	Swab without medium (crop/pharynx + cloaca) + feather + faeces
Parameter	Trichomonas, circovirus (pigeon), salmonella, aPMV-1

Quarantine Large (parrots) ➢ **see Catalogue of Prices and Services**

Quarantine Medium (parrots)	
Material	EB, feather + swab without medium (eye, pharynx, cloaca; preferably 1 swab from all 3 sites), faeces
Parameter	Circovirus (PBFD), polyomavirus, herpesviruses (e.g. Pacheco's virus), chlamydia, bornavirus

Quarantine Small (parrots)	
Material	EB, feather + swab without medium (eye, pharynx, cloaca; preferably 1 swab from all 3 sites), faeces
Parameter	Circovirus (PBFD), polyomavirus, chlamydia

Vector-borne	
Material	EB
Parameter	West Nile virus, Usutu virus, avian haemosporidia (avian malaria)

Reptiles

Hibernation/Brumation Check (tortoise) ➢ **see Catalogue of Prices and Services**

Quarantine (aquatic turtle)	
Material	Swab without medium (pharynx, cloaca; preferably 1 swab from both sites), nasal lavage
Parameter	Herpesviruses, mycoplasma, ranaviruses

Quarantine (boa, python)	
Material	Swab without medium (pharynx, cloaca; preferably 1 swab from both sites), tracheal lavage + EB
Parameter	Adenoviruses, reptarenaviruses, paramyxoviruses/ferlaviruses, reoviruses, serpentoviruses

Quarantine (colubrid, viper)

Material	Swab without medium (pharynx, cloaca; preferably 1 swab from both sites), tracheal lavage + skin (swab without medium or tissue)
Parameter	Adenoviruses, paramyxoviruses/ferlaviruses, reoviruses, Ophidiomyces ophidiicola
Note	For pharynx + cloaca, 1 swab can be used. Please take a separate swab for the skin.

Quarantine (lizard)

Material	Swab without medium (pharynx, cloaca; preferably 1 swab from both sites)
Parameter	Adenoviruses, ranaviruses, reoviruses

Quarantine (tortoise) ➢ **see Catalogue of Prices and Services**
Quarantine (tropical tortoise) ➢ **see Catalogue of Prices and Services**

Respiratory/Neurology (boa)

Material	Swab without medium, tracheal lavage + EB
Parameter	Adenoviruses, reptarenaviruses, paramyxoviruses/ferlaviruses, reoviruses

Respiratory/Neurology (pythons)

Material	Swab without medium (pharynx, cloaca; preferably 1 swab from both sites), tracheal lavage + EB
Parameter	Adenoviruses, reptarenaviruses, serpentoviruses, paramyxoviruses/ferlaviruses, reoviruses, mycoplasma

Respiratory Profile Large (tortoise)

Material	Swab without medium (pharynx), nasal lavage
Parameter	Herpesviruses, mycoplasma, picorna-/torchiviruses

Respiratory Profile Small (tortoise, turtle)

Material	Swab without medium (pharynx), nasal lavage
Parameter	Herpesviruses, mycoplasma

Skin Profile (lizard)

Material	Skin + swab without medium (skin)
Parameter	Mycology PCR: adenoviruses, Devriesea agamarum, ranaviruses, Nannizziopsis spp.

Amphibians

Skin Profile Large (amphibian)

Material	Skin, swab without medium (skin)
Parameter	Batrachochytrium dendrobatidis, Batrachochytrium salamandrivorans, bufonid herpesvirus 1 (BfHV-1), ranid herpesvirus 3 (RaHV-3)
Note	After a positive PCR result for Batrachochytrium dendrobatidis, the specific detection of BdGPL can be requested.

Skin Profile Small (amphibian)

Material	Skin, swab without medium (skin)
Parameter	Batrachochytrium dendrobatidis, Batrachochytrium salamandrivorans
Note	After a positive PCR result for Batrachochytrium dendrobatidis, the specific detection of BdGPL can be requested.

Quarantine (anura)

Material	Swab without medium (skin), tissue (skin)
Parameter	Batrachochytrium dendrobatidis, bufonid herpesvirus 1 (BfHV-1), ranid herpesvirus 3 (RaHV-3), ranaviruses
Note	After a positive PCR result for Batrachochytrium dendrobatidis, the specific detection of BdGPL can be requested.

Quarantine (caudata)

Material	Swab without medium (skin), tissue (skin, organs)
Parameter	Batrachochytrium dendrobatidis, Batrachochytrium salamandrivorans, ranaviruses
Note	After a positive PCR result for Batrachochytrium dendrobatidis, the specific detection of BdGPL can be requested.

Fish

Koi Carp Profile 1

Material	Tissue (gills), swab (skin or gills)
Parameter	Koi herpesvirus, carp edema virus

Koi Carp Profile 2

Material	Tissue (gills), swab (skin or gills)
Parameter	Carp edema virus, Flavobacterium columnare

Koi Carp Profile Large

Material	Tissue (gills), swab (skin or gills)
Parameter	Koi herpesvirus, carp edema virus, Flavobacterium columnare

14.5.3 PCR Profiles Horse

Abortion Profile (horse)

Material	Swab without medium (vagina, uterus), abortion material
Parameter	EHV-1, EHV-4, EVA, leptospira, Listeria monocytogenes

Anaemia Small (horse)

Material	EB
Parameter	Anaplasma phagocytophilum, piroplasms (babesia, theileria; incl. species differentiation)

CEM Profile Mare 1

Material	2 swabs with medium with charcoal, e.g. Amies (fossa clitoridis, sinus clitoridis)
Parameter	Taylorella equigentialis from the 2 sites listed above
Note	▪ The sites meet the requirements of the EU Council Directive 92/65/EEC (cf. Chapter 14.2.36, p. 241). ▪ Samples must be analysed within 48 hours after collection.

CEM Profile Mare 2

Material	3 swabs with medium with charcoal, e.g. Amies (fossa clitoridis, sinus clitoridis, cervix)
Parameter	Taylorella equigenitalis from the 3 sites listed above

CEM Profile Stallion 1

Material	3 swabs with medium with charcoal, e.g. Amies (penile shaft, urethra, fossa glandis)
Parameter	Taylorella equigenitalis from the 3 sites listed above
Note	▪ The sites meet the requirements of the EU Council Directive 92/65/EEC (cf. Chapter 14.2.36, p. 241). ▪ Samples must be analysed within 48 hours after collection.

CEM Profile Stallion 2

Material	3 swabs with medium with charcoal, e.g. Amies (penile shaft, urethra, fossa glandis) + sperm
Parameter	Taylorella equigenitalis from the 3 sites listed above and in sperm

CEM Profile Stallion 3

Material	4 swabs with medium with charcoal, e.g. Amies (sinus urethralis, urethra, fossa glandis, prepuce)
Parameter	Taylorella equigenitalis from the 4 sites listed above and in sperm

Eye Profile (horse)

Material	Swab without medium (eye)
Parameter	EHV-2, EHV-5

Foal Diarrhoea Pathogens

Material	Faeces
Parameter	Rotaviruses A, Clostridium perfringens netF gene, Clostridioides difficile toxin A + B gene, Rhodococcus equi (incl. vapA), equine coronavirus, Lawsonia intracellularis

Hepatotropic Viruses (horse)

Material	Serum, EB, liver
Parameter	Equine parvovirus (EqPV-H), equine hepacivirus (EqHV)

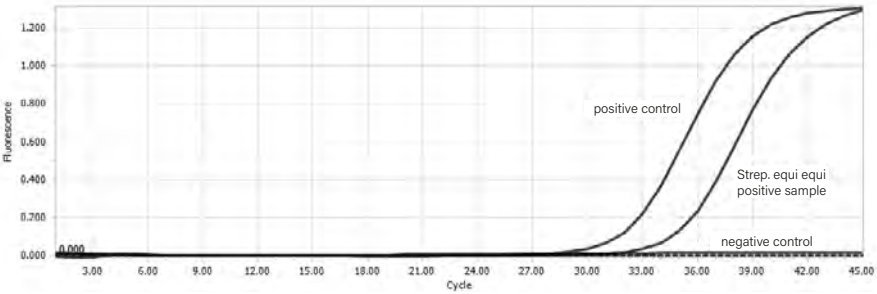
Neurology (horse, donkey) ➢ see Catalogue of Prices and Services

Respiratory Profile (foal)

Material	Swab without medium (deep nasal), BAL, TBS
Parameter	EHV-1, EHV-4, Influenza A virus, Rhodococcus equi (incl. vapA)

Respiratory I (horse)

Material	Swab without medium (deep nasal), BAL, TBS
Parameter	EHV-1, EHV-4, influenza A virus, Streptococcus equi equi/zooepidemicus



A **realtime PCR** curve, here using the example of Streptococcus equi equi. In contrast to classic gel electrophoresis, realtime PCR not only uses a specific primer pair, but also a probe which is labelled with a fluorescent dye. In positive samples, this label is cleaved and a fluorescence signal proportional to the amount of cleaved fragments is generated – this signal is measured and can be displayed in a curve in real time. Each PCR is accompanied by a positive and a negative control, which is the only way to analyse the PCR.

Respiratory II (horse)

Material	Swab without medium (deep nasal), BAL, TBS + faeces
Parameter	EHV-1, EHV-4, Influenza A virus, Streptococcus equi equi, equine coronavirus

Respiratory III (horse)

Material	Swab without medium (deep nasal), BAL, TBS
Parameter	EHV-1, EHV-4, Streptococcus equi equi/zooepidemicus

Respiratory IV (horse)

Material	Swab without medium (nose or pharynx), BAL, EB (viraemia) (detection from buffy coat is possible on request; we need at least 5 ml EB for this)
Parameter	EHV-1, EHV-4
Note	Herpesviruses usually have only a short viraemic phase. Detection from EB is therefore often only useful at the beginning of the disease.

Skin	
Material	Scabs; skin scraping, skin biopsy
Parameter	Dermatophytes (including species differentiation), Dermatophilus congolensis

Uveitis Profile ➢ **see Catalogue of Prices and Services**

14.5.4 PCR Profiles Ruminants (Infectious Disease Profiles)

Bovine Abortion Profile	
Material	Abortion material, swab without medium + swab with medium (vagina, uterus)
Parameter	Bacteriology PCR: Neospora caninum, Coxiella burnetii, chlamydia, BVDV

Bovine Respiratory Profile 1	
Material	Swab without medium (nose, pharynx), lavage sample (nasal lavage, tracheal lavage, BAL), tissue (lung) + swab with medium (nose, pharynx)
Parameter	Bacteriology PCR: BRSV, BPIV-3, Mycoplasma bovis

Bovine Respiratory Profile 2	
Material	Swab without medium (nose, pharynx), lavage sample (nasal lavage, tracheal lavage, BAL), tissue (lung)
Parameter	Mannheimia haemolytica, Histophilus somni, Mycoplasma bovis, Pasteurella multocida (toxigenic)

Bovine Respiratory Profile 3	
Material	Swab without medium (nose, pharynx), lavage sample (nasal lavage, tracheal lavage, BAL), tissue (lung)
Parameter	BRSV, BPIV-3, BCoV, Mannheimia haemolytica, Histophilus somni, Pasteurella multocida (toxigenic), Mycoplasma bovis

Camelid Abortion Profile	
Material	Abortion material, swab without medium (vagina, uterus)
Parameter	Leptospira, Toxoplasma gondii, chlamydia

Small Ruminant Abortion Profile	
Material	Abortion material, swab without medium + swab with medium (vagina, uterus)
Parameter	Bacteriology PCR: chlamydia, Coxiella burnetii

14.5.5 PCR Profiles Pig (Infectious Disease Profiles)

Porcine Reproduction Profile	
Material	Abortion material, swab without medium (vagina, uterus)
Parameter	PPV, PRRSV, PCV-2, leptospira, chlamydia

Porcine Respiratory Profile	
Material	Nasal lavage, swab without medium + swab with medium (nose, pharynx)
Parameter	Bacteriology PCR: Mycoplasma hyopneumoniae, APP*, PRRSV, Influenza A, Pasteurella multocida (toxigenic)

14.6 Pathogen Characterisation Using Next-generation Sequencing

Next-generation sequencing (NGS) provides a comprehensive overview of all potentially pathogenic viral and bacterial agents in the sample. DNA and RNA sequencing is performed using a random sequencing approach. In contrast to conventional targeted, PCR-based methods, this approach amplifies and then sequences the entire genome or transcriptome present in the sample without prior knowledge of the target sequence.

NGS Analysis – Viruses/Bacteria	
Material	Special kit (please request in advance)
Parameter	Pathogenic agents, virological and bacterial
Method	Next-generation sequencing
Species	No limitations known
Duration	7–10 working days
Note	Please consult us before submitting your sample.

15 Bacteriology/Mycology

15.1 Smears/Aspirates/Blood/Milk/Urine/Faeces

Below, the most frequent requirements for general microbiology are listed. If indicated, special tests can be ordered separately (see Chapters 14.2, p. 200; 14.3, p. 243; 14.6. p. 289, 15.3, p. 295; 15.4, p. 297; and 17.1, p. 308).

In Chapter 1.2, p. 20, we have summarised the pre-analytical requirements for the sample material and sample collection as well as the necessary information about the sample that needs to be provided on the submission forms.

The bacteriological examination detects **aerobic** pathogens.
Anaerobic pathogens are not detected in aerobic bacteriology; their examination can either be requested as an individual service or as a combined service Bacteriology (aerobic and anaerobic).

To ensure the best possible test results, it is essential to indicate the sampling site on the submission form. This will allow us to use the appropriate culture media and evaluate the antibiogram correctly. In aerobic bacteriology, antibiograms are automatically prepared if the pathogens are clinically relevant; for more information, see Chapter 15.5, p. 299.

Mycology can be ordered as an individual test or in combination with the bacteriological examination for aerobic pathogens.

Abscess Material	
Parameter	Facultative pathogens, aerobic or anaerobic
Method	Bacterial culture and mycological culture
Species	Dog, cat, small mammals, birds, reptiles, large animals
Duration	Aerobic: 2–3 working days Anaerobic: 4–7 working days If mycology is included: up to 1 week
Note	▪ Split the abscess cavity and swab the inside of the abscess membrane (swab with medium). ▪ Requesting an anaerobic bacteriological examination is recommended, too.

Aspirates (from primarily sterile body cavities)	
Parameter	Pathogenic agents, aerobic or anaerobic
Method	Bacterial culture and mycological culture
Species	Dog, cat, small mammals, birds, reptiles, large animals
Duration	Aerobic: 2–3 working days Anaerobic: 4–7 working days If mycology is included: up to 1 week

Note
- For aspirates from primarily sterile body cavities, the use of a Peds Plus™ blood culture bottle is recommended; the sample material should not be cooled.
- If testing for actinomycetes and Nocardia is required, it needs to be requested separately.

Blood Culture

Parameter	Pathogenic agents
Method	Bacterial culture aerobic and anaerobic
Species	Dog, cat, large animals
Duration	5 working days up to 2 weeks

Note
- Please order blood culture bottle(s) in advance (subject to a charge).
- Different blood culture bottles are available (see Chapter 1.8, p. 27). If there is a single bottle, analysis of aerobic and anaerobic pathogens is carried out from this bottle. The set contains a separate bottle for the blood sample for anaerobic testing with a transport medium optimised for these pathogens. The set should be preferred if sufficient blood can be obtained from the patient.
- Inoculation is done with 1–3 ml of blood for the single bottle; in the set, each bottle must be inoculated with 5–10 ml of blood.
- Blood should be collected during a fever episode.
- It is recommended to send in 2–3 (sets of) blood culture bottles (blood collection at different times, intervals of at least 1 hour).
- Storage and transport are uncooled.
- It is not recommended to send blood in standard blood collection tubes or swabs, as it is often not possible to achieve reliable results without blood culture bottles.

Bronchial Lavage, Bronchial Secretion, Tracheal Secretion

Parameter	Facultative pathogens, aerobic
Method	Bacterial culture and mycological culture
Species	No limitations
Duration	Aerobic: 2–3 working days If mycology is included: up to 1 week
Note	For microbiological examination, lavage fluid should be sent in using a swab with transport medium.

Cerebrospinal Fluid

Parameter	Pathogenic agents, aerobic or anaerobic
Method	Bacterial culture and mycological culture
Species	No limitations known

Duration	Aerobic: 2–3 working days Anaerobic: 4–7 working days If mycology is included: up to 1 week

Ear Smear

Parameter	Facultative pathogens, aerobic
Method	(1) Bacterial culture and mycological culture (2) Parasitology
Species	Dog, cat, small mammals, large animals
Duration	(1) 2–3 working days, mycology up to 1 week (2) Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Please send in a swab with medium for culture examination. For the parasitological examination, we require a swab without medium or sample material placed directly onto a slide. ▪ An antimycogram for Malassezia spp. is only performed on special request.

Faeces

Parameter	Aerobic, facultative pathogens (incl. salmonella) and fungi
Method	Bacterial culture and mycological culture
Species	No limitations
Duration	2–3 working days

Milk

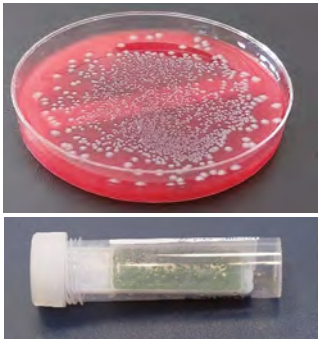
Parameter	Major and minor pathogens, aerobic, including bacterial count
Method	Bacterial culture and mycological culture
Species	Cow, sheep, goat (others: see note)
Duration	2–3 working days, mycology up to 1 week
Note	▪ Cow: Examination of quarter (1/4) or composite (4/4) milk samples is possible. ▪ Sheep and goat: Examination of milk samples from one udder half (1/2) or both udder halves (2/2) is possible. ▪ Bacteriological examination of milk samples of other mammalian species can be requested via the standard service Bacteriology + Mycology. ▪ Determination of the cell count in 10 ml of cow's milk can be requested as a separate service. The cell count is determined by flow cytometry (duration: 1 working day).

Swabs (nose, pharynx, vagina, etc.)

Parameter	Facultative pathogens, aerobic or anaerobic
Method	Bacterial culture and mycological culture
Species	No limitations
Duration	Aerobic: 2–3 working days Anaerobic: 4–7 working days If mycology is included: up to 1 week
Note	▪ For detection by culture, a swab with medium is required. A detection by culture from purulent material is often difficult as the bacteria are pre-damaged and therefore difficult to breed. ▪ Please indicate the sampling site on the submission form, especially if Histophilus somni is suspected.

Urine, Uricult

Parameter	Pathogenic agents, aerobic, including bacterial count
Method	Bacterial culture
Species	Dog, cat, small mammals, large animals
Duration	2–3 working days Uricult: 1–3 working days
Note	▪ It is best to submit urine (ideally cystocentesis or catheter urine or clean-catch midstream urine) and a urine swab (swab with medium). ▪ The urine culture test is also offered in combination with the Urinalysis/Sediment test (see Chapter 5, p. 78). In this case, at least 6 ml of urine or 5 ml of urine + swab with medium or 5 ml of urine + Uricult are required for the test.



Blood agar plate showing growth, and Uricult for differentiation (Laboklin & Sarstedt (2024))

Wound Swab

Parameter	Pathogenic agents, aerobic or anaerobic
Method	Bacterial culture and mycological culture
Species	No limitations
Duration	Aerobic: 2–3 working days Anaerobic: 4–7 working days If mycology is included: up to 1 week

15.2 Skin/Hair/Feathers

Skin Swabs

Parameter	(1) Facultative pathogens, aerobic (2) Dermatophytes, yeasts
Method	(1) Bacterial culture (2) Mycological culture
Species	Dog, cat, small mammals, birds, reptiles, amphibians, large animals, fish
Duration	(1) 2–3 working days (2) 2 working days up to 3 weeks
Note	▪ For skin swabs, the service Bacteriology (testing for facultative pathogenic aerobic bacteria) can be requested in combination with Mycology (skin) and, if required, with testing for Ectoparasites. For these combined services, it is necessary to submit a swab with medium and skin or skin scales or scab or hairs/feathers and, if parasitology is requested (see Chapter 16.4, p. 307), an additional skin scraping or tape test. ▪ For fish, we also offer this test in combination with the test for fish tuberculosis (Ziehl-Neelsen staining).

Skin, Danders, Hairs, Feathers

Parameter	(1) Facultative pathogens aerobic (2) Dermatophytes, yeasts (3) Parasites (4) Facultative pathogens (aerobic), dermatophytes, yeasts, ectoparasites
Method	(1) Bacterial culture (2) Mycological culture + paraffin oil preparation (3) Parasitology: paraffin oil preparation, tape test (4) Bacterial culture, mycological culture, paraffin oil preparation
Species	Dog, cat, small mammals, birds, reptiles, large animals
Duration	(1) 2–3 working days (2, 4) 2 working days up to 3 weeks (3) Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ For skin swabs, the service Bacteriology (testing for facultative pathogenic aerobic bacteria) can be requested in combination with Mycology (skin) and, if required, with testing for Ectoparasites. For these combined services, it is necessary to submit a swab with medium and skin or skin scales or scab or hairs/feathers and, if parasitology is requested (see Chapter 16.4, p. 307), an additional skin scraping or tape test. ▪ For yeasts, an antimycogram can be performed on special request.

- In symptomatic animals, it is absolutely necessary to collect samples from the edge of the lesion. In asymptomatic animals, the coat can be brushed with a toothbrush (taken straight out of the packaging). The toothbrush and the brushed-out hair should be submitted for testing.
- For PCR detection of dermatophytes, see Chapter 14.3.4, p. 245.

Trichogram/Pennogram	
Parameter	Current condition of coat/plumage incl. ectoparasites
Method	Microscopy
Species	Dog, cat, small mammals, birds, large animals
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	In skin patients, a trichogram serves as an additional method for diagnostic assessment. It cannot replace bacteriological, mycological and parasitological examinations, cytology, histology and other tests, such as the determination of clinical-chemical parameters or hormone assays, but it can provide very valuable information. Trichograms are particularly suitable in the diagnosis of cats with hair loss that have no apparent pruritus and for which alopecia sine causa is already clinically suspected. A trichogram can also provide valuable diagnostic information in case of colour mutant alopecia.

15.3 Bacteriological Examination Horse

BAL Profile ➢ **see Chapter 19.3, p. 326**

Reproductive Fitness	
Material	Swab with medium **Mare:** cervical swab **Stallion:** shaft swab, urethral swab or glans penis swab
Parameter	Pathogenic agents, aerobic
Method	Bacterial culture and possibly mycological culture
Species	Horse
Duration	2–3 working days, mycology up to 1 week
Note	▪ This test can be ordered with or without mycological examination. ▪ Culture examination for reproductive fitness is also offered either in combination with culture-based CEM detection or with PCR detection. When combined with CEM please send in an additional swab with Amies medium with charcoal. ▪ Furthermore, we offer a combination of bacterial and mycological culture as well as pathological examination of 1–3 endometrial biopsies for mares.

Streptococcus equi

Material	(1) Swab with medium (nose, abscess, lymph node), BAL, TBS, guttural pouch lavage sample (gold standard, highest sensitivity), pharyngeal lavage sample (2) Swab without medium (nose), lavage sample (guttural pouch, BAL), TBS, lymph node aspirate/lymph node pus, tissue (lymph node)
Method	(1) Bacterial culture (2) Realtime PCR
Species	Horse
Duration	(1) 2–3 working days (2) 1–3 working days
Note	▪ In culture, both subspecies (Streptococcus equi equi and Streptococcus equi zooepidemicus) are determined and differentiated by MALDI-TOF. ▪ If detection is to be done by means of PCR, it can be chosen between the single detection of Streptococcus equi equi or the detection of both subspecies mentioned above.

Taylorella equigenitalis (CEM)

Material	(1+2) Swab with medium (Amies with charcoal, not older than 48 hours) **Stallion:** penile shaft, urethra, fossa glandis (optional: prepuce or sperm) **Mare:** fossa clitoridis, sinus clitoridis (optional: cervix)
Method	(1) Bacterial culture (2) Realtime PCR
Species	Horse
Duration	(1) Reporting of results **one week** after the sample is received (Mon–Fri); for export tests, however, the processing time may be longer depending on the specific requirements of the respective export country. (2) 1–3 working days
Note	▪ Even after successful bacteriological cultivation, it is not possible to create an antibiogram for Taylorella equigenitalis. ▪ Detection by PCR is offered as an individual service for one sample or as CEM profile for the examination of several sites. The CEM Profiles stallion 1 and mare 1 are suitable as PCR detection before export to another EU country (see Chapter 14.5.3, p. 285). ▪ Contagious equine metritis is listed under the **EU Animal Health Law (AHL)**.

15.4 Specific Pathogen Detection

Actinomyces, microaerophilic	
Material	Aspirates, swab with medium, etc.
Method	Bacterial culture
Species	Dog, cat, small mammals, large animals
Duration	7–8 calendar days
Note	This examination is offered as service "Nocardia/Actinomyces".

Bordetella bronchiseptica (aerobic)	
Material	(1) Swab with medium (Amies) (nose, pharynx), bronchial secretion (2) Swab without medium, bronchial secretion, BAL
Method	(1) Bacterial culture (2) Realtime PCR
Species	Dog, cat, rabbit, guinea pig, rat, mouse, ruminants, others
Duration	(1) 2–3 working days (2) 1–3 working days
Note	When requesting bacterial culture, please indicate the sampling site on the submission form.

ESBL – Pathogen Detection	
Material	Swab with medium, faeces
Method	Bacterial culture; phenotypic antimicrobial susceptibility testing by microdilution
Species	Dog, cat, horse, cattle, others
Duration	3–4 working days
Note	▪ Extended-spectrum β-lactamase (ESBL)-producing bacteria of the order Enterobacterales such as E. coli, Klebsiella spp. and Proteus spp. are called ESBL. Due to the specific β-lactamase with extended spectrum of activity, the bacteria are resistant to β-lactam antibiotics, both to penicillins as well as cephalosporins (also to 3rd and 4th generation cephalosporins). The property of ESBL formation is encoded on easily transferable genetic segments and, during reproduction, can be transferred from one bacterial generation to the next (vertical transfer) or exchanged between bacteria (horizontal transfer). ▪ This test is only performed after prior bacteriological examination. From 1 July 2026 onwards, the service ESBL differentiation (by culture or antibiogram) will also include bacteriological examination. ▪ Testing for ESBL is also part of the service "Analysis of Multidrug-resistant Bacteria" (see below).

Analysis of **Multidrug-resistant Bacteria (MRSA/MRSP, VRE, ESBL, Carbapenemase producer)**	
Material	4 swabs with medium ▪ Swab 1: nasal-buccal ▪ Swab 2: skin (armpit or groin) or conjunctiva ▪ Swab 3: pooled swab from the animal's environment (dog basket + food bowl + floor) ▪ Swab 4: rectal swab
Method	Bacterial culture; phenotypic antimicrobial susceptibility testing by microdilution
Duration	3–4 working days
Note	▪ This profile is used to specifically screen for bacteria that are resistant to critically important antibiotics in order to identify asymptomatic carriers (e.g. therapy dogs in hospitals and care facilities). Particularly critical resistances occur in methicillin-resistant staphylococci (mainly Staphylococcus (S.) pseudintermedius in dogs and S. aureus), vancomycin-resistant enterococci (mainly Enterococcus (E.) faecium and E. faecalis) and enterobacteria resistant to 3rd and 4th generation cephalosporins and to carbapenem antibiotics. ▪ The sampling sites are recommendations. If other sites are prescribed by the hospital or the respective facility, please follow these recommendations. ▪ The profile provides phenotypic detection of antimicrobial resistance in selected bacterial isolates. It does not test for resistance genes by molecular biology. ▪ The test result reflects the current status of the animal, so it needs to be considered whether regular screenings should be carried out.

Nontuberculous **Mycobacteria**	
Material	Fluids, tissue, faeces
Method	Bacterial culture and/or microscopy (Ziehl-Neelsen staining)
Species	No limitations known
Duration	Staining: reporting of results on the day the sample is received (Mon–Fri); Culture: approx. 8 weeks
Note	▪ Testing for pathogens can be requested individually using culture, individually using Ziehl-Neelsen staining (microscopic detection of acid-fast bacilli), or in combination. Testing is only performed for nontuberculous mycobacteria. ▪ For PCR pathogen detection and antibody detection of M. avium ssp. paratuberculosis, see Chapter 14.2.27, p. 227.

Nocardia

Material	Aspirates, swab with medium
Method	Bacterial culture
Species	No limitations
Duration	7–8 calendar days
Note	This examination includes the detection of Actinomyces.

Paenibacillus larvae (American foulbrood , AFB, malignant foulbrood)

Material	Honey and wax sample
Method	Bacterial culture
Species	Bees
Duration	3 weeks
Note	▪ Two tablespoons of feed honey from the honey dome should be scratched from a central brood comb, packed into a freezer bag and sent in. ▪ American (malignant) foulbrood is listed under the **EU Animal Health Law (AHL)**.

15.5 Susceptibility Testing

All antibiograms are performed by microdilution method according to CLSI standard. In aerobic bacteriology, antibiograms are automatically created when clinically relevant pathogens are detected, unless this service is actively cancelled (for printed submission forms, enter service ID 2202, and for online orders, enter 220200). For fixed service packages combining bacteriology and antibiograms, the costs for the antibiogram are included, even if the bacteriological examination is negative, and it is not possible to exclude this service.

Antibiogram (aerobes)

There are species-specific standard antibiograms (see note). An antibiogram is invoiced as a fixed price per bacterial culture, even if several antibiograms need to be performed.

Duration	Requested separately: 1 working day With following prior culture: 2–3 working days
Note	The antibiograms include the following number of antibiotics (at the time of printing) ▪ small animals: 31 ▪ rabbits and rodents: 29 ▪ birds: 25 ▪ reptiles and amphibians: 19 ▪ large animals: 34 ▪ fish: 19

Antibiogram (anaerobes)

We can also perform an antibiogram if anaerobes are detected. Only antibiotics with potential efficacy against anaerobes are tested.

Duration	Requested as a separate service: 7–10 calendar days With prior culture: up to 2 weeks

Antimycogram

We can perform an antimycogram if yeasts incl. Malassezia have been cultured. This needs to be requested, though. We store the cultivated yeasts incl. Malassezia for one week.

Method	Agar diffusion test
Duration	2–7 calendar days

Analysis of **Multidrug-resistant Bacteria** ➢ **see Chapter 15.4, p. 298**

15.6 Additional Susceptibility Testing

Aromatogram Bacteria or Yeasts

The aromatogram is an in vitro test for determining the susceptibility of bacteria or yeasts/Malassezia to various essential oils. The procedure is based on the principle of the agar diffusion test (disk diffusion test).

The in vitro efficacy of essential oils is classified into 4 categories: from ineffective to slightly, moderately and highly effective.

Duration	Bacteria: 1 working day following culture Yeasts: up to 1 week

16 Parasitology

16.1 Parasitological Examination – Faeces

Below, the most frequent requirements for parasitological faecal examination are listed. For the enrichment by flotation or SAFC method (sodium acetate-acetic acid-formalin concentration), we need a cherry-sized amount of faeces, if possible a 3-day pooled faecal sample (for sedimentation and larval culture, larger quantities are required; see test descriptions).

Digital Endoparasites/Protozoa – Image Analysis

The image upload in "MyLab" allows you to quickly get a veterinary diagnosis of digital images with unclear findings from your practice. You can upload up to 4 images of a microscopic preparation with your diagnostic task via the **image analysis "Digital Parasitology"** in the password-protected area of our "MyLab" website. You will receive the laboratory findings by e-mail, usually on the same day.

Laboklin "MyLab" https://app.laboklin.com/imageAnalysis

Egg Count: Modified McMaster Method

Counting of worm eggs and protozoan stages is done using a counting chamber after enrichment by flotation.
This method is primarily used in horses, small ruminants and South American cameldis to carry out targeted deworming to reduce the development of resistance to strongyles. In targeted or selective deworming, individual deworming is only carried out if there are > 200 eggs per gram of faeces.
If all animals of a population that have a worm infestation are dewormed, only resistant worms survive. However, if only animals that have a more severe worm infestation are dewormed, an untreated worm population is also found in the animal population, which reduces the selective advantage of resistant worms and thus counteracts the further increase in resistance.

Duration Reporting of results on the day the sample is received (Mon–Fri)

Egg Count Reduction Test

The egg count reduction test is used to check whether there is resistance to anthelmintics. To do so, the number of worm eggs in the faeces is counted before and after deworming. The **modified McMaster method** described above is used for this analysis. In selective deworming (see above), only animals with an egg count > 200 are dewormed. 10–14 days after treatment, further individual samples are tested using the modified McMaster method. If high egg counts are still present, anthelmintic resistance should be considered. This method is mainly used in the large animal practice in ruminants, horses and pigs.

Even if deworming does not take place selectively at the level of the individual animal but, for example, of groups of animals, regular monitoring of the effectiveness of anthelmintics by means of an egg count reduction test is recommended.

Duration	Reporting of results on the day the sample is received (Mon–Fri)

Endoparasites (protozoa and worms)

Material	Faeces (3-day pooled sample; as fresh as possible) Perianal tape preparation in horses (Oxyuris equi)
Method	Microscopy (faeces: after enrichment by flotation and SAFC method)
Species	No limitations
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ As parasite eggs or protozoa are only shed intermittently, the test needs to be repeated if there is any suspicion (it is best to send in 3 consecutive samples). ▪ **Horse:** From the eggs, differentiation of large and small strongyles is not possible; a larval culture (see below) would be required here, which can be requested separately. **Strongyloides westeri** (intestinal threadworm) can be detected in fresh faecal samples by flotation. For the detection of **Oxyuris equi** in horses, an tape preparation from the perianal region must be submitted. Affected animals have egg strings and crusts in the perianal region and show signs of pruritus and tail rubbing. ▪ **Camelids, small ruminants:** If strongyle eggs are detected in the flotation test, subsequent fluorescence staining may be requested to determine the presence of **Haemonchus contortus**. Special staining for Haemonchus contortus can also be requested directly as a combined service together with the parasitological examination.

Larval Culture

Material	Faeces 50 g (3-day pooled sample; as fresh as possible)
Method	Culture of strongyle eggs until larvae develop, with subsequent microscopic differentiation
Species	Horse
Duration	10–12 calendar days
Note	▪ To differentiate between large/small strongyles ▪ A larval culture should always be performed if large strongyles are suspected, and at least once a year in herds that use selective deworming.

- A larval culture is only initiated only after a positive strongyle result. If a parasitological examination is requested at the same time, the sample can be reused after flotation; however, this requires sufficient sample volume.

Lungworm Larvae (Baermann Test)

Material	Faeces (3-day pooled sample; as fresh as possible)
Method	Baermann technique
Species	Dog, cat, small mammals, large animals
Duration	1–2 working days

Note

- A Baermann test is indicated in cases of chronic cough and dyspnoea because of possible lungworm larvae infections.
- **Dog, cat:** The lungworms **Angiostrongylus vasorum**, **Capillaria aerophila**, **Crenosoma vulpis**, **Aelurostrongylus abstrusus** and **Troglostrongylus brevior** cannot only be detected by Baermann technique but also by PCR in blood and, if necessary, BAL as individual test (see Chapter 14.4, p. 249 ff.) as well as in the Lungworm Profile Dog and the Lungworm Profile Cat (see Chapter 14.5.1, p. 279).
- **Horse, donkey:** Detection of **Dictyocaulus arnfieldii** also in BAL. In donkeys, detection in faeces is a suitable method, whereas in horses (foals, yearlings), the excretion of eggs is rare. Infection with Dictyocaulus arnfieldii requires joint grazing with donkeys or mules that shed lungworm larvae.
- **Cattle: Dictyocaulus viviparus** is a major pasture parasite in wetlands, especially affecting young animals during their first grazing season. Infections in barns are rare (may occur when feeding contaminated grass).
- **Small ruminants:** In Germany and Austria, the sheep and goat lungworm (**Dictyocaulus filaria**) is rarely seen in sheep and occasionally found in goats. Small lungworms are detected much more frequently. **Muellerius capillaris, Protostrongylus rufescens,** and **Cystocaulus ocreatus** are common in sheep and goats. **Neostrongylus linearis** is rarely found in these animals. **Protostrongylus spp.** are found in the bronchioles and medium-sized bronchi, while the other genera are found in worm/brood nodules in the lung parenchyma. After the larvae have been detected by Baermann technique, the genus is differentiated based on the size of the larvae and the characteristics of the tail ends. Mixed infections may occur.

16.2 Endoparasite profiles

It is recommended to send in pooled faecal samples (collected over 3 days) to increase the probability of detection, as worm eggs are excreted intermittently.

Endoparasite Profile (dog, cat)	
Material	Faeces
Method	Flotation, EIA
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ Analysis is done for endoparasites and Giardia sp. antigen (EIA). ▪ For other animal species, the parameters can be ordered individually.

Endoparasite Profile (horse, camelids, farm animals)	
Material	Faeces
Method	Flotation, SAFC method and modified McMaster method
Duration	Reporting of results on the day the sample is received (Mon–Fri)

Endoparasites + IFAT	
Material	Faeces (3-day pooled sample; as fresh as possible)
Method	Flotation and IFAT
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	The profile Endoparasites and IFAT includes the microscopic detection of helminths and protozoa by means of flotation and the detection of giardia and cryptosporidia by means of IFAT.

Endoparasites (reptiles)	
Material	Faeces
Method	Microscopy after enrichment by flotation and SAFC method, Ziehl-Neelsen staining, fresh specimen
Duration	1–2 working days
Note	As parasite eggs or protozoa are only shed intermittently, the test needs to be repeated if there is any suspicion.

Large **Feline Endoparasite Profile**	
Material	Faeces
Method	Flotation, EIA, realtime PCR
Duration	1–3 working days
Note	▪ Test for endoparasites, Giardia sp. antigen (EIA) and Tritrichomonas foetus/blagburni (PCR). ▪ For other animal species, the parameters can be ordered individually.

Ferret and Chinchilla Parasite Profile	
Material	Faeces
Method	Flotation, EIA
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	Analysis is done for endoparasites and Giardia sp. antigen (EIA).

Hedgehog Parasite Profile	
Material	Faeces
Method	Flotation, SAFC method and Baermann test
Duration	1–2 working days
Note	Analysis is done for endoparasites and lungworm larvae.

Ruminant Endoparasites	
Material	Faeces
Method	Flotation, SAFC method and Baermann test
Species	Cattle, sheep, goat
Duration	1–2 working days

16.3 Testing for Specific Parasitic or Protozoa Infections

Cryptosporidia – Pathogen Detection	
Material	Faeces, in snakes also: regurgitated material, gastric lavage, stomach biopsy
Method	(1) Antigen detection: EIA (mammals), IFAT (reptiles) (2) Modified Ziehl-Neelsen staining (3) PCR
Species	Dog, cat, small mammals, reptiles, ruminants, South American camelids, others on request
Duration	(1) IFAT: reporting of results on the day the sample is received (Mon–Fri), EIA: 1–2 working days (2) Reporting of results on the day the sample is received (Mon–Fri); reptiles: 2 working days (3) 1–3 working days
Note	If the PCR yields positive results in reptiles, differentiation of the Cryptosporidium species is possible on request. This is done to distinguish between harmless intestinal passengers (origin: infected feeder animals) and pathogenic Cryptosporidia.

Echinococcus multilocularis/granulosus – Pathogen Detection

Material	Faeces, tissue
Method	Realtime PCR
Species	Dog, cat, fox
Duration	1–3 working days
Note	▪ This PCR test differentiates between E. multilocularis and E. granulosus. ▪ In contrast to this species-specific PCR, microscopy after enrichment can only detect morphologically indistinguishable Taenia eggs. ▪ E. multilocularis is listed under the **EU Animal Health Law (AHL)**.

Echinococcus – Antibody Detection

Material	S, HP 0.5 ml
Method	ELISA
Species	Dog
Duration	2–4 working days
Note	**Obligation to notify the authorities** (see above)

Fasciola hepatica ➢ **see Chapter 14.4.13, p. 263**

Giardia – Pathogen Detection

Material	Faeces
Method	(1) Microscopy after enrichment (2) EIA (antigen detection) (3) IFAT (microscopic detection of cysts) (4) Realtime PCR
Species	Dog, cat, small mammals, reptiles, large animals
Duration	(1, 2 and 3) Reporting of results on the day the sample is received (Mon–Fri) (4) 1–3 working days
Note	▪ If the examination should also clarify whether human-pathogenic assemblages A and B are present, PCR is available as an alternative detection method (see Chapter 14.4.15, p. 265). ▪ For information on sensitivity and specificity, see Chapter 14.4.15, p. 265.

Nosema – Pathogen Detection

Material	30–40 dead bees
Method	(1) Microscopy (2) PCR (differentiation)

Species	Bees
Duration	(1) 2–3 working days (2) 1–3 working days
Note	If the result of the microscopic examination is positive, PCR can differentiate between Nosema apis and Nosema ceranae.

Ostertagia ostertagi – Antibody Detection

Material	Milk, tank milk 0.5 ml
Method	EIA
Species	Cattle
Duration	1–5 working days

Toxoplasma gondii ➢ **see Chapter 14.4.23, p. 273**

Tritrichomonas foetus/blagburni ➢ **see Chapter 14.4.25, p. 275**

16.4 Parasitological Examination – Skin

Digital Ectoparasites – Image Analysis

The image upload in "MyLab" allows you to quickly get a veterinary diagnosis of digital images with unclear findings from your practice. You can upload up to 4 images of a case with your diagnostic task via the **image analysis "Digital Parasitology"** in the password-protected area of our "MyLab" website. You will receive the laboratory findings by e-mail, usually on the same day.

Laboklin "MyLab" https://app.laboklin.com/imageAnalysis

Skin

Material	Skin scraping, tape test, plucked hairs, feathers
Method	Microscopy
Species	Dog, cat, small mammals, birds, large animals
Duration	1–2 working days
Note	▪ The detection of ectoparasites is done by examination of skin material (see above), which should possibly be placed into shipping containers before they are sent in. If mites are suspected, the depth of the scraping should be adapted to the habitat of the respective mite. ▪ Ectoparasite detection is also part of the service Bacteriology + Mycology + Ectoparasites.

17 Tests for Indigestion and Diarrhoea

17.1 Bacteriological Examination

17.1.1 Faecal Profiles

If possible, please submit a faeces tube that is ¾ full. When doing a culture test, an aerobic bacteriological and possibly mycological examination, including enrichment for salmonella, is performed. **Pathogen differentiation** is based on colony morphology, growth on selective culture media, biochemical tests, and, if necessary, MALDI-TOF. Unless otherwise stated, the test duration is 2–3 working days.
If required, **serological pathogen differentiation** (e.g. salmonella) and an **antibiogram**, which are subject to a charge, will be performed additionally. For information on how to exclude the antibiogram and on the inclusion of costs in fixed service combination, please refer to Chapter 15.5, p. 299.

Dog and Cat

Combined Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, gas producers, endoparasites as well as Giardia sp. antigen (EIA) and Cryptosporidia antigen (EIA)

BARF Faecal Profile

Salmonella, yersinia, campylobacter, listeria, endoparasites

Duration 3–4 working days; yersinia: up to 4 weeks

Faecal Profile Pathogenic Bacteria

Salmonella including enrichment, yersinia including enrichment, campylobacter, PCR: enteropathogenic E. coli incl. virulence factors (STa, STb, LTb, stx1, stx2, eae)

Duration 2–4 working days; yersinia: up to 4 weeks

Faecal Profile Puppy/Kitten

Bacteriology (aerobic) and mycology, obligate and facultative pathogenic bacteria including enrichment for salmonella, gas producers, parvovirus (EIA), endoparasites, Giardia sp. antigen (EIA)

Large Faecal Profile

Bacteriology (aerobic) and mycology, obligate and facultative pathogenic bacteria including enrichment for salmonella, Clostridium perfringens enterotoxin, Clostridioides difficile toxin A and B, gas producers, endoparasites, Giardia sp. antigen (EIA)

Small Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, gas producers, endoparasites

Dog and Cat – Faecal Profiles with PCR

Diarrhoea, Human Pathogenic Causes

PCR: salmonella, Yersinia enterocolitica, Campylobacter jejuni

Diarrhoea Pathogens Cat

PCR: coronavirus, Tritrichomonas foetus, giardia, parvovirus, cryptosporidia

Diarrhoea Pathogens Dog

PCR: coronavirus, parvovirus, circovirus, giardia, cryptosporidia

Dysbiosis Profile

Key bacteria intestinal microbiome quantitative (PCR), mycology, calprotectin, α-1 anti-trypsin, secretory IgA (sIgA), pancreatic elastase (dog) and microscopic nutritive digestion (cat), endoparasites

Note For information on microbiome analysis/dysbiosis analysis, see Chapter 17.5, p. 320.

Haemorrhagic Diarrhoea (dog)

Bacteriology including salmonella, PCR: parvovirus, Clostridium perfringens netE gene, Clostridium perfringens netF gene, pathogenic E. coli (EHEC, EPEC, ETEC)

Small Mammals, Birds and Reptiles

Avian Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, endoparasites

Ferret Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, endoparasites, Giardia sp. antigen (EIA)

Pigeon Faecal Profile

Salmonella, endoparasites (incl. coccidia)

Reptile Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, endoparasites

Rodent and Rabbit Faecal Profile

Bacteriology (aerobic) and mycology incl. Cyniclomyces guttulatus, facultative pathogenic bacteria including enrichment for salmonella, endoparasites

Horse

Dysbiosis Analysis ➢ **see Chapter 17.5, p. 321**

Faecal Profile Foal

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, gas producers, endoparasites incl. protozoa, Strongyloides westeri,
PCR: rotaviruses A, Clostridium perfringens enterotoxin gene, Clostridium perfringens netF gene, Clostridioides difficile toxin A + B gene

Large **Faecal Profile (horse)**

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, gas producers, endoparasites,
PCR: Clostridium perfringens enterotoxin gene, Clostridioides difficile toxin A + B gene, equine coronavirus

Small **Faecal Profile (horse)**

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, endoparasites

Camelids

Camelid Faecal Profile

Bacteriology (aerobic) and mycology, facultative pathogenic bacteria including enrichment for salmonella, gas producers, endoparasites incl. coccidia, cryptosporidia, rotavirus, coronavirus

Ruminants

Bovine Faecal Profile

In addition to an aerobic bacteriological and mycological examination and the test for obligate and facultative pathogenic bacteria, including enrichment for salmonella, as well as testing for endoparasites, this Bovine Faecal Profile also includes the detection of Mycobacterium avium ssp. paratuberculosis by means of PCR.

Calf Faecal Profile – Large

The Calf Faecal Profile Large includes the general aerobic bacteriological and mycological examination, including enrichment for salmonella and, if E. coli is present, its serological typing (F5). Furthermore, this profile includes testing for endoparasites, cryptosporidia and coccidia as well as the virological examination for rotavirus and coronavirus.
If salmonella are detected, they will be serologically typed as an additional service (subject to a charge).

Calf Faecal Profile (EIA)

The Calf Faecal Profile includes testing for rotavirus and coronavirus, E. coli F5 fimbrial antigen and cryptosporidia. The advantage of ELISA testing is the short test duration (1 working day, max. 2 working days).

Pig

Piglet Faecal Profile

The Piglet Faecal Profile includes the general aerobic bacteriological and mycological examination, including salmonella and, if E. coli is present, also its serological typing (F4), testing for endoparasites, the virological examination for rotavirus and coronavirus (PCR) as well as the test for Clostridium perfringens enterotoxin (EIA). If salmonella are detected, they will be serologically typed as an additional service (subject to a charge).

Porcine Faecal Profile

The Porcine Faecal Profile includes the general aerobic bacteriological and mycological examination, including salmonella, as well as the detection of Lawsonia intracellularis by means of PCR.

17.1.2 Single Determinations

Campylobacter

Material	(1) Faeces, swab with medium (intestine, cloaca) (2) Faeces, swab without medium (intestine, cloaca)
Method	(1) Bacterial culture (2) Realtime PCR (only detection of Campylobacter jejuni)
Species	No limitations known
Duration	(1) 2 working days or 4 working days with antibiogram (2) 1–3 working days
Note	▪ The culture test for campylobacter is also available in combination with yersinia and as part of the BARF Faecal Profile and the Faecal Profile Pathogenic Bacteria (see Chapter 17.1.1, p. 308). ▪ Resistances are common; treatment should therefore only be carried out after an antibiogram has been performed. Preparation of an antibiogram is only possible after performing a culture test. ▪ In dogs, feeding a barf diet is a source of infection for C. jejuni. ▪ Bovine genital campylobacteriosis is listed under the **EU Animal Health Law (AHL)**. Infections with thermophilic campylobacter are not yet listed under the EU Animal Health Law (AHL) (as of December 2025). ▪ For genital infection cattle, sheep, see Chapter 14.2.9, p. 208.

Clostridioides difficile Toxin A and B

Material	Faeces
Method	(1) ELISA (detection of toxins) (2) PCR (detection of toxin genes)
Species	No limitations known
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ Determination is particularly indicated in case of colitis. ▪ For the ELISA, a faecal sample at least the size of a cherry must be sent in. ▪ **Dog, cat, horse:** Detection of toxins/toxin genes can be requested as individual test and is included in the species-specific faecal profiles and in the Foal Diarrhoea Pathogens profile.

Clostridium perfringens Alpha Toxin

Material	Faeces
Method	PCR (detection of toxins)
Species	No limitations known
Duration	1–3 working days

Clostridium perfringens Enterotoxin

Material	Faeces
Method	(1) ELISA (detection of toxin) (2) PCR (detection of toxin gene)
Species	No limitations known
Duration	(1) 1–2 working days (2) 1–3 working days
Note	▪ Determination is particularly indicated in case of colitis. ▪ For the ELISA, a faecal sample at least the size of a cherry must be sent in. ▪ In **carnivores**, Clostridium perfringens enterotoxin can cause diarrhoea and vomiting of varying severity; enterotoxaemia is rare. Toxin formation is induced by antibiotic treatment, stress, co-infections or an unbalanced diet with high amounts of poorly digestible protein sources such as connective tissue. ▪ In farm animals, young animals, particularly calves and lambs, are susceptible to serve disease. Older animals, however, are often affected by clostridiosis (cattle) or sporadic catarrhal and haemorrhagic enteritis (pig). ▪ **Dog, cat, horse, piglet:** Detection of toxins/toxin genes can be requested as individual tests and is included in the species-specific faecal profiles and the Foal Diarrhoea Pathogens profile.

Clostridium perfringens netE/netF

Material	Faeces
Method	Realtime PCR (detection of toxin gene)
Species	No limitations known
Duration	1–3 working days
Note	Detection of the netE-/netF gene can either be requested as an individual test or is included in the Haemorrhagic Diarrhoea profile for dogs and the Faecal Profile Foal as well as in the Foal Diarrhoea Pathogens profile.

E. coli, eae Gene (Intimin)

Material	Faeces
Method	PCR detection of the eae gene after prior detection of E. coli by culture
Species	All, especially calf, piglet
Duration	3–4 working days
Note	▪ The eae gene is a virulence factor of E. coli. The eae gene (E. coli attaching and effacing) encodes the production of intimin, which permits E. coli to attach itself to the intestinal cells.

- Detection of the eae gene is also part of the Faecal Profile Pathogenic Bacteria, the profile Haemorrhagic Diarrhoea (dog) and the detection of enteropathogenic E. coli (see below).

E. coli, enteropathogenic (STa, STb, LTb, stx1, stx2, eae)

Material	Faeces
Method	PCR after prior detection of E. coli by culture
Species	All
Duration	3–4 working days
Note	E. coli which carry genes for the synthesis of enterotoxins or shiga-toxins (ETEC, STEC) and/or the virulence factor intimin (EHEC, EPEC, ETEC) can cause intestinal complaints such as diarrhoea, especially in young animals. Adult animals may shed enteropathogenic E. coli in faeces without showing any clinical signs.

Helicobacter spp.

Material	Vomitus, gastric lavage, gastric biopsy Sheep: abortion material, chelonians: swab (without medium)
Method	PCR
Species	Dog, cat, hamster, mouse, ferret, sheep, others on request
Duration	1–3 working days
Note	▪ Positive PCR results from faecal samples do not necessarily indicate involvement of the stomach (gastritis, stomach ulcer, etc.), as PCR also detects intestinal Helicobacter spp. For this diagnostic task, stomach biopsies or vomitus are recommended. ▪ In Muridae, helicobacter can cause typhlitis and rectal prolapse, in sheep, however, it can cause abortions (see Chapter 14.2.19, p. 219)

Lawsonia intracellularis

Material	Faeces, tissue (intestine)
Method	Realtime PCR
Species	Horse (mainly foal), pig, small mammals
Duration	1–3 working days
Note	As very few pathogens are excreted in faeces, PCR is the method of choice here; however, false negative results are possible due to the low shedding rate.

Macrorhabdus ornithogaster

Material	Faeces, smear on slide, crop lavage, proventriculus
Method	Stain, microscopy
Species	Birds
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	A faecal sample at least the size of a cherry is required.

Mycobacteria (Microscopic Detection of Acid-fast Rods)

Material	Faeces, smear on slide
Method	Ziehl-Neelsen staining, microscopy
Species	No limitations known
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	▪ A faecal sample at least the size of a cherry is required. ▪ For fish, we also offer this test in combination with the bacteriological examination (service Bacteriology Fish + Fish Tuberculosis, material: tissue or swab without medium).

Salmonella

Material	(1) Faeces, swab with medium (intestinal or cloacal swab) (2) Faeces; in birds also swab without medium (cloaca), eggs, tissue
Method	(1) Bacterial culture including enrichment, MALDI-TOF (2) Realtime PCR
Species	No limitations known
Duration	(1) 2–3 working days (2) 1–3 working days
Note	Culture with enrichment is the most sensitive test method. After successful culture cultivation, a serological pathogen differentiation follows (subject to a charge).

Shigella

Material	Faeces, intestinal or cloacal swab (swab with medium)
Method	Bacterial culture
Species	No limitations known
Duration	2 working days

Yersinia

Material	Faeces
Method	(1) Bacterial culture with cold enrichment (2) Realtime PCR (only Yersinia enterocolitica)
Species	No limitations known

Duration (1) Up to 4 weeks
(2) 1–3 working days

Note
- A faecal sample at least the size of a cherry is required. In exceptional cases, a swab with transport medium can also be used for culture.
- After successful culture cultivation, a serological pathogen differentiation follows (subject to a charge).
- The culture test for campylobacter is also available in combination with yersinia and as part of the BARF Faecal Profile and the Faecal Profile Pathogenic Bacteria (see Chapter 17.1.1, p. 308).

17.2 Virological Examination

17.2.1 Faecal Profiles – Virology

Diarrhoea Profiles (dog/cat) ➢ **see Chapter 14.5.1, p. 278**

Virological Faecal Profile (dog, cat)

Parvovirus (EIA), rotaviruses A and coronaviruses (PCR)

17.2.2 Single Determinations

Coronavirus – Pathogen Detection

Material Faeces, in pigs also tissue (intestine)
Method Realtime PCR; PCR (ferrets), droplet digital PCR (quantitative PCR in cats)
Species Dog, cat, ferret, horse, ruminants, pig
Duration 1–3 working days

Note
- In small animals, a pooled faecal sample is recommended as it increases sensitivity.
- **Cat: Quantitative PCR** (from a 3-day pooled faecal sample) is available to evaluate the pathogen excretion, e.g. during rehabilitation of the cat population. For more information, see Chapter 14.1.12, p. 161.
- Bovine coronaviruses also cause respiratory diseases (see Chapter 14.1.12, p. 161).
- For SARS-CoV-2, see Chapter 14.1.47, p. 195.

Parvovirus – Antigen Detection/Pathogen Detection

Material	(1) Faeces (sample at least the size of a cherry) (2) **Dog:** qualitative PCR: faeces, EB, tissue (e.g. intestine or heart) quantitative PCR: faeces **Cat**: faeces, EB **Ferret:** rectal swab without medium, EB (viraemia), tissue (e.g. spleen, lymph nodes or bone marrow), (faeces – lower sensitivity than rectal swab) **Horse (EqPV-H):** EB, serum, tissue (liver) **Pig:** swab without medium (genital tract), EB, tissue (e.g. abortion material)
Method	(1) EIA (2) Realtime PCR/ferret: PCR
Species	(1) Dog, cat (2) Dog, cat, ferret, horse, pig
Duration	EIA: 1–2 working days; PCR: 1–3 working days
Note	▪ Antigen detection by EIA may be positive 5–12 days after vaccination with a live vaccine! ▪ **PCR** can be positive up to four weeks after vaccination with live vaccine. ▪ In **dogs**, after a positive PCR differentiation between vaccine strain and field strains is possible on request (see Chapter 14.1.35, p. 186). ▪ In dogs, quantitative PCR is also possible from faeces (see Chapter 14.1.35, p. 186). ▪ Direct detection of parvoviruses in blood or serum is possible approx. 1–5 days post infection. ▪ Porcine parvovirus causes fertility disorders (SMEDI, see Chapter 14.1.35, p. 186).

Rotaviruses – Antigen Detection/Pathogen Detection

Material	(1) Faeces (at least the size of a cherry) (2) Faeces, intestinal tissue
Method	(1) ELISA (antigen detection) (2) Realtime PCR (Rotavirus A)
Species	(1) Cattle, camelids (2) All mammals
Duration	1–3 working days
Note	Rotavirus antigen detection is part of the Calf Faecal Profile – Large, Calf Faecal Profile and Camelid Faecal Profile and can only be requested via these profiles.

17.3 Tests for Maldigestion/Malabsorption

A faecal sample the size of a cherry is required.

Bile Acids

Material	Faeces
Method	ELISA
Species	Dog, cat
Test frequency	1 x per week
Note	Bacterial overgrowth of the small intestine or a shortened intestinal passage after surgery can lead to diarrhoea which causes a loss of bile acids. The signs are aqueous diarrhoea or steatorrhoea.

Microscopic Nutritive Digestion

Material	Faeces
Method	Microscopy
Species	Dog, cat
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	This is a semi-quantitative detection of undigested food components, which depends on the type and composition of the diet. Increased excretion of starch, neutral fats, fatty acids and muscle fibres can therefore only indicate a reduced digestive and absorptive capacity (maldigestion or malabsorption). Microscopic Nutritive Digestion is also part of the Dysbiosis Profile for cats (see Chapter 17.1.1, p. 309).

Pancreatic Elastase E1

Material	Faeces
Method	EIA
Species	Dog
Duration	1–2 working days
Note	Canine pancreatic elastase is a functional test used to rule out exocrine pancreatic insufficiency in dogs. Elastase is pancreas-specific, stable in the intestine, and the test results are not altered by a substitution therapy. Pancreatic Elastase is also part of the Dysbiosis Profile (see Chapter 17.1.1, p. 309).

Particle Size	
Material	Faeces
Method	Measurement
Species	Horse
Duration	Reporting of results on the day the sample is received (Mon–Fri)
Note	The particle size provides information about insufficient chewing of the feed components. If any abnormalities are found, a dental examination should be performed. Furthermore, the ration should be checked with regard to the amount of components that are difficult to digest (e.g. excessive feeding of straw) and to structure (e.g. sufficient fibre length).

17.4 Determination of an Inflammatory Exudative Process

For these tests, a faecal sample approximately the size of a cherry is required.

α-1-Antitrypsin	
Material	Faeces
Method	ELISA
Species	Dog
Test frequency	2 x per week
Note	▪ To detect protein loss syndrome ▪ α-1-antitrypsin is also part of the Dysbiosis Profile (see Chapter 17.1.1, p. 309).

Calprotectin	
Material	Faeces
Method	Photometry (immunoturbidimetry)
Species	Dog, cat
Duration	1 working day
Note	▪ Calprotectin is a biomarker used in the diagnosis of acute or chronic inflammatory bowel disease (IBD). It can serve as an additional non-invasive marker to support the diagnosis of IBD. ▪ Calprotectin is also part of the Dysbiosis Profile (dog, cat) (see Chapter 17.1.1, p. 309).

Chemical Detection of Blood	
Material	Faeces
Method	Immunochromatographic detection
Species	Carnivore
Duration	Reporting of results on the day the sample is received (Mon–Fri)

Secretory Immunoglobulin A (sIgA)	
Material	Faeces
Method	ELISA
Species	Dog, cat
Test frequency	Dog: 2 x per week, cat: 1 x per week
Note	▪ Mucosa-associated inflammatory parameter ▪ As part of the adaptive and mucosa-associated immune system, sIgA protects against infections. In chronic inflammatory bowel disease, recurrent infections and atopy, sIgA concentrations may be reduced. Elevated concentrations indicate an increased immune response, e.g. to defend against enteropathogens or food allergens. ▪ Testing for sIgA is also part of the Dysbiosis Profile (see Chapter 17.1.1, p. 309).

Zonulin	
Material	Faeces
Method	ELISA
Species	Dog, cat
Test frequency	1 x per week
Note	For detecting functional disorders of the intestinal barrier

17.5 Microbiome Analysis

The microbiota is the total of all microorganisms that colonise the body surfaces and the inside of an animal. Most of them are located in the colon (10^{11}–10^{12} bacteria/g of faeces). 99.9% of the bacteria that grow under these conditions are anaerobes. The main function of these organisms is the nutrition and protection of the mucous membrane. If there are bacterial imbalances, these tasks can only be fulfilled insufficiently. As a result, colonisation resistance is reduced and increased colonisation with obligatory or facultative pathogens takes place. Due to the reduced barrier function of the mucosa, antigens, endotoxins and histamine, amongst others, can pass from the intestinal lumen into the bloodstream and thus initiate or aggravate pathomechanisms.
As bacterial markers, some bacteria and groups of bacteria indicate a dysbiotic state of the gut.

Dysbiosis Analysis

Material	Faeces
Method	PCR (quantitative)
Species	Dog, cat, horse
Duration	3–5 working days
Note	▪ Key bacteria intestinal microbiome quantitative ▪ Indications for the examination of the microbiome: – chronic diarrhoea, flatulence, constipation – exocrine pancreatic insufficiency, deficiency symptoms – disorders of the immune system (immune deficiency, feed allergies, atopic dermatitis) – inflammatory intestinal diseases (also for therapy monitoring) – leaky gut – loss of performance – diagnosis of microflora dysfunction after antibiotic treatment ▪ It is also possible to perform this test during treatment with synbiotics or probiotics! ▪ For dogs and cats, microbiome analysis is also part of the **Dysbiosis Profile** (see Chapter 17.1.1, p. 309) ▪ The Dysbiosis Analysis can be requested for either dogs/cats or horses via two separate service IDs.

18 Autogenous Vaccine (Autovaccine)

For chronic recurrent bacterial infections, treatment with an autogenous vaccine (autovaccine) is an alternative and promising option. Such treatment also helps to counteract the development of resistance, as it can often reduce or avoid the administration of antibiotics.
Autogenous vaccines are individually produced for each animal from their own aerobic pathogens which are relevant for the infection – a previous culture test with pathogen isolation is required. It is also possible to produce an autovaccine for several animals that show the same signs. The aim of the treatment with autovaccines is to sensitise the immune system to the isolated pathogen(s) and to stimulate the formation of specific antibodies.
Pathogen concentration, application method (see Chapters 18.1 and 18.2) as well as application quantity, intervals and duration depend on the sampling site, clinical history and species.
It should be noted that an autovaccine can only reach its full potential if underlying diseases have been excluded in advance through extensive diagnostics.

Preparation of an autovaccine

Order	Needs to be done in writing. We need a **prescription** from your veterinary practice/clinic for the preparation of this product!
Species	We prepare autovaccines for animals that are **not** used for food production and are not farm animals.
Method	An aerobic microbiological examination is performed of a sample of the affected organ system and the relevant pathogens are isolated. They are multiplied in pure culture, then inactivated and subsequently used to produce the vaccine.
Duration	3 weeks
Delivery	Exclusively to the in-house pharmacy of the veterinary practice

18.1 Autovaccine

Injection Vaccine	
Material	Swab with medium
Note	▪ Indications: chronic skin/ear infections (e.g. Staphylococcus pseudintermedius), respiratory infections ▪ For ordering, species, method and duration, see introduction.

Oral Vaccine	
Material	Faeces (possibly also faecal swab with medium)
Note	▪ Indications: chronic diarrhoea, faecal water syndrome horse ▪ For ordering, species, method and duration, see introduction. ▪ Chronic diarrhoea is one of the indications for microbiome analysis (see Dysbiosis Analysis/Profile in Chapter 17.5, p. 320). For the subsequent preparation of an autovaccine, a previous culture test with pathogen isolation is required.

Vaccine for Inhalation (aerosol vaccine)	
Material	Swab with medium (respiratory tract), BAL, tracheal lavage
Note	▪ Indications: chronic respiratory infections (nasopharyngeal area) ▪ For ordering, species, method and duration, see introduction.

18.2 Combination Vaccine

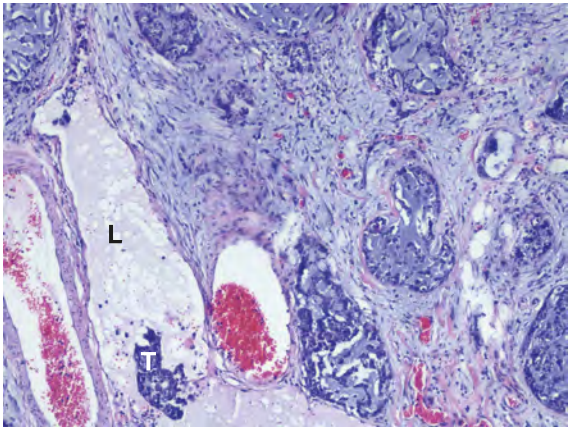
Combination Vaccine (Oral and Injection Vaccine)	
Material	Swab with medium (e.g. vagina), urine
Note	▪ Indications: chronic urogenital infections ▪ For ordering, species, method and duration, see introduction.

19 Pathology

19.1 Histopathology

Endometrial Biopsy (mare)	
Material	1–3 tissue samples approx. 1.0 x 1.0 x 0.5 cm (1 x corpus, 2 x cornua uteri), formalin-fixed (4% neutral buffered formaldehyde ≙ 10% formalin; if there is a risk of freezing, please add a maximum of 10 vol% abs. of alcohol to prevent the sample from freezing)
Method	Microscopy (standard und special stainings)
Duration	3–7 working days
Note	▪ For the following clinical issues: breeding suitability test, barren mare, abortion, etc. ▪ Histological diagnosis of endometritis, endometrosis, angiopathies, (pathological) inactivity, lymphatic lacunae, false differentiations, etc. ▪ Fertility prognosis (categorisation according to Kenney & Doig 1986, mod. according to Schoon et al. 1992) ▪ Endometrial biopsy can also be requested via the standard service Pathology and as a combined service together with Reproductive Fitness and Mycology. In this case, a swab with medium must be submitted in addition to the formalin-fixed sample.

Histopathology	
Material	▪ Formalin-fixed tissue samples (fixation in 4% neutral buffered formaldehyde ≙ 10% formalin; if there is a risk of freezing, please add a maximum of 10 vol% abs. of alcohol to prevent the sample from freezing) ▪ For dermatologic issues use skin punches (≥ 0.6 cm).
Method	Microscopy (standard und special stainings)
Duration	3–7 working days
Note	▪ Fill in the submission form Pathology. ▪ Depending on the sample material, histopathology must be requested separately on the submission forms, based on the effort required: - Examples of histopathology at a basic price (per diagnostic task): tumours (up to 2 sites), skin biopsies, uterine biopsies, organ biopsies up to 3 organs - Examples of histopathology with higher costs: toe, whole organs (e.g. spleen, testicles), 3–5 mammary complexes, biopsies of 4–6 organs, tumour margins/tumour bed biopsies extensive



Histopathology: Malignant mammary tumour in a dog, invasion of tumour cells (T) into a lymph vessel (L). Haematoxylin-eosin staining, 100x magnification.

19.2 Immunohistology

Immunohistology	
Material	Formalin-fixed and/or paraffin-embedded tissue samples
Method	Microscopy (labelling with specific antibodies)
Duration	5–7 working days
Note	**Tumour diagnosis:** ▪ CD3/CD79a/PAX-5 in lymphoma diagnosis ▪ c-KIT expression pattern in mast cell tumours ▪ Ki-67 antigen as proliferation marker ▪ Cox-2, prostaglandin synthesis enzyme, in tumours possibly an indicator of the effectiveness of inhibitors (NSAIDs) ▪ Cytokeratin, vimentin, CD18, melan-A, NSE to differentiate between epithelial/spindle cell/round cell/melanocytic tumours **Infection diagnosis:** ▪ e.g. FIP virus

19.3 Cytology

Cytology	
Material	Aspirate, air-dried smears on slides (SLD) after puncture, impression smears or fine needle aspiration (stained or unstained on slides **without** cover glass)
Method	Microscopy (standard and special stainings)
Duration	2–4 working days
Note	▪ Please send **liquids** (puncture fluids, excretions, secretions) for further clinical chemical examinations native in neutral tubes (also suitable for bacteriology) and additionally in an EDTA tube (superior cell morphology). ▪ Depending on the sample material, cytology must be requested separately on the submission forms, based on the effort required: - Examples of cytology at a basic price: 1 site: up to 4 SLD, 1x liquid/lavage plus 2 SLD - Examples of cytology with higher costs: 1 site: 5–6 SLD, 2 sites up to 4 SLD per site, liquid/lavage plus more than 2 SLD or several liquids ▪ Quick **analysis of digital images** via image upload in **"MyLab"**: To get a veterinary diagnosis, you can upload up to 4 images of a cytological preparation from your practice with your diagnostic task via the image analysis **"Digital Cytology"** in the password-protected area of our "MyLab" website. You will receive the laboratory findings by e-mail, usually on the same day. **Laboklin "MyLab"** – https://app.laboklin.com/imageAnalysis

BAL Profile	
Material	Bronchoalveolar lavage (1 ml), native smear, swab with medium
Method	Cytology, Culture (bacteriology, mycology), Molecular biology: PCR (dog), realtime PCR (cat)
Species	Dog, cat, horse
Duration	2–7 working days
Note	The profile includes cytology, bacteriology and mycology, as well as analysis for mucous membrane-associated mycoplasmas in dogs and Mycoplasma felis in cats.

Body Cavity Effusion Profile (thorax, abdomen)

Material	Liquid (2 ml) + native smear + sediment smear
Method	Cytology, photometry, flow cytometry, Rivalta test (cat)
Species	Dog, cat, horse
Duration	2–4 working days
Note	The profile includes cytology, protein, albumin/globulin ratio, cell count, cholesterol, triglycerides, Rivalta test (cat). Please send puncture fluid for clinical chemical examinations native in a neutral tube (also suitable for bacteriology) and additionally in an EDTA tube (superior cell morphology).

Body Cavity Effusion FIP (thorax, abdomen)

Material	Liquid (2 ml) + native smear + sediment smear
Method	Cytology, photometry, flow cytometry, Rivalta test, realtime PCR
Species	Cat
Duration	2–7 working days
Note	The profile includes cytology, protein, cell count, Rivalta test, albumin/globulin ratio and qualitative coronavirus PCR. Please send puncture fluid native for clinical chemical examinations in a neutral tube (also suitable for bacteriology) and additionally in an EDTA tube (for improved cell morphology).

Bone Marrow Cytology ➢ see Chapter 3.1, p. 40

Cerebrospinal Fluid (CSF) Profile

Material	Liquid (0.7 ml) (+ cytocentrifuged sample, if possible)
Method	Cytology, photometry, flow cytometry
Species	Dog, cat, horse
Duration	2–4 working days
Note	The profile includes cytology, protein, cell count. Please send puncture fluid for clinical chemical examinations native in a neutral tube (also suitable for bacteriology) and additionally in an EDTA tube (superior cell morphology).

Synovia Profile

Material	Synovial fluid (1 ml) + native smear
Method	Cytology, photometry, flow cytometry
Species	Dog, cat, horse
Duration	2–4 working days
Note	The profile includes cytology, protein, cell count.

Please send puncture fluid for clinical chemical examinations native in a neutral tube (also suitable for bacteriology) and additionally in an EDTA tube (superior cell morphology).

Synovia Profile (horse)

Material	Synovial fluid (1 ml) + native smear
Method	Cytology, photometry, flow cytometry
Species	Horse
Duration	2–4 working days
Note	The profile includes cytology, protein, cell count, SAA (serum amyloid A). Please send puncture fluid for clinical chemical examinations native in a neutral tube (also suitable for bacteriology) and additionally in an EDTA tube (superior cell morphology).

Differentiation Exudate/Transudate

Parameter	Low-protein transudate	Exsudate	High-protein (modified) transudate
Colour	colourless/light yellow	bloody/yellowish/ brownish	variable
Transparency	transparent	mostly opaque	cloudy
Protein	< 25 g/l	> 30 g/l	25–75 g/l
Cell count	< 1000/µl	> 5000/µl	1000–7000/µl

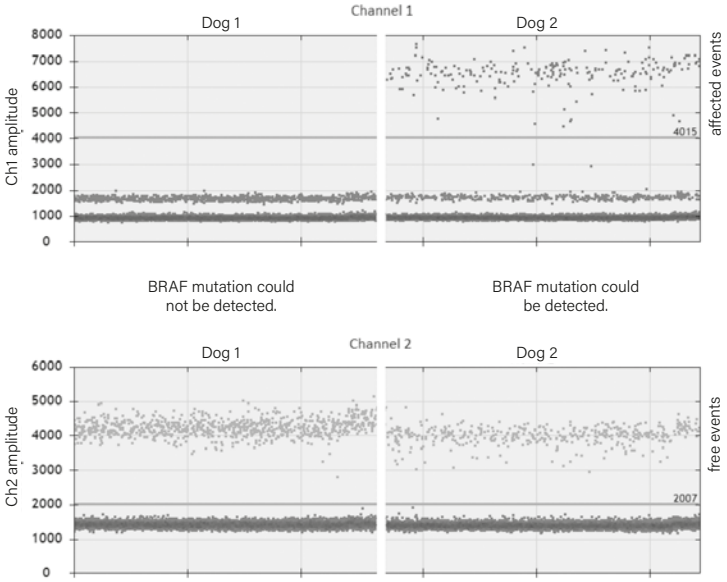
19.4 Lymphocyte Clonality by PARR

Lymphocyte Clonality (PARR)	
Material	Formalin-fixed tissue, paraffin material, air-dried stained or unstained cytological smears on slides **without** cover glass, lymphocyte-rich fluid, EB in case of lymphocytosis, other lymphoid material
Method	PCR for antigen receptor rearrangements (PARR)
Species	Dog, cat
Duration	3–5 working days
Note	This test provides the possibility 1) to confirm a suspected diagnosis (lymphoma/lymphatic leukaemia vs. reactive hyperplasia) and 2) if lymphoma/lymphatic leukaemia is present, to differentiate between T- or B-cell origin. As only a cytological or a histological examination can reliably determine the presence of a lymphocyte population, the respective examinations are highly recommended. With regard to interpretation and limitations, please refer to the literature (e.g. Vet Clin Small Anim 43 (2013) 1331–1347). Furthermore, the results of all pre-examinations as well as the clinical picture should be included in the overall diagnosis (summary probability diagnosis). The examination can be performed on all materials containing a sufficient number of lymphocytes (fixed and unfixed cell material/ tissue/smears/EDTA blood). Cell material can also be obtained directly from the cytological smear (without cover glass) or the histological paraffin block.

19.5 Tumour-genetic Tests

BRAF Mutation Test (V595E)

Material	If urothelial carcinoma (transitional cell carcinoma) is suspected: Urinary sediment (especially early morning urine; fluid + smear) or aspiration cytology (smears) or formalin-fixed, paraffin-embedded tissue (from previous histological examination) If prostate carcinoma is suspected: Smears rich in cells or formalin-fixed, paraffin-embedded tissue (from previous histological examination)
Method	Droplet digital PCR
Species	Dog
Duration	3–5 working days
Note	▪ Detection of BRAF variant V595E. ▪ Indications: - It was not possible to get a reliable histological/cytological diagnosis. - Screening for urothelial carcinoma (transitional cell carcinoma) in certain predisposed terrier breeds (e.g. Scottish Terrier, Fox Terrier, Jack Russell Terrier, West Highland White Terrier) - Difficult patient ▪ Only a positive result is conclusive. ▪ Reasons for negative results: - The urothelial (transitional cell)/prostate carcinoma is not caused by BRAF mutation (approx. 30–50% of these carcinomas – depending on the breed). - There were no mutated cells present in the sample. - It is not a urothelial (transitional cell)/prostate carcinoma. ▪ The test cannot be used for cats.



BRAF diagnosis (V595E) by droplet digital PCR
("Affected events": detection of cells with BRAF mutation;
"free events": detection of cells without BRAF mutation)

BRAF Comp. (V595E + 2 CNA)	
Material	Urinary sediment (especially early morning urine; fluid + smear) or aspiration cytology (smears) or formalin-fixed, paraffin-embedded tissue (from previous histological examination)
Method	Droplet digital PCR and copy number alteration (CNA)
Species	Dog
Duration	2–7 working days
Note	▪ Detection of BRAF variant V595E and detection of copy number alterations (CNAs) 13/19 and 36/19. ▪ Indications: - It was not possible to get a reliable histological/cytological diagnosis. - Screening for urothelial carcinoma (transitional cell carcinoma) in certain predisposed terrier breeds (e.g. Scottish Terrier, Fox Terrier, Jack Russell Terrier, West Highland White Terrier) - Difficult patient ▪ Only a positive result is conclusive.

- Reasons for negative results:
  - It is not a urothelial (transitional cell) carcinoma.
  - The carcinoma does not have copy number alterations/BRAF mutation.
  - There were no or not enough relevant cells present in the sample.
  - There is severe (secondary) inflammation.
- Testing for CNAs is not suitable for prostate cancer.
- The test cannot be used for cats.

BRAF Comp. Subsequent Testing (2 CNA)

Material	See BRAF Comp. (V595E + 2 CNA) (p. 331)
Method	Copy number alteration (CNA)
Species	Dog
Duration	2–7 working days
Note	▪ Detection of copy number alterations (CNAs) 13/19 and 36/19. ▪ Indication: Urothelial carcinoma (transitional cell carcinoma) after negative BRAF mutation analysis (V595E) ▪ Only a positive result is conclusive. ▪ Reasons for negative results: see notes for BRAF Comp. (V595E + 2 CNA)

c-kit Mutation

Material	Formalin-fixed tissue, slide
Method	Sequencing
Species	Dog
Duration	14 working days
Note	▪ Sequencing is performed on exons 8, 9 and 11. ▪ It is tested whether there is a mutation in the c-kit gene. ▪ The higher the histological grade of a cutaneous mast cell tumour (according to Patnaik et al. 1984 or Kiupel et al. 2011), the more likely it is that there is a mutation in the c-kit gene in exon 8, 9 or 11. Detecting the c-kit gene mutation helps to improve prognostic assessment and allows to design an individual treatment plan.

Molecular Genetic Tumour Panel

Material	15 smears rich in tumour cells (not covered), biopsies > 0.5 cm (formalin-fixed), tumour resections (formalin-fixed), paraffin blocks with sufficient tumour material (paraffin rolls or decalcified tissue are not suitable)
Parameter	Analysis of approximately 20,000 genes for mutations
Species	Dog
Method	Next Generation Sequencing (NGS) (VetOmics, Canine CGP®)
Duration	Approx. 3 weeks
Note	Panel for a more precise characterisation of malignant tumours in dogs in selected cases:

Therapeutic indications

- No known or conventional treatment concepts
- (Treatment-resistant) recurrence

Genome-based individualised treatment may potentially offer a new therapeutic option (please pay attention to the European Cascade Rule, if applicable).

Diagnostic indication

- A reliable cytological or (immuno)histological diagnosis was not possible.

The molecular genetic signature can help to further refine the diagnosis (e.g. histiocytic neoplasia versus inflammation), and possibly a therapeutic option may also be identified.

Results (findings provided in English)

- Summary of molecular genetic results
- Explanations and literature references on the biomarkers found
- Specification of the tumour mutation burden to predict response to checkpoint inhibitors (e.g. PD-1, PDL-1 inhibitors, APAVAC)
- Suitable drugs for individualised tumour treatment are suggested, along with dosages and information on the level of evidence.
- If required, further advice on the treatment options identified is provided directly by the oncologists in the USA via email (in English).

Limitations

- A sufficient number of tumour cells and DNA quality are required.
- It is not always possible to isolate DNA in sufficient quantity and quality.
- It is not always possible to find mutations that open up therapeutic options.
- The availability and costs of medication may vary between countries.
- The drugs may not be approved for dogs in all countries.

- The efficacy of the medication in dogs is supported by varying degrees of evidence.
- Data on effectiveness and side effects in the respective canine tumours is often incomplete.

The decision and responsibility for using the medication listed in the findings lies with the veterinarian in charge!
It is recommended to consult a specialised oncologist in such cases.

19.6 Publication on the Subject of Pathology

Book "Diagnostic Colour Atlas of Bee Pathology"

With this bilingual book (German/English), **PD Dr. Heike Aupperle** and **Prof. Dr. Elke Genersch** have created a new standard work for all those interested in bees, bee diseases and the (functional) anatomy of bees. The atlas with more than 350 full-colour images is a reference work for pathologists, scientists, students and interested bee-keepers when it comes to diagnosing diseases of all developmental stages of bees. The book was published by Laboklin in 2016.

20 Sex Determination

Our method for sex determination is based on the polymerase chain reaction (PCR). It allows us to determine the sex quickly and reliably using only small amounts of genetic sample material.

20.1 Sex Determination in Mammals

Which sample material is suitable?

Sex determination can be done by using blood, swabs, or hairs with roots. Suitable samples are plucked hairs (about 10 hairs with follicles), EDTA blood, and, to a limited extent, mucosal swabs (buccal swabs).
To ensure accurate analysis, the sample must not be contaminated with foreign DNA. It is important to label the samples in such a way that the animals can be clearly identified.

Which animal species can be tested?

Information on animal species will be provided on request. Please contact us before submitting your sample. Our friendly staff will be happy to assist you.

20.2 Sex Determination in Birds

The PCR assay is based on the replication of two highly conserved target genes, which makes it possible to examine many different species.
The method carried out by us provides double safety: During PCR, one probe specifically binds to the "female" sequence, while the other one binds to the "male" sequence, if these are present. This way, there will be one sex confirmed and the other sex excluded.

Which sample material is suitable?

Sex determination can be done by using either blood or quills. One to three drops of whole blood (preferably EB) are sufficient. They can be collected in suitable micro capillary tubes or applied dropwise to a filter card. Filter cards/blood cards should be completely dry before shipment.
Alternatively, 2–3 quills are required from feathers freshly plucked under anaesthesia (breast feathers, no wing or tail feathers). Lost feathers and down feathers are not suitable for the test.

To ensure a correct analysis, the sample must not be contaminated with foreign DNA. For this purpose, please wear gloves when sampling or wash your hands after each sample you take. Please pack feathers separately for each bird. For "dry" feathers, it is sufficient to use an envelope or a small paper bag, "wet" feathers can, for example, be packed in blood or urine tubes or in standard freezer bags. Additionally, we offer so-

called SampleKits for submitting feather samples or blood cards. You can request them free of charge. It is important to label the samples in such a way that the animals can be clearly identified. If available, please mark the samples with the ring or chip number of the bird.

Which bird species can be tested?

We have performed sex determination tests for several years and thus have already tested many different bird species. Only after we tested a female and a male bird of a species, we give clearance for routine diagnostics. In some species, PCR differentiation is not possible. We will be pleased to provide you with information on which bird species we test.
It is **essential to specify the exact bird species** when submitting the samples.

20.3 Sex Determination in Snakes

PCR testing for sex determination in snakes detects a specific gene sequence on the W chromosome of females, which is absent in males, as they lack a W chromosome.

Which sample material is suitable?

Sex determination can be performed using various materials. Fresh shed skins are preferred. They must be dry and should ideally contain no residues of, for example, substrate. It may also be possible to use mucosal swabs and EDTA blood samples; please enquire separately about these options.
To ensure accurate analysis, the sample must not be contaminated with foreign DNA. Therefore, please wear gloves when taking samples or wash your hands before each collection. Please pack the shed skins for each snake individually, ideally in sealable plastic bags. It is important to label the samples in such a way that the animals can be clearly identified.

Which snake species can be tested?

We have already validated our test for more than 100 species. Please contact us to request information on which snake species can be examined. It is **essential to specify the exact snake species** when submitting the samples.

21 Hereditary Diseases/Phenotype/ Breed Characteristics

Individual Tests and Packages

In addition to the individual tests, we also offer various breed-specific packages covering hereditary diseases and coat traits in dogs, cats and horses. These packages provide excellent value for money and can be used to request several diseases and genetic traits in a compact format. The package combinations are continuously adapted to new findings. You will always find the latest and most suitable packages on our website laboklin.com in the section Services/Genetics.

Furthermore, dogs of any breed can be tested for known hereditary diseases within the respective symptom complex using our **Symptom Complex Combinations** (anaemia, respiratory diseases, endocrinopathy, dermatology).
For more information on **Symptom Complex Combinations,** please refer to the Catalogue of Prices and Services or visit the Laboklin website.

If you would like to get a comprehensive overview of the genetic status of your dog or your cat, our **LABOGenetics XXL** packages offer extensive, cost-effective screening for hereditary diseases, genetic risk factors and coat colours/traits.

LABOGenetics XXL cat ➢ **see Chapter 21.3.3, p. 439**

LABOGenetics XXL dog ➢ **see Chapter 21.2.4, p. 425**

21.1 Heredities

Autosomal recessive inheritance
Carriers (N/mut) do not fall ill themselves, but each of them passes on the defective gene to their offspring with a probability of 50%. If two carriers are mated, there is a probability of 25% that one of the offspring will be affected (mut/mut; carriers 50%, free (N/N) 25%). Recessively inherited diseases can spread within the population without clinical manifestation.

X-linked recessive inheritance
The defective gene is located on a sex chromosome. Heterozygous female animals (X_n/X_{mut}) are carriers, male carriers (X_{mut}/Y) express the disease.

Autosomal dominant inheritance with incomplete penetrance
Heterozygous carriers also show signs of the disease, although the degree of severity varies.

Autosomal dominant inheritance
Heterozygous carriers also show signs of the disease.

21.2 Dog

21.2.1 Hereditary Diseases

Acatalasaemia

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Beagle
Inheritance	Probably autosomal recessive
Duration	3–5 working days

Disease

Acatalasaemia is caused by the absence of the enzyme catalase which is important for cellular defence in oxidative stress. Affected dogs suffer from tissue necrosis in the mouth.

Achromatopsia/Day Blindness (ACHM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Shepherd, Labrador Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

ACHM is a disease in which the cone cells of the retina, which are responsible for colour and daylight vision, are not developed properly. Initial signs of day blindness are noticeable in affected dogs from 8–10 weeks of age. In low light conditions, their visual function is comparable to healthy dogs.

Acral Mutilation Syndrome (AMS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay or sequencing (German Spitz)
Breed	English Cocker Spaniel, English Pointer, English Springer Spaniel, French Spaniel, German Short-haired Pointing Dog, German Spitz
Inheritance	Autosomal recessive
Duration	3–5 working days or sequencing 1–2 weeks (German Spitz)

Disease

AMS is characterised by a sensory neuropathy of the peripheral parts of the body. Affected puppies show an insensitivity to pain in their distal extremities and begin to lick, bite or injure themselves on the paws and toes at around 4 months of age.

Acute Respiratory Distress Syndrome (ARDS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dalmatian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In Dalmatians, a familial juvenile respiratory disease similar to ARDS in humans was found. The clinical signs are tachypnoea, dyspnoea and pulmonary lesions. Some affected puppies also showed renal aplasia and hydrocephalus. The first signs of the disease typically appear at 5–10 months; these puppies usually have to be euthanised 1–6 weeks later.

Afibrinogenaemia (AFG)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dachshund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A genetic variant of the fibrinogen alpha chain gene (FGA) is associated with afibrinogenaemia. In the absence of the coagulation factor I (fibrinogen), it can result in prolonged clotting, bleeding of the mucous membranes or in joints as well as in haematomas. Severe haemorrhage may occur after surgery, injuries or even spontaneously. Affected dogs have extremely prolonged clotting times in various coagulation tests (PT, PTT, TT); however, the activity of factors II, V, VII and X and the platelet count are normal.

Alaskan Husky Encephalopathy (AHE)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Husky
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

AHE is a disease that is already fatal in puppies. Affected dogs mainly show behavioural disorders and central nervous deficits such as dysphagia, lack of responsiveness and analgesia, blindness, movement and coordination disorders as well as ataxia and paralysis.

Alaskan Malamute Polyneuropathy (AMPN)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Alaskan Malamute
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

AMPN is a neurological disease which leads to progressive muscle weakness and exercise intolerance as well as signs of paralysis and respiratory problems at a later stage.

Alexander Disease (AxD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Labrador Retriever
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

In Labrador Retrievers, Alexander disease causes progressively worsening tetraparesis with a spastic posture of the thoracic limbs and a flattened chest. Later on, myoclonic jerks at the head and the cervical region, absent patellar reflexes, weakness of the four limbs and mild generalised muscle atrophy may become apparent.

Amelogenesis Imperfecta/Familial Enamel Hypoplasia (AI/FEH)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Akita, American Akita, Italian Sighthound) Sequencing (Parson Russell Terrier, Samoyed)
Breed	Akita, American Akita, Italian Sighthound, Parson Russell Terrier, Samoyed
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay 3–5 working days Sequencing 1–2 weeks

Disease

AI is a hereditary enamel hypoplasia. Affected animals have small, pointed teeth with thin, brown enamel.

Behaviour Propensity

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Belgian Shepherd (only Malinois)
Inheritance	See information below
Duration	1–2 weeks

Disease

The Malinois is a variety of the Belgian Shepherd. In addition to the provoked form of aggression ("targeted aggression") aimed at in their training, unpredictable, episodic aggression is reported. This undesired aggression happens for no apparent reason and is completely unpredictably; these dogs no longer react to any external influences and cannot be controlled. A correlation was found between undesirable aggression and the dopamine transporter gene SLC6A3: allele A22 occurs more frequently. According to their owners, Malinois with the genotypes A0/A22 or A10/A22 more often show undesired aggression. Genotype A22/A22 was found to be particularly common in extreme behavioural problems.

Brachyuria (stumpy tail)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Australian Shepherd, Australian Stumpy Tail Cattle Dog, Austrian Pinscher, Bourbonnais Pointing Dog, Bouvier des Ardennes, Brazilian Terrier, Brittany Spaniel, Croatian Sheepdog, Danish-Swedish Farmdog, Jack Russell Terrier, Karelian Bear Dog, Miniature American Shepherd, Mudi, Polish Lowland Sheepdog (PON), Pyrenean Sheepdog, Savoy Sheepdog, Schipperke, Spanish Water Dog, Swedish Vallhund, Welsh Corgi Cardigan, Welsh Corgi Pembroke
Inheritance	Autosomal dominant
Duration	3–5 working days

Disease

Particularly the tail length gives many dog breeds their characteristic look. In most countries, docking a dog's tail is forbidden. Exhibiting and participating in events where these dogs are compared, tested or judged is also no longer permitted under the Animal Welfare Dog Ordinance in some countries. DNA analysis now allows to confirm whether the stumpy tail is of natural origin.

C3 Deficiency (C3)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Brittany Spaniel
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The third component of the complement system (C3) plays an important role in the body's immune defence against microorganisms such as bacteria, fungi or parasites. The causative mutation in the C3 gene prevents the complete formation of C3 and interrupts the defence cascade. Affected dogs exhibit higher susceptibility to bacterial infections, e.g. glomerulonephritis.

Canine Leukocyte Adhesion Deficiency (CLAD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Irish Red and White Setter, Irish Red Setter
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

CLAD is a hereditary immune deficiency that is usually fatal. Clinical signs include various inflammatory lesions and unsteady gait.

Canine Multi-focal Retinopathy (CMR1/2/3)

Material	EB 1 ml, buccal swab
Method	Sequencing (Finnish Lapphund, Lapponian Herder, Swedish Lapphund) or TaqMan SNP assay (all the other breeds listed below)
Breed	American Bulldog, Australian Shepherd, Boerboel, Bullmastiff, Coton de Tuléar, Dogue de Bordeaux, English Bulldog, Finnish Lapphund, French Bulldog, Italian Cane Corso, Lapponian Herder, Mastiff, Miniature American Shepherd, Presa Canario, Pyrenean Mountain Dog, Swedish Lapphund
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay 3–5 working days Sequencing 1–2 weeks

Disease

CMR is an inherited disease which causes multiple lesions of the retina. First signs typically appear at the age of four months. In some cases, the lesions of the retina disappear for some time and occur again at a later point in time. Impaired vision or sight disorders are not described in affected dogs.

Canine Multiple System Degeneration (CMSD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Chinese Crested Dog, Kerry Blue Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Animals affected by CMSD show normal development up to an age of 3–6 months. After that, symptoms such as cerebellar ataxia and movement disorders become apparent. Most dogs must be euthanised at 1–2 years of age.

Cardiomyopathy with Juvenile Mortality (CJM)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Belgian Shepherd (all varieties: Groenendael, Laekenois, Malinois, Tervueren)
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease

In the Belgian Shepherd, a genetic variant in the tyrosyl-tRNA synthetase gene (YARS2) correlates with a form of mortality in puppies. CJM manifests itself through non-specific signs (vomiting, movement disorders, respiratory problems) at the latest at the age of 6–8 weeks. The animals usually die of heart failure within a few days. Carriers should only be mated with dogs that do not carry this variant.

Centronuclear Myopathy (CNM)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (German Hunting Terrier, Great Dane) FLP (Labrador Retriever)
Breed	German Hunting Terrier, Great Dane, Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days (German Hunting Terrier, Great Dane) 1–2 weeks (Labrador Retriever)

Disease

If Labrador Retrievers or Great Danes suffer from CNM, the dog's muscles do not develop properly. Affected dogs lack tendon reflexes and gain less weight than puppies of the same age (at 4 weeks). From an age of approximately 12 to 20 weeks onwards, muscular weakness, abnormal posture, clumsy gait and feeding difficulties appear.
In German Hunting Terriers, the disease is also called Exercise Induced Metabolic Myopathy (EIMM). EIMM is caused by a deficiency of acyl-CoA dehydrogenase (VLCAD) and therefore of the fatty acid oxidation (insufficient energy production). During or after exertion, affected dogs suffer from weakness up to collapse, severe muscle pain, muscle cell necroses and myoglobinuria from an age of 7–24 months onwards. About 30–120 minutes after physical exertion, they can develop tetraparesis or tetraplegia. Increased levels of CK, ALT and the long-chain fatty acid C14:1 can be detected.

Cerebellar Ataxia (CA)

Material	EB 1 ml, buccal swab
Method	Partner laboratory
Breed	Spinone Italiano
Inheritance	Autosomal recessive
Duration	4–6 weeks

Disease
CA is a progressive disease of the cerebellum caused by a mutation in the ITPR1 gene, which codes for a calcium channel and is involved in synaptic transmission. Typical signs of the disease are hypermetria and hyperextension, uncoordinated movements, impaired balance, tremor of the head as well as nystagmus. Gait disorders normally begin at 4 months of age; on average, affected dogs are no longer able to stand up at the age of one year and have to be euthanised.

Cerebellar Ataxia (CA1)

Material	EB 1 ml, buccal swab
Method	FLP (Belgian Shepherd) Sequencing (Pyrenean Mountain Dog)
Breed	Belgian Shepherd, Pyrenean Mountain Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
In Belgian Shepherds, CA1 is caused by a variant in the RALGAPA1 gene. A cerebellar dysfunction leads to a wide-based stance, ataxic and hypermetric gait, as well as stumbling, unsteadiness and tremor of the head. There are slight proprioceptive deficits. CSF and blood are unremarkable. The first signs of CA1 appear at around 4 weeks of age. The disease is usually progressive leading to euthanasia even in puppies. In other cases, dogs reach adulthood without any worsening of the symptoms.
In Pyrenean Mountain Dogs, CA1 is caused by a variant of the SACS gene. The first signs appear at around 4 months of age: difficulty walking on slippery surfaces, clumsiness and uncoordinated movements. Affected animals like to lean on things, lie down a lot (even when eating) and are reluctant to use stairs. The disease is slowly progressive with neuromuscular weakness as the predominant sign. MRI shows cerebellar hypoplasia. The animals are usually euthanised at 4–7 years of age.

Cerebellar Degeneration – Myositis Complex (CDMC)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Nova Scotia Duck Tolling Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
CDMC is caused by a mutation in the SLC25A12 gene. In affected dogs, the first signs appear between 10 weeks and 6 months of age. Clinical signs include generalised ataxia, hypermetria, delayed movements and reduced withdrawal reflexes in all four limbs. One affected dog also showed head tremor, others suffered from generalised muscle weakness with episodic collapse, stiff-legged gait and "bunny hopping". MRI findings showed bilateral symmetrical lesions in the cerebellum and multifocal lesions in the masticatory muscles. Biopsies detected lymphohistiocytic myositis and serum CK elevation.

Cerebellar Hypoplasia (CH)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	White Swiss Shepherd Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A mutation in the RELN gene which causes cerebellar hypoplasia (CH) was detected in White Swiss Shepherd Dogs. Affected puppies showed no clinical signs at birth, then they stopped gaining weight and progressive ataxia developed from around 2 weeks of age. They were euthanised at 4 weeks of age. Post-mortem examination revealed anatomical abnormalities in the brain, including severe cerebellar hypoplasia with lissencephaly (congenital lack of brain folds) and moderate internal hydrocephalus with enlarged lateral ventricles and fourth ventricle.

Cerebral Dysfunction (CDFS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Stabijhoun
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease

CDFS in the Stabijhoun breed is an inherited disease of the brain.
Clinically affected animals exhibit a large variety of neuronal signs such as depressive behaviour, walking circles, obsessive sniffing and running backwards.

Charcot-Marie-Tooth Neuropathy (CMT)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Miniature Schnauzer) Sequencing (Lancashire Heeler)
Breed	Lancashire Heeler, Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

In the Miniature Schnauzer, the neuromuscular disease CMT leads to changes in the myelin sheath of the axons of peripheral nerves due to a variant in the SBF2 gene (also called MTMR13 gene). Affected dogs show frequent regurgitation and respiratory difficulties at a young age (< 2 years) caused by megaoesophagus and laryngeal paralysis. They have a relatively long survival after diagnosis.
In the Lancashire Heeler, a variant of the ITPR3 gene is associated with CMT. The predominant signs are amelogenesis imperfecta with enamel hypoplasia, discolouration, severe abrasion up to exposed dentine. Peripheral neuropathy is also possible though

it is subclinical. Neurogenic changes in the muscles, especially distal to the elbow and knee joints, correspond to the findings of demyelinating neuropathy. However, the animals show normal locomotion and activity levels.

Chondrodysplasia (dwarfism)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Chinook, Karelian Bear Dog, Norwegian Elkhound
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Chondrodysplasia is a genetically determined skeletal dysplasia which leads to malformations in the structure of the long bones and dwarfism. In addition to shortened limbs, clinical signs include a large skull, spine changes and deformations of the legs.

Chondrodysplasia and -dystrophia (IVDD risk) (CDDY & CDPA)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	All, particularly short-legged breeds
Inheritance	Autosomal dominant for CDPA, semi-dominant for CDDY-related leg length, dominant for IVDD risk
Duration	1–2 weeks

Disease

Breed-specific short limbs can be caused by chondrodystrophy (CDDY) and/or chondrodysplasia (CDPA). Only CDDY is associated with an increased **risk of a herniated disc** (Hansen's Type I Intervertebral Disc Disease, IVDD).
CDDY is semi-dominantly inherited with regard to leg length, i.e. heterozygous dogs have shorter legs than homozygous free dogs, while homozygous affected dogs have even shorter legs than the heterozygous dogs. The IVDD risk is inherited as an autosomal dominant trait, which means that already one copy of the altered chromosome significantly increases the risk.

Cleft Lip/Palate and Syndactyly (CLPS + CP1)

Material	EB 1 ml, buccal swab
Method	FLP (CP1) and TaqMan SNP assay, if necessary sequencing (ADAMTS20)
Breed	Nova Scotia Duck Tolling Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

There are two different genetic causes of cleft palate in the Nova Scotia Duck Tolling Retriever: a variant in the CP1 gene and another variant in the ADAMTS20 gene. Affected puppies have difficulty nursing and a high risk of aspiration pneumonia. They may also exhibit brachygnathia. In dogs with the ADAMTS20 variant, syndactyly of the middle toes may be an additional clinical sign.

CNS Atrophy with Cerebellar Ataxia (CACA)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Belgian Shepherd
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

CACA is caused by a deletion of the SELENOP gene for selenoprotein P, which is responsible for selenium transport to the brain and tissues. Selenium deficiency in the brain causes uncoordinated movements, intention tremor, spastic fits, increased muscle tone and a reduced swallowing reflex. These neurological signs can be observed in varying intensity from the age of about 2 weeks onwards and either result in early euthanasia or are mild.

Collie Eye Anomaly (CEA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Australian Kelpie, Australian Shepherd, Bearded Collie, Border Collie, Boykin Spaniel, Collie (rough/smooth), Hokkaido, Lancashire Heeler, Silken Windsprite (Long-haired Whippet), Miniature American Shepherd, Nova Scotia Duck Tolling Retriever, Shetland Sheepdog (Sheltie), Silken Windhound
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

CEA leads to changes in the retina of the eye and can manifest itself in different degrees of severity. In the most severe form of CEA, blood vessel changes cause retinal haemorrhage, which can lead to retinal detachment and blindness in the dog.

Colour Dilution and Neurological Defects (CDN)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dachshund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
In Dachshunds, a variant in the MYO5A gene has been found which causes CDN and resembles human Griscelli syndrome type I. Myosin VA-mediated transport plays an important role in neurons, the cerebellum and in the transport of melanosomes into growing hair shafts.
An affected 4-week-old puppy had noticeably pale fur, was unable to hold itself in a prone position and showed rowing movements in the lateral position. It could neither maintain an upright head position nor coordinate head movements. The puppy also hardly reacted to environmental stimuli and was euthanised. The histopathological findings were a multifocal accumulation of melanin and a deposition of clumped keratin in the follicular epithelium of hairy skin.

Cone Degeneration (CD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Short-haired Pointing Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
In CD, a mutation in the CNFB3 gene is responsible for the degeneration of the cone cells of the retina already at puppy age. This results in day blindness. Affected dogs avoid exposure to light, and bright light may even be painful. With increasing age, the degeneration of the cone cells progresses.

Congenital Hypothyroidism (CHG)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (French Bulldog) Sequencing (all other breeds)
Breed	Fox Terrier, French Bulldog, Rat Terrier, Spanish Water Dog, Tenterfield Terrier, Toy Fox Terrier
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease
Affected dogs usually die a few days after birth. Administration of hormones can prolong the life span, but the dogs still suffer from dwarfism and goitre formation.

Congenital Ichthyosis

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Great Dane
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
So far, lamellar ichthyosis is only known in Great Danes. In the course of the disease, the skin becomes dry and loses its elasticity, resulting in a generally wrinkled appearance particularly in the head area. In addition, affected puppies may develop severe swelling of the eyelids. The skin changes in the area of the folds enhance the risk of secondary infections.

Congenital Idiopathic Megaoesophagus (CIM) – Risk Analysis

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Shepherd
Duration	1–2 weeks

Disease
Megaoesophagus is characterised not only by dilation of the oesophagus but also by reduced peristalsis. Affected dogs regurgitate food and water so that puppies fail to thrive. German Shepherds have a high risk of CIM; factors that play a role include gender (the risk is twice as high in male dogs) as well as a genetic variant (especially in the homozygous state).

Congenital Mirror Movement Disorder 1 (CMM1)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Weimaraner
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
In CMM1, the nerve pathways in the spinal cord are defective. Affected puppies cannot control their hind legs and therefore hop like a bunny ("bunny hopping syndrome"). According to current knowledge, there is no improvement in the puppies' development, so this disease usually leads to euthanasia.

Congenital Myasthenic Syndrome (CMS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Golden Retriever, Heideterrier, Jack Russell Terrier, Labrador Retriever, Old Danish Pointing Dog, Parson Russell Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
The main sign of CMS is a generalised muscle weakness, especially after stress or excitement. It can already be seen at just two weeks of age. Mobility of all limbs is severely limited, even the ability to carry the own body weight diminishes over time. In all areas of the limbs, reflexes are significantly reduced.

Congenital Stationary Night Blindness (CSNB)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary FLP
Breed	Briard
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of FLP

Disease

In affected dogs, night vision is already severely impaired at a few weeks of age; after a few years, some dogs also develop reduced daylight vision.

Copper Storage Disease (CT/COMMD1) in the Bedlington Terrier

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Bedlington Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Copper toxicosis in Bedlington Terriers is caused by a disorder of copper metabolism which leads to an accumulation of copper in the liver and other organs. A genetic variant in the COMMD1 gene causes dysregulation of copper concentrations in the liver cells, resulting in inflammation, fibrosis and liver cirrhosis. Affected dogs suffer from reduced appetite, excessive thirst, vomiting, weight loss, jaundice, ascites and neurological abnormalities. The release of copper into the blood can also lead to haemolytic anaemia. Possible therapeutic approaches include: liver diet with reduced copper content, chelation therapy, the intake of zinc or, if necessary, a combination of several treatment approaches.

Copper Storage Disease (CT) in the Dobermann and Labrador Retriever

Material	EB 1 ml, buccal swab
Method	Partner laboratory
Breed	Dobermann and Labrador Retriever
Inheritance	See note
Duration	1–2 weeks

Disease

In Labrador Retriever and Dobermann breeds, a variant in the copper-transporting ATP7B-ATPase gene leads to reduced copper excretion resulting in excessive copper storage in the liver and other organs. Usually, signs only appear in middle-aged or older dogs. Inheritance is autosomal dominant with incomplete penetrance. Dogs with 2 mutant alleles are normally more severely affected than heterozygous animals, but may also be asymptomatic throughout their lives.
In Labrador Retrievers, the risk of contracting the disease may be reduced: A second mutation – in the ATP7A-ATPase gene – leads to reduced accumulations of copper. As this second variant is inherited in an X-linked dominant manner with incomplete

penetrance, female dogs are more likely to have the disease, since the second mutation often only affects the metabolism if it is homozygous, whereas in male dogs, one copy of this gene variant is sufficient.
This second mutation was also identified in Dobermanns, but so far, no correlation with the hepatic copper concentration has been detected.

Craniomandibular Osteopathy (CMO)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Cairn Terrier, Scottish Terrier, West Highland White Terrier
Inheritance	Autosomal dominant with incomplete penetrance
Duration	3–5 working days

Disease
CMO is a painful proliferative disease of the jaw bones affecting dogs in the first year of life. Clinical signs of the disease are recurrent episodes of fever and painful mandibular swelling.

Cystinuria

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Continental Bulldog, English Bulldog, French Bulldog, Landseer, Mastiff, Newfoundland, Olde English Bulldog) Sequencing (Labrador Retriever, Miniature Pinscher) FLP (Australian Cattle Dog)
Breed	Australian Cattle Dog, Continental Bulldog, English Bulldog, French Bulldog, Labrador Retriever, Landseer, Mastiff, Miniature Pinscher, Newfoundland, Olde English Bulldog
Inheritance	Autosomal recessive Autosomal dominant in Australian Cattle Dog, Miniature Pinscher
Duration	3–5 working days (Continental Bulldog, English Bulldog, French Bulldog, Landseer, Mastiff, Newfoundland, Olde English Bulldog) 1–2 weeks (Australian Cattle Dog, Labrador Retriever, Miniature Pinscher)

Disease
A transport disorder of dibasic amino acids in the kidney leads to the formation of cystine calculi.

Dandy-Walker-like Malformation (DWLM)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Eurasian
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Dogs affected by DWLM suffer from underdevelopment of the cerebellum, which is already noticeable in puppies. Depending on the severity, ataxia, spontaneous falling, and even severe epileptic seizures may occur.

Degenerative Encephalopathy (DE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Nova Scotia Duck Tolling Retriever
Inheritance	Autosomal recessive (risk factor)
Duration	1–2 weeks

Disease
A genetic variant in the RB1CC1 gene has been identified as a risk factor for this slowly progressive neurological disease. It is characterised by degenerative changes in several brain regions with intraneuronal inclusions, similar to lysosomal storage disease. The age of onset of the first clinical signs ranges from 2 months to 5 years of age, with the signs worsening as the disease progresses. Affected dogs show cognitive impairment, anxiety, a low sensory threshold, compulsive or later aggressive behaviour, gait abnormalities as well as urinary and faecal incontinence.

Degenerative Myelopathy (DM) (Exon 1 and 2)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All (exon 2) Bernese Mountain Dog (exon 1+2)
Inheritance	Autosomal recessive with age-dependent incomplete penetrance; a major risk factor (mutation in the SOD1 gene), which is associated with DM, is detected.
Duration	3–5 working days

Disease
The disease is characterised by a degeneration of the axons and the myelin in the thoracic and lumbar part of the spinal cord causing progressive ataxia and paresis. The test detects a mutation which is considered the main risk factor for this disease.
DM exon 2: Laboklin owns the exclusive license to perform this genetic test.

Degenerative Myelopathy – Risk Modifier (DMRM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Welsh Corgi Pembroke
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

In the Welsh Corgi Pembroke, a risk haplotype (risk modifier) has been identified in the SP110 gene which further increases the risk of developing degenerative myelopathy (DM) in dogs homozygous for the SOD1 variant (see DM Exon 1 and 2 above). DMRM influences the overall risk of developing DM and also the age of onset of the first signs. Testing for DMRM is only useful in dogs that have previously been tested as homozygous for the SOD1 risk factor.

The risk haplotype has also been identified in other breeds. However, it is still unknown whether it also influences the development of DM in SOD1-affected dogs of other breeds.

Delayed Postoperative Haemorrhage (DEPOH)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	English Springer Spaniel, Greyhound, Magyar Agar, Scottish Deerhound, Welsh Springer Spaniel
Inheritance	Autosomal dominant with incomplete penetrance (Greyhound, Magyar Agar, Scottish Deerhound) Autosomal recessive (English Springer Spaniel, Welsh Springer Spaniel)
Duration	1–2 weeks

Disease

A variant in the SERPINF2 gene in the Greyhound, Magyar Agar and Scottish Deerhound is associated with an increased risk of delayed postoperative haemorrhage 1 to 4 days after surgery. Signs range from frank bleeding from the wound to severe bruising around the wound and haemoabdomen. Prothrombin time, partial thromboplastin time, von Willebrand antigen as well as the platelet count were unremarkable.

In English Springer Spaniels and Welsh Springer Spaniels, a genetic variant in the SERPINE1 gene is associated with a tendency towards post-operative haemorrhage due to hyperfibrinolysis. In addition to delayed, prolonged bleeding after surgical procedures or trauma, spontaneous haemorrhage may also occur in the abdominal cavity or subcutaneous tissue as well as the formation of haematomas.

Dental-skeletal-retinal Anomaly (DSRA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Italian Cane Corso
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

DSRA is the result of a defect in the MIA2 gene and is characterised, among others, by dental problems (discolouration, chips and fractures, smaller teeth than normal), skeletal problems and progressive retinal atrophy (PRA). Further manifestations and pathogenesis are subject of current research.

Dermatomyositis (DMS)

Material	EB 1 ml, buccal swab
Method	2 x TaqMan SNP assay + sequencing
Breed	Collie (rough/smooth), Shetland Sheepdog (Sheltie)
Inheritance	Polygenic
Duration	1–2 weeks

Disease

DMS is an autoimmune disease that causes skin lesions (hair loss and crusts) in Collies and Shetland Sheepdogs and can be detected histologically (biopsy). Only in Collies, additional muscular dysfunctions (difficulty to swallow, a high and stilted gait with muscular atrophy in the head and neck area) have been described. The complex genetic trait needs an additional external trigger like vaccination or viral infection to cause signs of the disease. Based on genotype combinations of three different loci (A, B, C), the likelihood of developing DMS can be classified. Breeding puppies with genotypes that have a high risk (especially: AABBCC, AaBBCC, AABbCC, AABBCc) should be avoided wherever possible. Genotypes with moderate risk are AAbbCC, AAbbCc, aaBBCC, AaBBCc, AABbCc; those with low risk are aabbCC, aabbCc, AabbCC, AabbCc, aaBbCC, aaBbCc, AaBbCC, AaBbCc, aaBBCc.

Dermoid Sinus (DS) – Risk Assessment

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Rhodesian Ridgeback
Inheritance	Marker test, for risk assessment see information below
Duration	3–5 working days

Disease

A DS is a tube-like invagination of the skin along the dorsal midline, less commonly in the cranial region, which varies in depth, sometimes extending as far as the spine. It can be palpated as a strand-like structure when the skin is lifted. The DS is filled with hair and sebum and does not cause any impairment as long as it does not become inflamed. The genetic test offered by Laboklin includes two genetic markers which – depending on the marker constellation present (nine possible combinations) – may be associated with an increased risk of DS.

Dermoid Sinus – Risk Assessment of the Different Genotype Combinations

The table shows which matings will not carry the risk genotype TTCC (marked in green). In the matings shown in red, some or all of the puppies may carry the risk genotype.

Digital Hyperkeratosis (DH/HFH)	
Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Dogue de Bordeaux, Irish Terrier, Kromfohrländer
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

This disease, which is also called "corny feet", manifests itself a few months after birth as excessive keratin formation on the foot pads, which can lead to skin cracks and subsequently to secondary infections at these sites. Nail growth is also often accelerated.

Dilated Cardiomyopathy (DCM) in the Schnauzer and Giant Schnauzer	
Material	EB 1 ml, buccal swab
Method	FLP
Breed	Giant Schnauzer, Schnauzer
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

DCM is caused by different mutations in different breeds. In the Schnauzer, a variant in the RBM20 gene was identified which correlates very well with DCM. In this breed, the first signs typically appear at the age of 1–3 years. DCM can lead to sudden cardiac death even without any previous clinical signs.

Dilated Cardiomyopathy (DCM) in English Toy Terrier, Manchester Terrier, Nova Scotia Duck Tolling Retriever and Welsh Springer Spaniel

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	English Toy Terrier, Manchester Terrier, Nova Scotia Duck Tolling Retriever, Welsh Springer Spaniel
Inheritance	Autosomal recessive (English Toy Terrier, Nova Scotia Duck Tolling Retriever, Manchester Terrier) Autosomal dominant with incomplete penetrance (Welsh Springer Spaniel)
Duration	1–2 weeks

Disease

In the Welsh Springer Spaniel, a genetic variant in the phospholamban gene is associated with DCM. Phospholamban plays an important role in regulating the intracellular calcium concentration. Typical findings of DCM are enlargement of the left ventricle, poor systolic function, cardiac arrhythmia and sudden cardiac death. In Welsh Springer Spaniels, DCM penetrance is very high, which is why almost all carriers of the variant show signs by the age of 20 months.

In the Manchester Terrier and the English Toy Terrier, a genetic variant in the ABCC9 gene, which encodes a cardiac ATP-sensitive potassium channel, has been identified. DCM can lead to sudden death, which occurs before 2 years of age, typically at the age of 6 months. In the acute form, the heart is macroscopically unremarkable. In the chronic form, there is often mild cardiomegaly with enlargement of the left ventricle and atrium as well as of the left ventricular wall. The dogs appear to be healthy before death, in some cases previous anaesthesia or extensive exercise before death has been reported.

A variant in the LMNA gene has been found in Nova Scotia Duck Tolling Retrievers with DCM. Affected dogs develop paroxysmal ventricular tachycardia. Mitral valve dysplasia and myocardial fibrosis may also be present. The age of onset of the disease varies. Sudden death is possible as early as 10–15 months of age.

Dilated Cardiomyopathy (DCM1–4) in the Dobermann

Material	EB 1 ml, buccal swab
Method	FLP (DCM1), TaqMan SNP assay (DCM2–4)
Breed	Dobermann
Inheritance	See information below
Duration	1–2 weeks

Disease

DCM is widespread in the Dobermann. Affected dogs suffer from ventricular tachyarrhythmias, heart failure or sudden cardiac death. So far, four genetic variants have been identified. In the American Dobermann population, the DCM1 variant in the PDK4 gene and the DCM2 variant in the titin gene are particularly relevant. Both variants are inherited in an autosomal dominant manner with incomplete penetrance. The DCM2 variant alone seems to be associated with a higher risk than the DCM1 variant. Dogs with both variants have an even higher risk of DCM due to the additive effect.

According to current knowledge, DCM3 and DCM4 are relevant in the European Dobermann population and are associated with left ventricular systolic dysfunction and dilatation. DCM3 is inherited as a dominant trait; even heterozygous carriers have a higher risk of developing DCM. Homozygous carriers of the DCM3 variant, in turn, have a higher risk of developing DCM than heterozygous animals. DCM4 is inherited in an autosomal recessive manner; only homozygous carriers of the variant have an increased risk of developing DCM. The DCM3 and DCM4 variants seem to have an additive effect, with DCM4 showing a stronger effect.
Heterozygous carriers of the DCM3 variant (that do not have the DCM4 variant or are heterozygous for it) have an increased risk of developing DCM ranging from under 50% to 50–75%. If at least one of the two risk factors is homozygous, the risk of developing DCM is over 75%.
Dogs with an increased risk should be examined regularly. In breeding, matings that may produce puppies with a high risk of developing DCM should be avoided in order to reduce the prevalence of risk variants in the breed without excessively restricting the gene pool.

Disproportionate Dwarfism

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dalmatian, Dogo Argentino, Magyar Vizsla
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the PRKG2 gene causes disproportionate dwarfism in the Dogo Argentino. From about 2 months of age onwards, a smaller body size and length, a disproportionately large head and possibly impaired gait due to carpus valgus can be seen. Radiographs indicate an uneven growth of the ulna and radius and show reduced calcification at the growth plate during bone formation. Adolescent dogs have shortened limbs, a shortened torso and neck, a relatively broad head, with the nose being slightly turned upwards, as well as a pronounced vertical groove between the eyes.
A severe form of skeletal dysplasia in Dalmatians has been documented since the 1980s. Chondrodysplasia primarily affects endochondral ossification and leads to shortening and deformation of the limbs. This becomes apparent from 2–3 months of age onwards and causes gait abnormalities. The forelimbs are curved, with lateral deviation of the elbow joints and an outward rotation of the paws. Ulna, radius, fibula and tibia are shortened, as is the body length. Affected dogs carry a variant in the PRKG2 gene. Extended screening has shown that this variant remains prevalent within the Dalmatian population.
In the Magyar Vizsla, a variant in the PCYT1A gene was found that causes disproportionate dwarfism (SD3). From 3 to 5 weeks of age, changes in the long bones can be noticed, in particular a shortening and deformation of the humerus and, to a lesser extent, the femur and other long bones. This results in an abnormal elbow position and a wide-based stance of the forelimbs. The severity of the signs varies.

Dry Eye Curly Coat Syndrome (CCS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Cavalier King Charles Spaniel
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease

Affected puppies have an unusual coat (rough and curly) and show signs of kerato-conjunctivitis sicca. Changes of the skin of the foot pads, the foot pads and the nails cause pain and lameness. Teeth and hair are also affected.

Dyserythropoietic Anaemia and Myopathy (DAMS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (English Springer Spaniel) Sequencing (Labrador Retriever)
Breed	English Springer Spaniel, Labrador Retriever
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

Different mutations in the EHBP1L1 gene cause DAMS in English Springer Spaniels and Labrador Retrievers. Clinical signs in the Labrador Retriever include muscle atrophy, pelvic limb weakness and regurgitation. Blood tests of affected dogs showed marked microcytosis and changes in the erythrocytes. Myopathy and megaoesophagus were detected at around 5 years of age, while microcytosis and erythrocyte abnormalities were already seen in affected dogs at a younger age.
In the English Springer Spaniel, the disease shows an early onset of anaemia, mega-oesophagus, cardiomyopathy and generalised, slowly progressive muscle atrophy. Despite the different clinical signs, both breeds have similar changes in erythrocyte morphology and muscle histopathology.

Dystrophic Epidermolysis Bullosa (DEB)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Central Asian Shepherd Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In DEB, blister formation occurs beneath the lamina densa of the cutaneous basement membrane. A severe form of DEB is found in Central Asian Shepherd Dogs. It is caused by a nonsense mutation in the COL7A1 gene, which encodes type VII collagen. Already at an early age, affected puppies suffer from skin lesions, blisters and ulcers on the paws, ears, muzzle and oral mucosa and must be euthanised due to the unfavourable prognosis.

Ectodermal Dysplasia/Skin Fragility Syndrome (ED/SFS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Chesapeake Bay Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Already at birth, the skin of affected dogs is translucent on the ears, foot pads, nose and mouth. Bleeding or skin detachment occurs in these areas when slight friction is present. Affected dogs have to be euthanised.

Epidermolytic Hyperkeratosis (EHK)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Norfolk Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Because of a keratin defect, this disease leads to superficial, mild, plantar epidermolytic hyperkeratosis with epidermal fragility. Affected dogs show clinical signs from birth up to old age.

Episodic Falling (EF)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Cavalier King Charles Spaniel
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Episodic falling is a neurological disorder. Episodes are triggered by stress, excitement or exertion and can range from stiffness to collapse.
Laboklin owns the exclusive license to perform this genetic test.

Exercise Induced Collapse (EIC)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Boykin Spaniel, Chesapeake Bay Retriever, Clumber Spaniel, Curly Coated Retriever, German Wire-Haired Pointing Dog, Labrador Retriever, Old English Sheepdog, Welsh Corgi Pembroke
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
The first signs of EIC are a swaying or stiff gait as if the dog had stiff legs. After only 5–15 minutes of exertion, affected dogs develop muscle weakness and collapse. Laboklin owns the exclusive license to perform this genetic test.

Exfoliative Cutaneous Lupus Erythematosus (ECLE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Short-haired Pointing Dog, Magyar Vizsla
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
The autoimmune skin disease ECLE, also known as lupoid dermatitis, is caused by a variant in the UNC93B1 gene, which plays an important role in the immune response. Typical signs of ECLE are excessive scales – local or all over the body, hypopigmentation, erythema, hair loss, crusts, ulcers as well as secondary bacterial skin infections caused by immunodeficiency and, sometimes, short-term lameness. The first signs are seen at a juvenile or early adult age. Due to the severe clinical signs and insufficient treatment options, affected dogs are usually euthanised.

Factor VII Deficiency

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Airedale Terrier, Alaskan Klee Kai, Beagle, Deerhound, Finnish Hound, Giant Schnauzer, Papillon, Phalène, Welsh Springer Spaniel
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Affected dogs show a mild to moderate bleeding tendency but can also remain asymptomatic.

Factor XI Deficiency

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Kerry Blue Terrier
Inheritance	Autosomal recessive with incomplete penetrance
Duration	1–2 weeks

Disease
A mutation in the F11 gene causes factor XI deficiency. In some cases, severe prolonged bleeding can occur in affected animals 12–24 hours after surgical procedures. Other dogs only have a slight tendency to spontaneous bleeding and some animals are asymptomatic.

Familial Nephropathy (FN)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (English Cocker Spaniel, Welsh Springer Spaniel) Sequencing (English Springer Spaniel, Samoyed)
Breed	English Cocker Spaniel, English Springer Spaniel, Samoyed, Welsh Springer Spaniel
Inheritance	Autosomal recessive (English Cocker Spaniel, English Springer Spaniel, Welsh Springer Spaniel) X-linked recessive in Samoyed
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

Dogs with FN typically develop chronic renal failure between 6 months and 2 years of age, which sometimes leads to a rapid destruction of both kidneys and is ultimately fatal.

Familial Thyroid Carcinoma (FTFC) – Risk Analysis

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Long-haired Pointing Dog
Duration	1–2 weeks

Disease

Two genetic variants in the thyroid peroxidase (TPO) gene have been identified in the German Long-haired Pointing Dog that are associated with familial thyroid follicular cell carcinoma (FTFC). The risk of developing FTFC in dogs with two copies of one or both variants is around 16 times higher than in dogs that do not carry these variants. Most of the dogs analysed were older than 10 years at the time of diagnosis.

Fanconi Syndrome

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Basenji
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Fanconi syndrome is a disease in which the kidneys are no longer able to reabsorb electrolytes and nutritive substances from the primary urine. Typical signs are polydipsia and polyuria. Without treatment, the disease leads to death because of muscle weakness and acidosis. In Basenjis, Fanconi syndrome is hereditary and is usually seen between the ages of 4–8 years.

Finnish Hound Ataxia (FHA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Finnish Hound, Norrbottenspitz
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Starting at about 4 weeks of age, this disease can lead to progressively worsening ataxia in affected animals, which initially manifests itself as slight coordination problems, but later as paralysis up to immobility.

Fucosidosis

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	English Springer Spaniel
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

This storage disease causes deposits in cerebral and peripheral nervous tissue. Affected animals show a disturbed coordination of movements, behavioural abnormalities, blindness, deafness and impaired deglutition. The disease manifests itself between the age of 18 months and 4 years with a progressive course and ultimately fatal outcome.

Gallbladder Mucoceles (GBM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Cocker Spaniel, Cairn Terrier, English Cocker Spaniel, Pomeranian, Shetland Sheepdog (Sheltie)
Inheritance	Autosomal dominant with incomplete penetrance
Duration	1–2 weeks

Disease

Undetected gallbladder mucoceles can lead to cholecystitis and thus increase the risk of a rupture of the gallbladder. Clinical signs occur in older dogs and include vomiting, anorexia, lethargy, icterus and abdominal pain.

Glanzmann Thrombasthenia (GT)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Pyrenean Mountain Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
GT is a bleeding disorder that occurs in two different types. They differ in the amount of specific glycoproteins (αIIbβ3) embedded in the cell membrane of platelets (thrombocytes), which are necessary for coagulation. In the more severe form of GT, type I, the level is less than 5% of the normal value. A mutation in the αIIb gene disrupts the production of one main component of these glycoproteins. Clinically, bleeding diathesis is usually recognised by continuous gingival bleeding after shedding of deciduous teeth. Persistent epistaxis can also be an indication for this disorder.

Glaucoma and Goniodysgenesis (GG)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Border Collie
Inheritance	Presumably autosomal recessive (still in research)
Duration	3–5 working days

Disease
A mutation in the olfactomedin-like 3 gene (OLFML3) leads to a predisposition for severe goniodysgenesis with narrowing or occlusion of intraocular channels of the iridocorneal angle and glaucoma and blindness as possible consequences. In heterozygous carriers, goniodysgenesis without glaucoma was diagnosed. Furthermore, several dogs did not develop glaucoma despite severe goniodysgenesis for 15 years or more. It is therefore assumed that the development of glaucoma is influenced by a combination of genetic factors as well as environmental and/or random factors.

Globoid Cell Leukodystrophy (Krabbe Disease)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Cairn Terrier, West Highland White Terrier) Sequencing (Irish Red Setter)
Breed	Cairn Terrier, Irish Red Setter, West Highland White Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days (Cairn Terrier, West Highland White Terrier) 1–2 weeks (Irish Red Setter)

Disease
Krabbe disease is an incurable lipid storage disorder with progressive degeneration of the white matter of the CNS. It is characterised by muscle atrophy and neurological degeneration with the onset of the signs being at 1–3 months of age.

Glycogen Storage Disease Type Ia (GSD Ia)

Material	EB 1 ml, buccal swab
Method	FLP (German Pinscher) Sequencing (Maltese)
Breed	German Pinscher, Maltese

Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
GSD Ia is caused by a congenital disorder of the glucose metabolism which leads to organ dysfunction of varying severity. In affected puppies, an undersupply of glucose and delayed growth occur very early after birth.

Glycogen Storage Disease Type II (GSD II, Pompe Disease)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if nessary sequencing
Breed	Finnish Lapphund, Lapponian Herder, Swedish Lapphund
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease
Affected dogs suffer from vomiting, progressive muscle weakness, loss of condition and cardiac insufficiency, which leads to death at about 1.5 years of age.

Glycogen Storage Disease Type IIIa (GSD IIIa)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Curly Coated Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Affected animals often only show few clinical signs in the first years of life. With advancing age, the disease manifests itself more and more frequently as lethargy and episodic hypoglycaemia with collapse.

Glycogen Storage Disease (GSD-PGBM1)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Basset Hound
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Polyglucosan body myopathy type 1 (PGBM1) is a glycogen storage disease (GSD) caused by a genetic variant in the RBCK1 gene. In Basset Hounds, it leads to the accumulation of glycogen, particularly in the myocardium and the smooth muscles.
Initial clinical signs such as chronic vomiting and diarrhoea typically occur at 8–12 months of age; later (at around 1–3 years of age) these are followed by muscle weakness, congestive heart failure and an increased risk of sudden cardiac death.

GM1 Gangliosidosis (GM1)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Shiba Inu) Sequencing (Husky, Portuguese Water Dog)
Breed	Husky, Portuguese Water Dog, Shiba Inu
Inheritance	Autosomal recessive
Duration	3–5 working days (Shiba Inu) 1–2 weeks (Husky, Portuguese Water Dog)

Disease

GM1 is a lysosomal storage disease that leads to neurological disorders. Affected dogs suffer from paralysis of the extremities and spasticity of the muscles.

GM2 Gangliosidosis (GM2)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Japanese Chin, Poodle, Shiba Inu
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

GM2 gangliosidosis, also known as Sandhoff's disease, is a progressive neuro-degenerative lysosomal storage disease. The first neurological signs appear at 9 to 12 months of age, which rapidly worsen and lead to death at 18 to 23 months. Signs include loss of vision, difficulty walking, loss of balance, tremor and vomiting.

Grey Collie Syndrome (GCS) (Canine Cyclic Neutropenia)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Collie (rough/smooth)
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Due to a dysfunction in stem cell formation in the bone marrow, affected dogs are more susceptible to infections and are prone to bleeding.

Haemophilia A (Factor VIII Deficiency)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (German Shepherd) Sequencing (Boxer, Labrador Retriever, Old English Sheepdog, Rhodesian Ridgeback) FLP (Havanese)

Breed	Boxer, German Shepherd, Havanese, Labrador Retriever, Old English Sheepdog, Rhodesian Ridgeback
Inheritance	X-linked recessive
Duration	3–5 working days (German Shepherd) 1–2 weeks (Boxer, Havanese, Labrador Retriever, Old English Sheepdog, Rhodesian Ridgeback)

Disease

Depending on the severity of factor VIII deficiency, there is slight to severe bleeding diathesis.

Haemophilia B (Factor IX Deficiency)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Rhodesian Ridgeback) Sequencing (American Akita, Hovawart, Lhasa Apso)
Breed	American Akita, Hovawart, Lhasa Apso, Rhodesian Ridgeback
Inheritance	X-linked recessive
Duration	3–5 working days (Rhodesian Ridgeback) 1–2 weeks (American Akita, Hovawart, Lhasa Apso)

Disease

Haemophilia B is one of the most important hereditary coagulation disorders in the Rhodesian Ridgeback. Depending on the severity of factor IX deficiency, there is a slight to severe bleeding diathesis. Other genetic causes of haemophilia B have been found in the American Akita, Hovawart and Lhasa Apso.

Haemorrhagic Diathesis (Scott Syndrome)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Shepherd
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

This bleeding diathesis is caused by impaired coagulation activity; activated platelets can be detected which are incapable of presenting anionic phospholipids, especially phosphatidylserine, and to release procoagulant microparticles. Other coagulation parameters remain unchanged, except for a reduced prothrombin consumption during the coagulation of whole blood.

Hereditary Ataxia (HA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Gordon Setter, Old English Sheepdog) Sequencing (Australian Shepherd, Miniature American Shepherd, Norwegian Buhund, Norwegian Elkhound)

Breed	Australian Shepherd, Gordon Setter, Miniature American Shepherd, Norwegian Buhund, Norwegian Elkhound, Old English Sheepdog
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

HA is a progressive disease of the musculoskeletal system characterised by hypermetria, uncoordinated gait, tremor and spasticity up to severe gait disturbances and loss of balance.

In the Old English Sheepdog and the Gordon Setter, first signs appear at the age of 5 months to 4 years. A variant in the RAB24 gene has been identified as the causative mutation in these breeds.

A mutation in the KCNIP4 gene causes HA in the Norwegian Buhund, while a mutation in the HACE1 gene causes HA in Norwegian Elkhounds. Affected puppies of both breeds show clinical signs between 4 and 20 weeks of age and have a drooping tail atypical for the breed.

In the Australian Shepherd and the Miniature American Shepherd, first signs such as hypermetria, "bunny hopping" and a wobbly and stiff-legged gait of the hind legs can be seen between 4 and 19 months of age. It may lead to an inability to walk at the age of 30 to 44 months. Histological findings revealed diffuse demyelination in the brain. A mutation in the PNPLA8 gene was found to cause HA in these breeds.

Hereditary Cataract (HSF4)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Australian Shepherd, Boston Terrier, French Bulldog, Miniature American Shepherd, Staffordshire Bull Terrier, Wäller, Wirehaired Pointing Griffon (Korthals Griffon)
Inheritance	Autosomal recessive (Boston Terrier, French Bulldog, Staffordshire Bull Terrier, Wirehaired Pointing Griffon (Korthals Griffon)) Unclear (Australian Shepherd, Miniature American Shepherd, Wäller)
Duration	1–2 weeks

Disease

Cataract is one of the most frequent causes of blindness in dogs. In the Boston Terrier, French Bulldog and Staffordshire Bull Terrier, hereditary cataract is caused by a different mutation in the HSF4 gene (heat-shock factor 4 gene) than in the Australian Shepherd, Miniature American Shepherd and Wäller.

In the latter breeds, homozygosity results in nuclear cataract, but heterozygosity only causes posterior subcapsular cataract, which rarely impairs vision. An autosomal recessive mode of inheritance is also suspected in these breeds, but it is influenced by at least one other genetic factor. In the Wirehaired Pointing Griffon (Korthals Griffon), the causative variant was detected in the FYCO1 gene.

Hereditary Deafness (DINGS1&2)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dobermann
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Variants in the PTPRQ gene (DINGS1) and the MYO7A gene (DINGS2) have been identified to cause congenital deafness and disorders of the vestibular system in the Dobermann. This results in progressive degeneration of the cochlea, accompanied by a loss of auditory sensory cells in the inner ear. Otoconia may be absent or malformed. Affected puppies are already deaf shortly after birth (always bilaterally in DINGS2, may be unilateral in DINGS1) and show head tilt, ataxia or circling. The vestibulo-ocular reflex is absent. Nystagmus may occur with body rotation. Vestibular dysfunction may become less pronounced with age.

Hereditary Deafness (EOAD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Beauceron, Rhodesian Ridgeback, Rottweiler
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In the Rottweiler, a variant in the LOXHD1 gene, which is thought to be involved in the function of the hair cells in the cochlea, leads to early hearing loss. It has not yet been conclusively clarified whether the puppies are born deaf or if they are initially hard of hearing and then become completely deaf within a few weeks.
In the Beauceron, a mutation in the CDH23 gene also causes hereditary bilateral deafness.
In the Rhodesian Ridgeback, a deletion in the EPS8L2 gene causes a form of hereditary deafness that leads to hearing loss at the age of 1–2 years. This form is called early-onset adult deafness (EOAD).

Hereditary Nasal Parakeratosis (HNPK)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Labrador Retriever) Sequencing (Greyhound)
Breed	Greyhound, Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days (Labrador Retriever) 1–2 weeks (Greyhound)

Disease
Affected dogs suffer from crust formation on the nose. Treatment can only be symptomatic. Laboklin owns the exclusive license to perform this genetic test in Labrador Retrievers.

Hereditary Neuropathy (GHN)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Greyhound
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Signs particularly include progressive amyosthenia, exercise intolerance, loss of reflexes and ataxia of all limbs, and later, loss of the ability to stand as well as breathing problems.

Hyperuricosuria (HUU/SLC)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Hyperuricosuria is a metabolic disorder that leads to an increased excretion of uric acid instead of allantoin, which is why the disease is also called "hyperuricosuria and hyperuricaemia". To prevent the formation of calculi, affected dogs should get a low purine diet. Additionally, adequate hydration is vital.

Hypomyelination/Shaking Puppy Syndrome (SPS)

Material	EB 1 ml, buccal swab
Method	Sequencing (English Springer Spaniel) TaqMan SNP assay (Weimaraner)
Breed	English Springer Spaniel, Weimaraner
Inheritance	Autosomal recessive (Weimaraner) X-linked recessive (English Springer Spaniel)
Duration	3–5 working days (Weimaraner) 1–2 weeks (English Springer Spaniel)

Disease
This disease is caused by abnormal myelination of the spinal cord. At the age of 12–14 days, affected dogs show generalised tremor, whose severity varies greatly. The dogs are able to walk, but have a hopping gait in the hind legs. Tremor decreases considerably from the age of 3–4 months onwards and may even disappear completely.

Hypophosphatasia (HPP)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Karelian Bear Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

HPP has been described in Karelian Bear Dogs and in humans.
Defective variants of the non-tissue-specific alkaline phosphatases are formed. This impairs the release of phosphate from inorganic compounds and leads to insufficient mineralisation of the skeleton. At the age of 2–10 weeks, dogs show growth retardation, movement disorders as well as muscle weakness and seizures. In the serum of affected puppies, total protein, albumin and urea levels may be elevated, and more PEA (phosphatase substrate phosphoethanolamine) is excreted in the urine. Affected animals usually die after a few weeks or are euthanised.

Ichthyosis in Great Danes ➢ see Congenital Ichthyosis p. 348

Ichthyosis (American Bulldog)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	American Bulldog
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Ichthyosis is a congenital disorder of the normal desquamation of the skin caused by a change in keratinisation. In addition, the skin may also appear differently pigmented. The first signs of the disease appear after only a few weeks of life.

Ichthyosis (Golden Retriever)

Material	EB 1 ml, buccal swab
Method	Partner laboratory
Breed	Golden Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

See Ichthyosis in American Bulldogs.

Ichthyosis Type 2 (Golden Retriever)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Golden Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In addition to the PNPLA1 variant, which has been known since 2012, another variant in the ABHD5 gene has been found in the Golden Retriever, which can also cause the typical signs of ichthyosis (called type 2 here). So far, the type 2 variant has mostly been identified in American breeding lines.

Imerslund-Gräsbeck Syndrome (IGS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Beagle, Border Collie) Sequencing (Komondor)
Breed	Beagle, Border Collie, Komondor
Inheritance	Autosomal recessive
Duration	3–5 working days (Beagle, Border Collie) 1–2 weeks (Komondor)

Disease

Malabsorption of vitamin B12 leads to neurological signs and irreversible damage of the brain and nervous system.

Inflammatory Myopathy (IM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dutch Shepherd
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Inflammatory myopathy (IM) is the result of homozygous inheritance of a variant in the SLC25A12 gene. The genetic defect causes a decreased activity of the mitochondrial aspartate-glutamate transporter and a resulting proinflammatory milieu as well as oxidative stress in the muscles. Beginning at 3–9 months of age, affected dogs show progressive muscle weakness up to the inability to walk. Serum CK is permanently elevated. Affected animals were euthanised at about 2 years of age.

Inflammatory Pulmonary Disease (IPD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Collie (rough and smooth)
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Just a few days after birth, IPD causes coughing, shallow breathing, heavy breathing sounds, foamy vomiting and fever. The dogs respond well to treatment with antibiotics and secretolytics but tend to relapse without antibiotic treatment.

Junctional Epidermolysis Bullosa (JEB)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	German Short-Haired Pointing Dog
Inheritance	Autosomal recessive; the genetic test detects a mutation that is inherited together with the causative mutation.
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

Due to a defect in the cutaneous basement membrane, erosions and encrustations occur in the area of the foot pads, at pressure points on the limbs, on the inside of the auricles, and in areas of the gums, tongue and lips.

Juvenile Brain Disease (JBD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Jack Russell Terrier, Parson Russell Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

JBD is a disorder with an early onset at the age of 6–12 weeks which leads to epileptic seizures. The disease progresses rapidly and causes irreversible brain damage leading to death.

Juvenile Epilepsy (JE)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Lagotto Romagnolo
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Between the 5th and 12th week of life, affected dogs suffer from episodes of slight trembling, unsteady gait or inability to walk and spastic paralysis.

Juvenile Laryngeal Paralysis and Polyneuropathy (JLPP)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Black Russian Terrier, Rottweiler
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
JLPP is a hereditary disease that leads to breathing difficulties when excited or physically stressed already at the age of three months. As the disease progresses, weakness and coordination problems in the hind limbs develop, which eventually extend to the front limbs, and swallowing difficulties appear. This disease cannot be cured and is fatal within a few months after the onset of the signs.

Juvenile Myoclonic Epilepsy (JME)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Rhodesian Ridgeback
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
For Rhodesian Ridgebacks, JME is a typical form of epilepsy with frequent myoclonic twitches. The dogs suffer from involuntary, sudden muscle jerks which especially occur at rest. First signs appear at the age of about 6 months. In more than 85% of the cases, seizures occur daily. In the course of the disease, 40% of the dogs develop generalised tonic-clonic seizures.

L-2-hydroxyglutaric Aciduria (L-2-HGA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Staffordshire Bull Terrier) Sequencing (Yorkshire Terrier)
Breed	Staffordshire Bull Terrier, Yorkshire Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days (Staffordshire Bull Terrier) 1–2 weeks (Yorkshire Terrier)

Disease
L-2-HGA produces a variety of neurological deficits, including psychomotor retardation, seizures and ataxia. Signs are "wobbly" gait, muscle stiffness as a result of exercise or excitement, and altered behaviour.

Lafora Disease

Material	EB 1 ml (EDTA blood only)
Method	Special FLP
Breed	Basset Hound, Beagle, Chihuahua, Dachshund, French Bulldog, Newfoundland, Welsh Corgi Cardigan, Welsh Corgi Pembroke
Inheritance	Autosomal recessive
Duration	2–3 weeks

Disease

Lafora disease is a glycogen metabolism disorder that causes progressive myoclonic epilepsy. Soluble glycogen is transformed to insoluble polyglucosan that aggregates to form Lafora bodies and accumulates in the neuronal somatodendritic compartments of the brain as well as in muscles, heart, skin and liver. The signs of this disease are: poor vision/blindness, generalised tonic-clonic seizures, myoclonic jerks, panic attacks, dementia, aggression and, in later stages, faecal and urinary incontinence. The first signs usually appear from 7 years of age onwards.

Lagotto Storage Disease (LSD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Lagotto Romagnolo
Inheritance	Autosomal recessive with incomplete penetrance
Duration	3–5 working days

Disease

Lagotto storage disease (LSD) is a neurodegenerative storage disorder that results in cerebellar damage in affected animals. These are the cause of movement control and balance disorders. In some affected dogs, nystagmus as well as behavioural changes like aggression and restlessness can be detected. The first signs appear at an age of four months to four years.

Laryngeal Paralysis (LP)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Bull Terrier, Miniature Bull Terrier
Inheritance	Autosomal recessive with incomplete penetrance (high-risk factor)
Duration	1–2 weeks

Disease

In Bull Terrier and Miniature Bull Terrier breeds, a genetic variant was identified to be a major genetic risk factor for an early form of laryngeal paralysis. Homozygous dogs have a 17-fold increased risk of developing laryngeal paralysis. Because of the high clinical relevance of LP (voice impairment, stridor, limited exercise tolerance, dyspnoea, collapse), mating should be done with at least one of the parent animals tested as homozygous-clear to avoid homozygous-affected puppies.

Laryngeal Paralysis with Polyneuropathy Type 3 (LPPN3)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Great Dane, Labrador Retriever, Leonberger, St. Bernard
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Dogs suffering from LPPN3 often show respiratory problems that can lead to laryngeal paralysis. Other typical signs of polyneuropathy such as gait disorders may also occur. In addition to this mutation, there are other causative mutations that lead to LPN1 or LPN2, which are similar diseases in the Leonberger.

Late Onset Ataxia (LOA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Jack Russell Terrier, Parson Russell Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

The disease leads to progressive restrictions of the musculoskeletal system and loss of balance. In affected animals, signs usually appear between 6 and 12 months of age. SCA can also cause this clinical picture, but usually has an earlier onset.

Leonberger Polyneuropathy (LPN1 and LPN2)

Material	EB 1 ml, buccal swab
Method	FLP (LPN1) Sequencing (LPN2)
Breed	Leonberger
Inheritance	Autosomal recessive (LPN1) Autosomal dominant with incomplete penetrance (LPN2)
Duration	1–2 weeks

Disease

LPN types 1 and 2 are characterised by increasing exercise intolerance and uncoordinated gait, especially in the hind legs. Eventually, the animals can hardly carry their own weight. Furthermore, there are distinct breathing sounds, altered barking and dysphagia. The onset of LPN1 is at about 2–4 years of age and it shows a severe progression. The LPN1 mutation causes around 11% of all cases of polyneuropathy in Leonbergers. The average onset of LPN2 is around 6 years of age. LPN2 causes around 21% of all cases of polyneuropathy in Leonbergers. In addition to these two mutations, there are other unknown causative mutations.

Lethal Acrodermatitis (LAD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Bull Terrier, Miniature Bull Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Already in the first weeks of life, LAD is characterised by typical skin lesions, especially on the paws, growth retardation and immunodeficiency. Initially, the skin lesions resemble a zinc deficiency, later on, severe infections (malassezia, candida) as well as hyperkeratosis of the foot pads and deformation of the nails occur. Additionally, diarrhoea and pneumonia occur. LAD usually leads to death in 1–2 years.

Lethal Lung Disease (LAMP3)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Airedale Terrier
Inheritance	Autosomal recessive with incomplete penetrance
Duration	1–2 weeks

Disease

In Airedale Terriers, a variant in the LAMP3 gene has been identified that encodes a membrane protein of the lamellar bodies. Since lamellar bodies are involved in surfactant formation in the pulmonary alveoli, synthesis of the surfactant is severely impaired. Homozygous affected puppies are already lethargic at birth, refuse to suckle and develop dyspnoea/tachypnoea and severe oxygen deficiency within the first days or weeks; they are usually euthanised.
It is suspected that there might be an unknown protective variant which causes incomplete penetrance of LAMP3.

Leukocyte Adhesion Deficiency III (LAD3)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Shepherd
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

LAD3 is an inherited immunodeficiency disease. It is caused by a recessive mutation affecting the cell-to-cell contact. As a result, granulocytes are unable to migrate to the site of the infection. Animals suffering from LAD3 can neither form pus nor develop neutrophilia. Affected dogs develop severe, often life-threatening infections at a very early stage, which cannot be treated even with high doses of antibiotics.

Leukoencephalomyelopathy (LEMP)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (Leonberger) Sequencing (Great Dane, Rottweiler)
Breed	Great Dane, Leonberger, Rottweiler
Inheritance	Autosomal recessive with incomplete penetrance
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease

LEMP is a neurodegenerative disease of the white matter of the CNS, in which lesions of the myelin sheath lead to coordination and movement disorders. The first signs appear at the age of 1–3 years; only a few months after the onset of the first signs, affected dogs will not be able to stand up or walk anymore. Since about 1% of the examined dogs without signs are tested as homozygous affected, it is assumed that the penetrance is incomplete and an influence of modifier genes or factors is suspected.

Leukoencephalopathy (LEP)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Schnauzer
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In LEP, there are defects in myelin proteins and/or metabolic defects of the oligodendrocytes with insufficient formation/maintenance of the myelin sheath. Signs include dysphagia, tetraparesis and ataxia, walking circles, distemper, head tilt, strabismus and tonic-clonic seizures or sudden death. Brains of affected dogs showed lesions of the cerebellar white matter, a reduced distinction between grey and white matter and mild hydrocephalus. Affected puppies are usually euthanised a few days after birth.

Limb Girdle Muscular Dystrophy (LGMD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dachshund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A mutation in the gene encoding the sarcoglycan alpha subunit (SGCA) causes LGMD, a dystrophy of the shoulder and pelvic girdle muscles. Affected dogs suffer from exercise intolerance, stiff-legged gait, progressive weakness, myoglobinuria, dysphagia and pneumonia. Persistently markedly elevated serum creatine kinase activity can be detected. The onset of signs was at around 7–17 months of age. Muscle biopsies were dystrophic.

Immunostaining and Western blot analysis of α, β and γ-sarcoglycans indicated sarcoglycanopathy, a form of limb girdle muscular dystrophy.

Lundehund Syndrome (LHS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Norwegian Lundehund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The typical signs of LHS are similar to those of protein-losing enteropathy (PLE). They include gastritis, protein loss, chronic inflammation, lymphangiectasia and malabsorption. In addition, poor general condition, frequent vomiting and oedema can be observed in affected animals.

Lysosomal Storage Disease (LSD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dalmatian, Dobermann, Weimaraner
Inheritance	Autosomal recessive (Dobermann) Yet unknown (Dalmatian, Weimaraner)
Duration	1–2 weeks

Disease

LSD is caused by abnormal intra-lysosomal accumulation of incompletely catabolised molecules and is associated with neurological signs. It is a progressive disease.
In Dalmatians, LSD is caused by a variant in the CNP gene. In homozygous affected dogs, the onset of signs is at around 1.5 years of age; they include anxiety, impaired vision, circling, hypersensitivity, sleep disturbances and incontinence. From around 7 years of age, the signs become more pronounced. MRI scans show generalised brain atrophy with marked degeneration of the white matter. From the age of 9–11 years onwards, heterozygous dogs may develop progressive neurological disorders such as ataxia, restlessness or sleep disturbances as well as inappetence. Furthermore, at around 12 years of age, significant loss of coordination as well as impaired vision and hearing may develop.
In Weimaraners, a different genetic variant in the CNP gene causes LSD. Clinical signs can be seen from the age of 4 years onwards and include drowsiness which can progress to trance-like episodes, paralysis, faecal incontinence and losing interest in food.
In the Dobermann breed, a variant in the MAN2B1 gene has been identified to cause LSD. In an affected dog, the first signs were observed at around two months of age and included divergent strabismus, later followed by aggression, dementia and hallucinations. The dog was euthanised at the age of 14 months.

Macrothrombocytopenia (MTC)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Cocker Spaniel, Bichon Frisé, Boxer, Cairn Terrier, Cavalier King Charles Spaniel, Chihuahua, English Cocker Spaniel, Havanese, Jack Russell Terrier, Labrador Retriever, Maltese, Norfolk Terrier, Parson Russell Terrier, Poodle, Shih Tzu
Inheritance	Autosomal dominant (intermediate) (American Cocker Spaniel, Bichon Frisé, Boxer, Cavalier King Charles Spaniel, Chihuahua, English Cocker Spaniel, Havanese, Jack Russell Terrier, Labrador Retriever, Maltese, Parson Russell Terrier, Poodle, Shih Tzu) Autosomal recessive (Cairn Terrier, Jack Russell Terrier, Norfolk Terrier, Parson Russell Terrier)
Duration	1–2 weeks

Disease

MTC is a hereditary disorder affecting platelet production. Two mutations have been identified in the β1-tubulin gene, one of which is recessive, while the other one is dominant.

Congenital MTC leads to thrombocytopenia, with counts ranging between 100.000 and 50.000 per µl or even below. Moreover, many platelets are larger than normal. Heterozygous carriers of the dominant mutation have counts that lie between those of affected and normal dogs. Affected dogs do not have a bleeding diathesis, but as treatment with antibiotics or steroids is contraindicated for congenital MTC, this genetic test should be considered as an important method for differential diagnosis.

Macular Corneal Dystrophy (MCD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

MCD is a progressive disease which affects the stroma of the cornea. The disease is caused by a genetic variant in the CHST6 gene, which encodes an enzyme involved in the synthesis of keratan sulphate. Keratan sulphate is thought to be relevant for corneal hydration. MCD leads to increasing corneal opacity at 4–6 years of age and severe visual impairment over time. In some dogs, vascularisation of the corneal epithelium may also occur.

Malignant Hyperthermia (MH)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal dominant
Duration	3–5 working days

Disease

This disease is caused by inhalation narcotics and muscle relaxants and is characterised by increased body temperature, hypercapnia, rhabdomyolysis, cardiac arrhythmias and renal failure. Damage to neural, hepatic and renal tissue and death occur if narcotics and muscle relaxants are further administered.

Maxillary Canine Tooth Mesioversion (MCM)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Shetland Sheepdog (Sheltie)
Inheritance	Autosomal dominant (risk factor)
Duration	3–5 working days

Disease

A variant in the FTSJ3 gene has been identified that is associated with tooth displacement and reduced body size and weight in Shetland Sheepdogs. Mesioversion of the maxillary canines (MCM) can affect one or both canines and displace them towards the nose, which may cause abnormal occlusion, ulceration of the upper lip and periodontal disease and require extraction or orthodontic treatment.

May-Hegglin Anomaly (MHA)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Pug Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Animals with MHA show persistent thrombocytopenia and greatly enlarged platelets which are variably altered in morphology. In addition, cytoplasmic inclusions can be detected in neutrophil granulocytes. In affected animals, coagulation is delayed.

MCAD Deficiency

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Cavalier King Charles Spaniel

Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A mutation in the ACADM gene causes medium-chain acyl-CoA dehydrogenase (MCAD) deficiency. Affected dogs display focal seizures with prolonged lethargy, reduced responsiveness and proprioceptive ataxia. These conditions occur several times a week and can last from 20 minutes to 24 hours. Urine and blood analyses show an increased level of medium-chain fatty acids. Signs improve with treatment and a low-fat diet, resulting in several months without seizures.

MDR1 Gene Variant (Ivermectin Hypersensitivity)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Australian Shepherd, Border Collie, Collie (rough/smooth), Elo, German Shepherd, Silken Windsprite (Long-haired Whippet), McNab Shepherd, Miniature American Shepherd, Old English Sheepdog, Shetland Sheepdog (Sheltie), Silken Windhound, Wäller, White Swiss Shepherd
Inheritance	Autosomal recessive; hypersensitivity is also to be expected in carriers
Duration	3–5 working days

Disease

Hypersensitivity to the antiparasitic drug ivermectin is caused by a variant in the multi-drug resistance transporter (MDR1). In addition to ivermectin and loperamide, **numerous other pharmaceutical substances** have been identified which are known to show increased penetration into brain tissue if applied in combination with an altered MDR1 transporter.

Methaemoglobinaemia (MetHg)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Pomeranian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A variant in the CYB5R3 gene that causes methaemoglobinaemia (MetHg) has been detected in the Pomeranian dog breed. Methaemoglobin causes cyanosis and exercise intolerance. The oral mucosa, tongue and the skin on the lower abdomen of affected dogs show a bluish discolouration. Blood tests performed on affected dogs revealed a significantly lower level of b5R (NADH cytochrome b5 reductase).

Microphthalmia (RBP4)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Irish Soft Coated Wheaten Terrier) Sequencing (Portuguese Water Dog)
Breed	Irish Soft Coated Wheaten Terrier, Portuguese Water Dog
Inheritance	Autosomal recessive with maternal influence (Irish Soft Coated Wheaten Terrier) Autosomal recessive (Portuguese Water Dog)
Duration	3–5 working days

Disease

Microphthalmia in the Irish Soft Coated Wheaten Terrier can be caused by a hereditary prenatal vitamin A deficiency. Homozygous affected puppies only show signs if their mother is also homozygous affected and suffers from disturbed vitamin A transport. If the mother is heterozygous for the genetic defect, the puppies will probably not show any signs.

In Portuguese Water Dogs, a variant in the DNAJC21 gene causes microphthalmia and haematopoietic defects. One or both eyes are affected and they are reduced in size by more than 50%. Other possible ocular defects include cataracts, corneal dystrophy, microphakia/aphakia, glaucoma, retinal lesions and persistent pupillary membranes. Furthermore, dental enamel abnormalities, growth retardation as well as thrombocytopenia and anaemia may occur. Anaemia may improve with age while the platelet counts remain low.

Mitochondrial Fission Encephalopathy (MFE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bullmastiff
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A mutation in the MFF gene causes MFE. Homozygous affected dogs suffer from ataxia, uncoordinated gait and behavioural abnormalities; the signs develop at a very young age and are progressive. Other signs of the disease are a wide-based stance and impaired vision. A neurological examination indicates a disease of the cerebral cortex and the vestibulocerebellum; changes in the cerebellum were confirmed by MRI.

Mucopolysaccharidosis Type IIIa (MPS3a)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Dachshund, New Zealand Huntaway
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
MPS3a-affected animals suffer from severe degeneration of the central nervous system. First neurological signs usually appear from the age of eighteen months onwards, rapidly worsen, culminating in ataxia, and often lead to the death of the affected dog.

Mucopolysaccharidosis Type IIIb (MPS3b)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Schipperke
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
In Schipperkes, MPS3b is a lysosomal storage disease that is also known as "Sanfilippo syndrome type 3b". An enzyme defect prevents the breakdown of heparan sulphate, which accumulates in the lysosomes. Signs include tremor and imbalance, even with falling to either side. The onset of the signs is between 2–4 years and they become worse, so that these animals are usually euthanised 1–2 years later.

Mucopolysaccharidosis Type VI (MPS6)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Miniature Pinscher
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
The genetic variant causing MPS6 appears to be relatively common in the Miniature Pinscher and causes lysosomal storage disease in homozygous affected dogs due to an arylsulphatase B (ARSB) deficiency, so that sulphate cannot be broken down from chondroitin sulphate and dermatan sulphate. In case of MPS6, these sulphate compounds are detectable in the urine (toluidine blue staining strongly positive). There is no serum ARSB enzyme activity. Severe signs (corneal opacity, disproportionate dwarfism, kyphosis, facial dysmorphia) usually lead to the animals being euthanised as puppies or young adult dogs.

Mucopolysaccharidosis Type VII (MPS7)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Brazilian Terrier) Sequencing (German Shepherd)
Breed	Brazilian Terrier, German Shepherd
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease
This lysosomal storage disease causes corneal clouding as well as severe skeletal deformities. Affected dogs cannot walk even at the age of several weeks to months.

Multiocular Defect (MOD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Old English Sheepdog
Inheritance	Autosomal dominant (see information below)
Duration	1–2 weeks

Disease
A variant in the collagen-forming COL11A1 gene is associated with MOD. Dogs affected by MOD typically suffer from cataracts. Furthermore, there may be abnormalities of the lens (microphakia, coloboma), the globe (macrophthalmos), the retina (folds, detachments) and the vitreous body, and secondary glaucoma may develop. The average age of diagnosis is 2 years (ranging from 6 months to 10 years). MOD is inherited as a dominant trait; however, homozygous affected dogs show more pronounced signs and/or an earlier onset of the disease than heterozygous dogs.

Muscular Dystrophy (MD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Landseer) Sequencing (American Staffordshire Terrier, Cavalier King Charles Spaniel, Golden Retriever, Norfolk Terrier)
Breed	American Staffordshire Terrier, Cavalier King Charles Spaniel, Golden Retriever, Landseer, Norfolk Terrier
Inheritance	X-linked recessive (Cavalier King Charles Spaniel, Golden Retriever, Norfolk Terrier) Autosomal recessive (American Staffordshire Terrier, Landseer)
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease
Golden Retrievers, Norfolk Terriers and Cavalier King Charles Spaniels with MD suffer from muscle atrophy with contractures and elevated CK concentrations, fibrosis and cardiomyopathy.
In the Landseer, muscle weakness affects the entire body, making movement difficult or preventing walking. The onset of first signs is usually at around 3–6 months of age. Life expectancy is approximately 4–24 months.
In the American Staffordshire Terrier, a variant in the COL6A3 gene causes MD. From 6 months of age onwards, progressive gait abnormalities and joint contractures develop. Affected dogs show diffuse muscle atrophy. The elbow and stifle joints are markedly thickened, whereas the joints of the distal limbs are hyperextensible. Additional signs include generalised weakness and tetraparesis with stiff gait and short strides, but without apparent ataxia. Reflexes are generally weak.

Musladin-Lueke Syndrome (MLS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Beagle
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Due to extensive fibrosis of the skin and joints, affected dogs suffer from arthrosis and stiffness, have shortened outer toes and a typical flat head shape.

Mycobacterium avium Complex Sensitivity (MAC)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

In Miniature Schnauzers, a variant in the CARD9 gene leads to immunodeficiency, which is associated with an increased susceptibility to Mycobacterium avium with its subspecies (Mycobacterium avium complex, MAC) and Mycobacterium intracellulare. Starting at the age of 1–8 years, this leads to a poor general condition, nasal discharge, conjunctivitis, diarrhoea and enlarged lymph nodes, liver and spleen. The animals do not respond adequately to treatment and may pose a risk to animal owners with a weakened immune system.

Myostatin Mutation (“Bully” Gene)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Whippet
Inheritance	Autosomal recessive (see information below)
Duration	1–2 weeks

Disease

In Whippets, a significant correlation between this mutation (in the heterozygous genotype) and racing performance was found. Dogs with two “bully” alleles (homozygous case) appear extremely muscular, but their ability to run is limited.

Myotonia Congenita

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Miniature Schnauzer) Sequencing (Australian Cattle Dog, Border Collie, Labrador Retriever)

Breed	Australian Cattle Dog, Border Collie, Labrador Retriever, Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days (Miniature Schnauzer) 1–2 weeks (Australian Cattle Dog, Border Collie, Labrador Retriever)

Disease

This disease affects the skeletal muscle ion channels. Clinical signs are mainly stiff-legged gait, dysphagia and excessive salivation.
All affected Miniature Schnauzers showed abnormal dentition and overbite, in some cases also abnormal barking.

Myxomatous Mitral Valve Disease (MMVD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Cavalier King Charles Spaniel, Dachshund
Inheritance	Autosomal recessive (risk factor)
Duration	3–5 working days

Disease

Myxomatous mitral valve disease (MMVD) is characterised by a slowly progressive degenerative change of the mitral valves of the heart leading to mitral valve prolapse and regurgitation (blood flowing back into the left atrium of the heart) and eventually to heart failure due to fluid accumulation in the lungs. The Cavalier King Charles Spaniel and the Dachshund have an early-onset form of this disease and therefore greater cardiac morbidity and mortality compared to other breeds. A variant in the NEBL gene is associated with an increased risk of developing this early-onset form.

Narcolepsy

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Labrador Retriever) Sequencing (Dachshund, Dobermann)
Breed	Dachshund, Dobermann, Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days (Labrador Retriever) 1–2 weeks (Dachshund, Dobermann)

Disease

Narcolepsy is a neurological disease which is characterised by sleep attacks, cataplexy and sleep paralysis.

Necrotizing Meningoencephalitis (NME/PDE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Pug Dog
Inheritance	Autosomal recessive with incomplete penetrance The test identifies a risk factor which is associated with NME (also called PDE, pug dog encephalitis).
Duration	1–2 weeks

Disease

Due to the autoimmune inflammation of the central nervous system, disorientation, confusion and seizures occur. The genetic test determines the risk for developing this disease.

Necrotizing Myelopathy (HNM)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Kooikerhondje
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

A variant in the IBA57 gene causes HNM in the Kooikerhondje breed. The onset of paresis and ataxia in the hind limbs is between 3 and 12 months of age and progresses to tetraparesis before the age of 2 years. There were increased spinal reflexes in the hind limbs. Affected dogs had abnormal MRI findings and were euthanised. Post-mortem examination revealed a symmetric bilateral necrotizing myelopathy with malacia in the ventral and dorsal white matter of the cervical spinal cord.

Nemaline Myopathy (NM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Bulldog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

NM in American Bulldogs is characterised by a variety of muscular disorders, such as muscle weakness, muscular hypotonia, hypoventilation and dysphagia.

Neonatal Cortical Cerebellar Abiotrophy (NCCD)

Material	EB 1 ml, buccal swab
Method	FLP (Beagle) Sequencing (Magyar Viszla)

Breed	Beagle, Magyar Vizsla
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Puppies with neonatal (cortical) cerebellar abiotrophy (NCCD) are slower and less coordinated than other puppies their age.

Neonatal Encephalopathy with Seizures (NEWS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Poodle
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

NEWS is a malformation of the cerebellum. Already at birth, affected puppies are relatively small and weak and they often die within the first week of their lives. Those surviving this phase develop ataxia, tremor and seizures. So far, these animals had to be euthanised before they were 8 weeks old.

Neuroaxonal Dystrophy (NAD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Lagotto Romagnolo, Miniature American Shepherd, Papillon, Rottweiler, Spanish Water Dog
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

Primary (hereditary) NAD is characterised by axonal swelling, dystrophy of distal axons and secondary myelin degeneration of the central and/or peripheral nervous system.
In the Papillon breed, a variant in the PLA2G6 gene causes primary NAD. Initial signs appear at 3–4 months of age and include intention tremor and hypermetria, coordination problems, limb weakness and an inability to stand. Strabismus and difficulty eating are also typical. The signs become more severe over time, leading to cerebellar ataxia, tetraplegia, blindness and deafness.
In Rottweilers, a variant in the VSP11 gene causes NAD. The first signs are seen in early adulthood. The course of NAD is usually mild. Clinical signs include abnormal posture, ataxia, hypermetria, intention tremor and nystagmus.
In Spanish Water Dogs and the Lagotto Romagnolo, a variant in the TECPR2 gene is associated with NAD. Clinical signs appear between 6 and 11 months of age and match those described above. In addition, behavioural changes (lethargy, nervousness, frequent barking) as well as urinary and sometimes faecal incontinence may occur. The disease is slowly progressive.

In the Miniature American Shepherd, a variant in the RNF170 gene causes primary NAD. Initial signs are seen at around two years of age: weakness and coordination problems in the hind limbs up to incomplete bilateral paralysis. The disease is slowly progressive. Gait abnormalities are more pronounced when walking slowly than at faster speeds; balance problems have not been observed. NAD does not seem to have a significant effect on life expectancy.

Neuronal Ceroid Lipofuscinosis (NCL)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (American Bulldog, American Staffordshire Terrier, Australian Cattle Dog, Australian Shepherd, Border Collie, English Setter, Golden Retriever, Gordon Setter, Miniature American Shepherd, Tibetan Terrier) Sequencing (Chihuahua, Chinese Crested Dog, Dachshund, Italian Cane Corso, Saluki, Schapendoes, Small Swiss Hound) TaqMan SNP assay and sequencing (Australian Cattle Dog)
Breed	American Bulldog, American Staffordshire Terrier, Australian Cattle Dog, Australian Shepherd, Border Collie, Chihuahua, Chinese Crested Dog, Dachshund, English Setter, Golden Retriever, Gordon Setter, Italian Cane Corso, Miniature American Shepherd, Saluki, Schapendoes, Small Swiss Hound, Tibetan Terrier
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

NCL is a progressive neurodegenerative disease caused by defects in lysosomal storage. Clinical signs include increasing levels of agitation, anxiety and aggression. The dogs become hyperactive and ataxic and may suffer from epileptic seizures and impaired vision. The age of onset of the disease as well as its severity may vary greatly.

Obesity

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Flat Coated Retriever, Labrador Retriever
Inheritance	Yet unknown
Duration	1–2 weeks

Disease

A mutation in the POMC (pro-opiomelanocortin) gene affects energy homeostasis. It is associated with increased body weight, obesity and increased food motivation. The mutation was particularly often detected in assistance and companion dogs.

Osteochondrodysplasia (OCD)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Miniature Poodle
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

OCD in Miniature Poodles is associated with a genetic variant in the sulphate transporter SLC13A1, which disturbs the regulation of serum sulphate levels. Affected puppies tend to show signs as early as 3 weeks of age: stunted growth, widely spread hind legs, shortened and abnormally bent tubular bones, deformed joints, a flattened chest, undershot jaws and misshaped paws resembling clubfeet. In addition to limited mobility and locomotor disorders, this often leads to arthritis.

Osteogenesis Imperfecta (Brittle Bone Disease)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (Dachshund) Sequencing (Beagle, Golden Retriever)
Breed	Beagle, Dachshund, Golden Retriever
Inheritance	Autosomal recessive (Dachshund) Autosomal dominant (Beagle, Golden Retriever)
Duration	3–5 working days (1–2 weeks in the case of sequencing) (Dachshund) 1–2 weeks (Beagle, Golden Retriever)

Disease

The cause of brittle bone disease (osteogenesis imperfecta) is a defective formation of type 1 collagen resulting in extremely brittle bones and teeth already in puppies.

Paradoxical Pseudomyotonia (PP)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	English Cocker Spaniel, English Springer Spaniel
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

PP is caused by a mutation in the SLC7A10 gene. Affected dogs develop exercise-induced episodes of muscle stiffness, similar to myotonia, from around 3–24 months of age onwards. The episodes are usually brief (45 seconds) and painless. In cold or hot weather, they can occur even after minimal exertion. In severe cases, cyanosis and apnoea may occur. Medical treatment can reduce the frequency and severity of episodes. PP is usually not progressive. Haematological tests and urinalysis as well as electromyography are unremarkable.

Paroxysmal Dyskinesia (PxD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Irish Soft Coated Wheaten Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Affected dogs suffer from episodes of involuntary, sudden, irregular and unpredictable movements of the limbs, especially the hind legs, known as hyperkinesia. These attacks last several minutes to hours and occur up to 10 times a day. The first signs typically occur at two years of age and worsen over time.

Paroxysmal Exercise-Induced Dyskinesia (PED)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Shetland Sheepdog (Sheltie), Weimaraner
Inheritance	Probably autosomal dominant (still in research) (Shetland Sheepdog) Autosomal recessive (Weimaraner)
Duration	1–2 weeks

Disease

In Shetland Sheepdogs, a variant in the PCK2 gene was found that is associated with PED. Affected dogs show short to long-lasting episodes of generalised ataxia and hypermetria, increased muscular tension in all four limbs, as well as decreased mental activity and mild tremor. Episodes are triggered by stress or excitement. Laboratory findings include hypoglycaemia, mild lactic acidosis, lactaturia, and mildly elevated CK concentrations. Good stress management, a specific diet (gluten- and grain-free, seafood-based with high levels of tryptophan) and anti-epileptic treatment can influence the frequency of episodes and reduce signs.

In Weimaraners, a variant in the TNR gene causes PED. Clinical signs such as abnormal gait, dystonia, ataxia and hypermetria, kyphosis, low head carriage, and possibly anisocoria and collapse occure from 3–7 months of age. As in Shelties, the episodes are triggered by stress, can occur several times a day and last for 5–15 minutes. Physical and neurological examinations, muscle and nerve biopsies as well as MRI are unremarkable.

Persistent Müllerian Duct Syndrome (PMDS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Persistent Müllerian duct syndrome (PMDS) is caused by a mutation in the MISRII gene and is associated with an incomplete regression of the Müllerian duct during sex differentiation in male dogs. Normally, the external genitalia are fully developed. In 50% of the affected animals, the testicles do not descend (testicular dystopia), which can lead to infertility and possibly tumour formation.

Phosphofructokinase Deficiency (PFKD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Cocker Spaniel, English Springer Spaniel, German Spaniel, Whippet
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Enzyme deficiency leads to the destruction of red blood cells, resulting in a red discolouration of the urine, anaemia and jaundice as well as exercise intolerance and muscle cramps.

Pituitary Dwarfism

Material	EB 1 ml, buccal swab
Method	FLP (Czechoslovakian Wolfdog, German Shepherd, Saarloos Wolfhond, Tibetan Terrier, White Swiss Shepherd Dog) Sequencing (Karelian Bear Dog, Lapponian Herder)
Breed	Czechoslovakian Wolfdog, German Shepherd, Karelian Bear Dog, Lapponian Herder, Saarloos Wolfhond, Tibetan Terrier, White Swiss Shepherd Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Dwarfism results from a lack of growth hormone caused by a dysfunction of the pituitary gland.
In Shepherds and Wolfhounds, growth stops at 3–8 weeks of age. If left untreated, the animals either keep their puppy fluff or completely lose their coat. Topcoat usually only develops in the head/foot area. Affected Karelian Bear Dogs, Tibetan Terriers and Lapponian Herders gain weight more slowly and keep their puppy coat or suffer from severe hair loss, relatively thin skin and skin inflammation at 2–3 years of age.

Polioencephalopathy (PE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Eurasian

Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

PE is characterised by lesions in the grey matter of the brain, which are caused by congenital metabolic defects, toxicity, malnutrition or metabolic disorders.
In a family of Eurasians, PE could be linked to a variant in the MECR gene, which encodes a mitochondrial enzyme. From 2–6 months of age onwards, the dogs showed episodic generalised ataxia, hypermetria, dystonia and uncontrolled flexion and extension movements of the forelimbs. The episodes were possibly triggered by excitement, noise or overstimulation. The frequency and severity of these episodes increased over time. As the disease progressed, difficulty standing, muscle atrophy, abnormal posture and, in some cases, divergent strabismus developed as well.

Polycystic Kidney Disease (PKD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bull Terrier
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

PKD is caused by a variant in the PKD1 gene and leads to the formation of cysts in the liver, pancreas and kidneys. The fluid-filled kidney cysts eventually cause renal failure and lead to death.

Postoperative Haemorrhage (P2Y12)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Great Swiss Mountain Dog
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

In Great Swiss Mountain Dogs, a mutation in the P2Y12 gene leads to severe coagulation disorders. Affected animals only show severe bleeding, which is often fatal, during major surgery or serious injuries. The genetic test is therefore diagnostically useful as a preventive measure before surgery.

Prekallikrein Deficiency (KLK)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Shih Tzu
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Even though KLK leads to deficiency in prekallikrein, a component of the coagulation cascade, it is not associated with increased bleeding diathesis. Only in combination with other defects in the coagulation cascade (factor VII, VIII and IX deficiencies), an increased tendency to bleed has been described in a few cases.

Primary Ciliary Dyskinesia (PCD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing (Old English Sheepdog) Sequencing (Alaskan Malamute, Australian Shepherd, Eurasian, Miniature American Shepherd, Nova Scotia Duck Tolling Retriever)
Breed	Alaskan Malamute, Australian Shepherd, Eurasian, Miniature American Shepherd, Nova Scotia Duck Tolling Retriever, Old English Sheepdog
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease
PCD belongs to the group of ciliopathies with functional impairment (impaired motility) of the cilia. This syndrome is characterised by recurrent respiratory tract infections and, in some cases, reduced fertility. In Old English Sheepdogs and Eurasians, some affected dogs also develop situs inversus (Kartagener syndrome). In Alaskan Malamutes, hydrocephalus may be present as well.

Primary Hyperoxaluria (PH)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Coton de Tuléar
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
PH leads to the accumulation of oxalate and the subsequent formation of calcium oxalate crystals in the urinary organs. The resulting crystals also accumulate in the kidney tissue and can lead to decreased renal function.

Primary Immunodeficiency Type 2 (PIP2)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Cavalier King Charles Spaniel
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the CARMIL2 gene causes primary immunodeficiency with an increased susceptibility to respiratory infections, gastrointestinal parasitic infections, chronic diarrhoea as well as skin diseases and abscess formation.

Primary Lens Luxation (PLL)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	American Eskimo Dog, American Hairless Terrier, Australian Cattle Dog, Chinese Crested Dog, Danish-Swedish Farmdog, Fox Terrier, German Hunting Terrier, Jack Russell Terrier, Lakeland Terrier, Lancashire Heeler, Lucas Terrier, Miniature Bull Terrier, Norfolk Terrier, Norwich Terrier, Parson Russell Terrier, Patterdale Terrier, Pug Dog, Rat Terrier, Sealyham Terrier, Teddy Roosevelt Terrier, Tenterfield Terrier, Tibetan Terrier, Toy Fox Terrier, Volpino Italiano, Welsh Terrier, Westfalen Terrier, Yorkshire Terrier
Inheritance	Autosomal recessive; it is estimated that about 2–20% of the carriers will develop PLL.
Duration	3–5 working days

Disease
Affected dogs may suffer from painful glaucomas and blindness due to a dislocation of the lens.

Primary Open Angle Glaucoma (POAG)

Material	EB 1 ml, buccal swab
Method	Sequencing (Basset Fauve de Bretagne, Basset Hound, Beagle, East Siberian Laika, Norwegian Elkhound) FLP (Petit Basset Griffon Vendeen)
Breed	Basset Fauve de Bretagne, Basset Hound, Beagle, East Siberian Laika, Norwegian Elkhound, Petit Basset Griffon Vendeen
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Without any prior eye disease, there is a rise in pressure in the eyeball which leads to visual field loss and blindness.

Primary Open Angle Glaucoma and Lens Luxation (POAG/PLL)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Shar Pei
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
A genetic dysfunction of the connective tissue in the eye leads to glaucoma (POAG) and often to lens luxation (PLL). POAG can lead to blindness. Usually, affected dogs show first signs at the age of 4–6 years.

Progressive Retinal Atrophy (PRA)

Progressive retinal atrophy (PRA) is a disease of the retina which continuously progresses and always leads to blindness. Over time, the photoreceptors of the eye will be destroyed. In most forms, rods are initially affected and cones are affected later, so that night blindness occurs first. Clinical signs usually appear in early youth, but the time of onset varies in different dog breeds. The ophthalmologic signs are similar in all forms (bilateral mydriasis, hyperreflective tapetum lucidum, atrophy of the retinal vessels).
The breed-specific forms of PRA are described below.

Bas-PRA1

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Basenji
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Further forms of PRA are suspected. The form of PRA in Basenjis, which can be detected by genetic testing, has an onset at about 5 years of age.

BBS2-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Shetland Sheepdog (Sheltie)
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
Besides the already known variant in the CNGA1 gene, a genetic variant in the Bardet-Biedl syndrome 2 (BBS2) gene is associated with PRA in Shetland Sheepdogs. The first signs have been reported from 8–10 years of age. Typically, affected dogs initially develop night blindness, followed by a noticeable decline in daylight vision and, in some cases, also a secondary cataract. In addition to PRA, phenotypic characteristics that are atypical for the breed (muzzle curved upwards, unusual wavy coat structure, dental abnormalities) may also be present.

BBS4-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Puli

Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Affected dogs have a variant in the BBS4 gene and were diagnosed with PRA at the age of 2 years. Signs were variable: reduced vision due to ophthalmological changes such as reduced myelination of the optic nerve, as well as obesity and infertility.

CNGA1-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Shetland Sheepdog (Sheltie)
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

There seems to be at least one more mutation in the CNGA1 gene. In Shetland Sheepdogs, first signs of PRA are usually seen from the age of two onwards. "Slowly progressing retinopathy" (SPR), which also occurs in Shetland Sheepdogs, is similar to PRA in the early stages and can only be distinguished in differential diagnosis by means of ERG.

cord1-PRA/crd4-PRA

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Beagle, Bolonka Zwetna, Clumber Spaniel, Curly Coated Retriever, Dachshund, English Springer Spaniel, French Bulldog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In cone-rod dysplasia (cord1), the cone cells degenerate first, approximately from the age of 6 months onwards. In some genetically affected dogs, however, no signs are seen even at a higher age. The connection between this mutation and the occurrence of the disease is still a subject of scientific debate.

crd-PRA

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Dachshund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The early loss of retinal cone cells is characteristic for crd-PRA.
The first clinical signs of crd-PRA can occur at the age of six months. After about 1 to 2 years, the full clinical picture (day blindness) becomes apparent.

crd1-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Staffordshire Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
See crd-PRA.

crd2-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Pitbull Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
See crd-PRA.

crd3-PRA

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Irish Glen of Imaal Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the ADAM9 gene causes crd3. At the age of 12–24 months, the cone and later also the rod photoreceptor cells begin to degenerate. It can take several years until complete blindness sets in. At ophthalmological examinations, crd3 can normally only be detected from 3–5 years of age onwards.

Dominant PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bullmastiff, Mastiff
Inheritance	Autosomal dominant
Duration	1–2 weeks

Early-onset PRA (eo-PRA)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Portuguese Water Dog, Spanish Water Dog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Early-onset PRA is caused by a variant in the PDE6B gene. Owners of eo-PRA-affected dogs report initial visual impairment at the age of about 1.5 years and describe the animals as mostly blind by 4.5 years. Early-onset PRA can often only be diagnosed through a clinical ophthalmological examination at a later point in time, after the owners have already noticed the first changes.

Generalised PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Schapendoes
Inheritance	Autosomal recessive
Duration	1–2 weeks

GR-PRA1 and GR-PRA2

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Golden Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
The onset of the disease varies within the breed, but diagnosis is often not made until about 5 years of age.

GTPBP2-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Labrador Retriever
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the GTPBP2 gene causes PRA in Labrador Retrievers. The age of onset of the first signs is between 7 months and 1.5 years. As the disease progresses, a cataract may also develop.

GUCY2D-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Spitz
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A genetic variant in the GUCY2D gene causes impaired vision both in daylight and at night already at around 3 months of age. The papilla is pale, the number of retinal blood vessels is slightly reduced and nystagmus may occur. With increasing age, retinal thinning may be observed.

IFT122-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Lapponian Herder
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
IFT122-PRA is usually diagnosed between 5–12 years of age. It is caused by a variant in the intraflagellar transport 122 gene (IFT122 gene) and progresses slowly so that some dogs still have some vision at 13 years of age.

JPH2-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Shih Tzu
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
A genetic variant in the JPH2 (junctophilin) gene causes PRA in the Shih Tzu. First signs were reported by owners of affected dogs from the age of 5–9 years.

MERTK-PRA

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Swedish Vallhund
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A mutation in the MERTK gene causes PRA in the Swedish Vallhund (Västgötaspets). The age of onset as well as the severity of the signs vary. The age of diagnosis is also highly variable (from 1–13 years).

NECAP1-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Giant Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
In Giant Schnauzers, a variant in the NECAP1 gene was found. This gene encodes a protein that is involved in clathrin-mediated endocytosis (CME) in the synapses. It is assumed that by inhibiting CME, rhodopsin accumulates in the photoreceptors and leads to retinal degeneration. First signs have been described from about 4 years onwards.

pap-PRA1

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Papillon, Phalène
Inheritance	Autosomal recessive
Duration	3–5 working days

Note
There are further forms of PRA in these breeds.

PRA3

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Tibetan Spaniel, Tibetan Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A genetic variant in the FAM161A gene, which encodes a ciliary protein and is expressed in retinal photoreceptors, causes PRA3 in Tibetan Spaniels and Tibetan Terriers. The onset of typical PRA signs is rather late, at around 5 years of age. It is assumed that other currently unknown variants which can cause PRA may occur in Tibetan Terriers in addition to the PRA3 variant and rcd4 PRA variant.

PRA4

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Lhasa Apso
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
PRA4 is caused by a variant in the IMPG2 gene. Clinical signs can appear as early as 2.5 years of age, although the age is very variable. It often takes several years until the owners of affected dogs notice any visual impairment.

prcd-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal recessive
Duration	3–5 working days

rcd1-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Irish Red and White Setter, Irish Red Setter
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

rcd1a-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Sloughi
Inheritance	Autosomal recessive
Duration	1–2 weeks

rcd2-PRA

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Collie (rough/smooth)
Inheritance	Autosomal recessive
Duration	1–2 weeks

rcd3-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Chinese Crested Dog, Pomeranian, Welsh Corgi Cardigan
Inheritance	Autosomal recessive
Duration	1–2 weeks

rcd4-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Australian Cattle Dog, Bolonka Zwetna, English Setter, Gordon Setter, Irish Red and White Setter, Irish Red Setter, Japanese Spitz, Old Danish Pointing Dog, Polish Lowland Sheepdog (PON), Poodle, Small Münsterländer, Tatra Shepherd Dog, Tibetan Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Type B1-PRA (HIVEP3)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
New research confirms the correlation between a mutation in the HIVEP3 gene and this early form of type B PRA in the Miniature Schnauzer. We recommend testing for the HIVEP3 variant as it has a better correlation than the previously offered test for the PPT1 gene.

XL-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Husky, Samoyed
Inheritance	X-linked recessive
Duration	1–2 weeks
Note	XL-PRA is a late form of the disease. The first signs usually occur at the age of three to five years.

Progressive Retinal Atrophy with Neurodegeneration (PCYT2 deficiency)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Saarloos Wolfhond
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the PCYT2 gene not only causes blindness but also widespread neurodegeneration with movement disorders, including cognitive impairment, behavioural changes (particularly aggression) and, in some cases, epileptic seizures. The first clinical signs are consistent with generalised PRA and can usually be seen from around 20 months of age onwards. Affected dogs often have to be euthanised.

Protein Losing Nephropathy (PLN) – Risk Analysis

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Airedale Terrier, Irish Soft Coated Wheaten Terrier
Duration	3–5 working days

Disease
Hereditary PLN manifests itself as hidden proteinuria from middle age onwards. The disease can be stable and mild for years. In some cases, however, severe complications such as kidney failure or thrombosis occur. The genetic test provides a risk assessment for PLN.

Pyruvate Dehydrogenase Phosphatase 1 Deficiency (PDP1)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Clumber Spaniel, Sussex Spaniel
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Even after minimal effort, affected dogs suffer from severe exercise intolerance which may lead to collapse. There may also be neurological signs.

Pyruvate Kinase Deficiency (PK)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Basenji, Beagle, Cairn Terrier, Labrador Retriever, Pug Dog, West Highland White Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The lack of pyruvate kinase causes severe chronic regenerative haemolytic anaemia, reticulocytosis, progressive myelofibrosis and osteosclerosis.

Raine Syndrome

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Border Collie
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Affected dogs show very severe tooth wear and gingivitis, which can lead to the loss of teeth. The excessive wear of the teeth results from a lack of mineralisation and, thus, reduced hardness of the enamel. The bones of these animals are usually less mineralised as well.

Renal Cystadenocarcinoma and Nodular Dermatofibrosis (RCND)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	German Shepherd
Inheritance	Autosomal dominant
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
A mutation in the BHD gene causes multifocal renal cystadenocarcinoma and nodular dermatofibrosis. Heterozygous affected dogs develop bilateral, multifocal renal tumours, uterine leiomyomas and skin nodules consisting of dense collagen fibres. This mutation seems to be embryonically lethal in most homozygous affected dogs.

Renal Dysplasia and Hepatic Fibrosis (RDHN)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Norwich Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
RDHN in Norwich Terriers is a structural/functional defect of primary cilia (ciliopathy). Primary cilia are only passively motile, occur on almost all types of cells and are, for example, important for organogenesis. Affected puppies suffer from diffuse cystic, enlarged kidneys, hepatic fibrosis, subcutaneous oedema, pleural effusion and ascites, underdeveloped lungs, cleft palate, diaphragmatic malformation/hernia and usually die shortly after birth.

Retinal Dysplasia (OSD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Labrador Retriever, Northern Inuit, Tamaskan
Inheritance	Autosomal dominant with incomplete penetrance (Labrador Retriever) Autosomal recessive (Northern Inuit, Tamaskan)
Duration	1–2 weeks

Disease
Retinal dysplasia (RD) or retinal folds is a relatively common clinical observation in many dog breeds and is per se not a breeding restriction. However, in the Labrador Retriever breed, retinal dysplasia can be associated with a more severe syndrome known as oculoskeletal dysplasia (OSD). Clinical signs of OSD are skeletal malformations, shortened limbs (dwarfism) as well as blindness at an early age. OSD in the Northern Inuit and the Tamaskan is caused by a different genetic variant (COL9A3 gene, exon 14) and is very similar to that in Labradors, but vision is not always impaired in these two breeds.

Robinow-like Syndrome (DVL2)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	American Bulldog, American Pitbull Terrier, American Staffordshire Terrier, Boston Terrier, Continental Bulldog, Dogue de Bordeaux, English Bulldog, French Bulldog, Olde English Bulldog, Shih Tzu, Staffordshire Bull Terrier

Inheritance	Autosomal recessive with incomplete penetrance
Duration	1–2 weeks

Disease

Robinow syndrome in humans is characterised by abnormal facial features (prominent forehead, wide-spaced eyes, flat nasal bridge) and shortened limbs.
In dogs, the English Bulldog, French Bulldog and Boston Terrier exhibit a breed-specific phenotype characterised by brachycephaly and a small body size. Malformed or missing caudal vertebrae result in a truncated screw tail. This phenotype is associated with a genetic variant in the dishevelled gene DVL2. DVL2, along with other genes (SMCO2 and BMP3), is associated with brachycephaly and does not only correlate with caudal vertebral malformations but also with thoracic vertebral malformations in these breeds. Inheritance seems to be recessive, with incomplete penetrance with regard to thoracic vertebral malformations. The DVL2 variant could also be linked to other health concerns like the brachycephalic obstructive airway syndrome (BOAS) and congenital heart defects, but this is still part of ongoing research.
The DVL2 variant has also been found homozygous or heterozygous in the following breeds: American Pitbull Terrier, Staffordshire Bull Terrier, Shih Tzu, American Staffordshire Terrier, Dogue de Bordeaux, Olde English Bulldog and American Bulldog. Here, too, DVL2 seems to be associated with brachycephaly and caudal vertebral malformations. In these breeds, however, the number of vertebrae is not reduced, the tail is not completely malformed and it does not seem to cause malformations of the thoracic vertebrae, but this could also be because of the incomplete penetrance.

Sensory Neuropathy (SN)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Border Collie
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

SN is caused by a degeneration of sensory and (to a lesser extent) motor neurons. Clinical signs start between 2 and 7 months of age and include progressive proprioceptive ataxia with hyperextension of the limbs and self-mutilation of the limbs. The hind legs are usually more affected. Proprioception and nociception are reduced in all limbs or are no longer present as the disease progresses. Urinary incontinence and vomiting may also occur. Sensory action potentials are reduced or absent, motor nerve conduction velocity is normal or reduced, the EMG of the innervated muscles is normal.

Severe Combined Immunodeficiency (SCID)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Frisian Water Dog, Jack Russell Terrier, Parson Russell Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
SCID is associated with very low immunoglobulin levels and lymphocyte counts, which causes a severe weakening of the cellular and humoral immune response. Affected dogs show increased susceptibility to viruses and bacteria and usually die of opportunistic infections at the age of 8–12 weeks.

Shar Pei Autoinflammatory Disease (SPAID)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Shar Pei
Inheritance	Autosomal dominant with incomplete penetrance (marker test)
Duration	3–5 working days

Disease
In addition to the typical fever, SPAID may cause the following clinical signs: arthritis, dermatitis, otitis, systemic amyloidosis, erythema in the area of the skin folds, skin that is stuck together and thickened, ocular inflammation and recurrent intestinal inflammation. First clinical signs of the disease usually appear at the age of 1 to 6 years.

Skeletal Dysplasia 2 (Dwarfism) (SD2)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
SD2 causes an early halt in growth of long bones. In contrast to other forms of dwarfism (pituitary dwarfism), the result are "disproportioned" dogs with shortened front limbs and a raising dorsal line, while torso length and depth are not altered.

Spinal Dysraphism (NTD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Weimaraner
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Neural tube defects result from abnormal closure or development of the neuronal tube during embryogenesis. In Weimaraners, spinal dysraphism is characterised by non-progressive ataxia and causes abnormal hair streams along the back, kinked tails, scoliosis in the lumbar spinal region, bunny-like hopping, crouched stance and paraparesis.

Spinocerebellar Ataxia (SCA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Fox Terrier, Jack Russell Terrier, Parson Russell Terrier, Patterdale Terrier, Tenterfield Terrier, Toy Fox Terrier) Sequencing (Alpine Dachsbracke)
Breed	Alpine Dachsbracke, Fox Terrier, Jack Russell Terrier, Parson Russell Terrier, Patterdale Terrier, Tenterfield Terrier, Toy Fox Terrier
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

The disease leads to a progressive restriction of the musculoskeletal system and loss of balance. The onset of the first signs is usually from the age of 3 months onwards.

Spondylocostal Dysostosis (Comma Defect)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Miniature Schnauzer
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks for sequencing)

Disease

Comma defect is mainly characterised by segmentation disorders of the spine and ribs. Already as newborns, affected dogs show disproportionate dwarfism as well as spinal shortening and rib defects. The skull has a prominent forehead and a protruding occiput. In addition, there may be malformations of the toes and abdominal wall defects. Malformed ribs lead to a smaller ribcage and respiratory insufficiency.

Spongiform Leukoencephalomyelopathy (SLEM)

Material	EB 1 ml, buccal swab
Method	Partner laboratory
Breed	Border Terrier
Inheritance	Autosomal recessive
Duration	5–6 weeks

Disease

SLEM, also known as shaking puppy syndrome, is a degenerative neurological disease. Changes in the myelin sheath of the nerve fibres in the white matter of the brain result in reduced transmission of nerve impulses. At around 2 weeks of age, there are usually initial tremors in the hind legs, later followed by generalised tremors, lack of coordination, seizures and a lower weight than the littermates. The onset of the first signs and their severity can vary, which is why it is assumed that other genetic variants or environmental factors are involved. The lack of effective treatment options leads to a poor quality of life, so that affected puppies usually have to be euthanised.

Spongy Degeneration with Cerebellar Ataxia (SDCA1 and 2)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (SDCA1) FLP (SDCA2)
Breed	Belgian Shepherd, Dutch Shepherd
Inheritance	Autosomal recessive
Duration	3–5 working days (SDCA1) 1–2 weeks (SDCA2)

Disease

SDCA is a neurodegenerative disease in Belgian and Dutch Shepherds.
Puppies with SDCA have an early onset of clinical signs at 5–8 weeks of age. They show ataxic gait, which is particularly obvious in the hind limbs. Other clinical signs are stumbling, staggering, intention tremor, muscle spasms, as well as loss of balance and falling. SDCA is a progressive disease, so that affected dogs must usually be euthanised at the age of 12 weeks.

Squamous Cell Carcinoma (SCC) of the Toe – Risk Analysis

Material	EB 1 ml (EDTA blood only)
Method	Droplet digital PCR
Breed	Giant Schnauzer (black), Poodle (black)
Duration	3–5 working days

Disease

Testing for digital SCC helps to assess the individual risk of developing acral squamous cell carcinoma in black Giant Schnauzers and black Poodles. A structural change, known as copy number variation, in the c-KIT ligand gene (KITLG) is analysed. A higher copy number of the KITLG gene indicates an increased risk of developing SCC.

Stargardt Disease (Retinal Degeneration) (STGD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Labrador Retriever
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

In Labrador Retrievers, a variant in the ABCA4 gene was found which can be associated with STGD and causes clinical signs similar to the human disease. The ABCA4 gene encodes a membrane transporter protein located in the rods and cones. The genetic variant leads to an increased accumulation of lipofuscin in the retinal pigment epithelium and to a degeneration of the cones and, later on, the rods. Some vision remains throughout lifetime.

Startle Disease

Material	EB 1 ml, buccal swab
Method	FLP (Irish Wolfhound) Sequencing (Australian Shepherd, Galgo Español, Miniature American Shepherd, Old English Sheepdog)
Breed	Australian Shepherd, Galgo Español, Irish Wolfhound, Miniature American Shepherd, Old English Sheepdog
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Startle disease or hyperekplexia is a hereditary neurodegenerative disease associated with impaired transport of the neurotransmitter glycine. In Irish Wolfhounds, Galgo Españols and Old English Sheepdogs, the disease is caused by individual mutations in the SLC6A5 gene, while a variant in the GLRA1 gene was found in Australian Shepherds and Miniature American Shepherds. The first signs appear at a very young age and intensify during movement, for example muscle tremors in response to acoustic or tactile stimuli, exaggerated stiffness of the leg muscles (up to a rigid position of all four limbs and inability to stand and walk). Cyanosis may also occur while suckling. Affected puppies must be euthanised.
Laboklin owns the exclusive license to perform this genetic test in the Irish Wolfhound.

Subacute Necrotising Encephalopathy (SNE)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Yorkshire Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

SNE is characterised by ataxia and spasticity as well as central nervous visual and sensory disorders. The first signs appear in the first year of life.

Succinic Semialdehyde Dehydrogenase Deficiency (SSADHD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Saluki
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

SSADH is involved in the degradation of the inhibitory neurotransmitter gamma-amino-butyric acid (GABA). In SSADH deficiency, the degradation of GABA is interrupted after the formation of succinic semialdehyde (SSA), which is then reduced to 4-hydroxybutyric

acid (GHB), among others. GHB is a major contributor to the clinical picture. The onset of neurological disorders (mild ataxia), seizures and behavioural changes (vocalisation, lethargy) is at 6–10 weeks and usually lead to euthanasia. Further abnormalities include absent reflexes (e.g. menace reflex), SSA in urine, GHB in serum and symmetrical spongiform changes in several areas of the brain (histology).

Thrombopathia

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Basset Hound, Landseer
Inheritance	Autosomal recessive
Duration	3–5 working days, 1–2 weeks in the case of sequencing

Disease

Dogs suffering from this hereditary form of thrombocytopathy have an unusually high number of veins, haematomas and bruises because their platelets do not respond normally to activation signals.

Trapped Neutrophil Syndrome (TNS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Border Collie
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Dogs with TNS can produce neutrophils but cannot release them into the bloodstream. Therefore, affected puppies have a weakened immune system. The onset and severity of the disease vary, but most dogs do not get older than four months.

Upper Airway Syndrome (UAS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Norwich Terrier
Inheritance	Autosomal dominant with incomplete penetrance
Duration	1–2 weeks

Disease

Although Norwich Terriers are considered a mesocephalic breed, they can suffer from UAS. In this breed, a variant in the ADAMTS3 gene was found which can be associated with UAS. Homozygous affected dogs show an elongated soft palate, malformed cartilage, everted laryngeal saccules and possibly vocal fold oedema. The resulting constriction of the respiratory tract leads – similar to brachycephalic breeds – to respiratory problems, heat and stress intolerance, cyanosis and the animals can collapse.

Van den Ende-Gupta Syndrome (VDEGS)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Fox Terrier, Toy Fox Terrier
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

All affected dogs exhibit a prominent underbite with short maxilla. Additional findings include lack of bone mineralisation, swollen knee joints as well as luxation of elbow or patella.

Ventricular Arrhythmia (IVA)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Rhodesian Ridgeback
Inheritance	Unclear (see note)
Duration	3–5 working days

Disease

IVA is triggered by a variant in the QIL1 gene. This gene encodes a protein involved in the formation and distribution of mitochondrial cristae. Affected dogs show ventricular and/or supraventricular tachycardia and other cardiac arrhythmias, usually between 6–18 months of age. In some cases, this leads to sudden cardiac death. This hereditary disease has incomplete penetrance and expression. Only about 60% of dogs carrying the variant have abnormal heart sounds and in some dogs the signs disappear with age.

Vitamin D-dependent Rickets (VDR)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Pomeranian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The hereditary form of vitamin D-dependent rickets type II is caused by a defect in the vitamin D receptor (VDR) gene. As a consequence, calcium cannot be absorbed intestinally, resulting in skeletal malformations and bone hypomineralisation during growth. Because the VDR gene is also involved in the hair growth cycle, alopecia may occur as well.

Von Willebrand Disease Type 1 (vWD1)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal dominant with incomplete penetrance and expressivity
Duration	3–5 working days

Disease

Clinical signs of vWD are prolonged bleeding time and severe bleeding.

Von Willebrand Disease Type 2 (vWD2)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	German Short-haired Pointing Dog, German Wire-Haired Pointing Dog
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Clinical signs of vWD are prolonged bleeding time and severe bleeding.

Von Willebrand Disease Type 3 (vWD3)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (Scottish Terrier, Shetland Sheepdog) Sequencing (Havanese, Kooikerhondje)
Breed	Havanese, Kooikerhondje, Scottish Terrier, Shetland Sheepdog (Sheltie)
Inheritance	Autosomal recessive
Duration	TaqMan SNP assay: 3–5 working days, sequencing: 1–2 weeks

Disease

Clinical signs of vWD are prolonged bleeding time and severe bleeding.

Xanthinuria Type 2

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Cavalier King Charles Spaniel, Dachshund, English Cocker Spaniel, English Toy Terrier, Manchester Terrier
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In xanthinuria type 2, genetic variants in the molybdenum cofactor sulfurase (MOCOS) gene lead to increased excretion of xanthine, a by-product of purine metabolism, in the urine. There is an increased risk of forming xanthine crystals and urinary stones. Signs can already occur at a few weeks of age but also in dogs that are several years old. Low-purine diets and increased water intake can reduce the risk of urinary stone formation.

X-linked Myotubular Myopathy (XL-MTM)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Labrador Retriever, Rottweiler
Inheritance	X-linked recessive
Duration	1–2 weeks

Disease

XL-MTM affects all skeletal muscles. The MTM1 gene encodes the production of myotubularin, which is not produced when this gene is defective. Clinical signs of this disease can already be seen from birth and include severe muscle hypotonia, muscle atrophy and progressive weakening of the hind limbs. Impaired breathing can ultimately lead to death by suffocation.

X-linked Retinal Dysplasia (XLRD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	English Cocker Spaniel
Inheritance	X-linked recessive
Duration	1–2 weeks

Disease

A variant in the NDP gene causes XLRD. Affected puppies suffer from severe visual impairment with absent dazzle and pupillary light reflexes. The animals develop nystagmus and the iris is darkened. There may be haemorrhages in the posterior segment of the eye as well as total retinal detachment.

X-linked Severe Combined Immunodeficiency (X-SCID)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Basset Hound, Welsh Corgi Cardigan, Welsh Corgi Pembroke
Inheritance	X-linked recessive
Duration	1–2 weeks

Disease

The disease is characterised by developmental disorders, increased susceptibility to pathogens and degeneration of peripheral lymph nodes. Affected dogs usually die as puppies.

21.2.2 Coat Colour/Coat Structure Dog

The coat colour of dogs is determined by the interaction of several genes that control the formation and distribution of the two main pigments eumelanin (black) and phaeomelanin (red/yellow).

Production is controlled by the gene MC1R (melanocortin-1 receptor, E-locus), other genes are responsible for colour variants and patterns. The gene for the brown coat colour (TYRP1, B-locus) modifies the black pigment to brown without the red pigment being involved. Other genes involved in coat colour include Agouti (ASIP, A-locus), which organises the distribution of black and red pigments, and Dilute (MLPH, D-locus), which dilutes, among others, black to blue/grey and brown to silver/lilac. There are other genes for the distribution of white patterns and other dilution genes which only play a role in certain breeds. Below, you will find the genetic tests for the inheritance of coat colour in dogs which are carried out at Laboklin.

A-locus: agouti (ASIP analysis)	
Material	EB 1 ml, buccal swab
Method	FLP + TaqMan SNP assay
Breed	All
Duration	1–2 weeks

B-locus: brown, chocolate, liver (nose) (bd, bc, bs)	
Material	EB 1 ml, buccal swab
Method	3 x TaqMan SNP assay
Breed	All
Duration	3–5 working days

B-locus: rare variants (b4, be, bh)	
Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (b4) Sequencing (be, bh)
Breed	b4: Australian Shepherd, Miniature American Shepherd be: Lancashire Heeler bh: Husky
Duration	3–5 working days (b4) 1–2 weeks (be, bh)

C-locus: albino (caL and OCA2)	
Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	French Bulldog, German Spitz, Lhasa Apso, Pekingese, Pomeranian
Duration	3–5 working days

C-locus: albino (OCA4)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bullmastiff
Duration	1–2 weeks

Coat Length I (long or short hair)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Coat Length II (long or short hair)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Afghan Hound, American Akita, Alaskan Malamute, Chow Chow, Eurasian, French Bulldog, Prague Ratter, Saluki, Samoyed, Shar Pei, Siberian Husky
Duration	1–2 weeks

Note

For these breeds, this test should be carried out in addition to the test Coat Length I listed above.

Cocoa: dark brown, dark chocolate

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	French Bulldog
Duration	3–5 working days

Phenotypic expression

Cocoa is inherited in a recessive manner and causes a brown coat colour in French Bulldogs that cannot be distinguished from the brown coat colour encoded at the B-locus. Cocoa, however, is associated with platelet dysfunction. Coagulation parameters are within the reference range, though. Nonetheless, in homozygous cocoa dogs, it is recommended to keep emergency medication at hand until bleeding diathesis can definitely be ruled out.

Curly (curled hair: C1, C2)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay and sequencing
Breed	All
Duration	1–2 weeks

Double Coat

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression

Double coat refers to the presence of two layers of hair: the topcoat and the undercoat. In dogs with a single coat, only the topcoat is present. The genetic test distinguishes between allele "A" (ancestral), which is associated with double coat, and the recessive allele "D" (derived), which, in homozygous form, is mainly found in dogs with single coat.

D-locus d1 (dilution)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

D-locus d2, d3 (rare variants)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	d2: Chow Chow, Sloughi, Thai Ridgeback Dog d3: Chihuahua, Italian Sighthound, Pumi and many more
Duration	1–2 weeks

Note

For breeds with d2 and d3, testing for d1 + d2 or d1 + d3 is recommended.

E-locus e1 (yellow, lemon, red, cream, apricot)

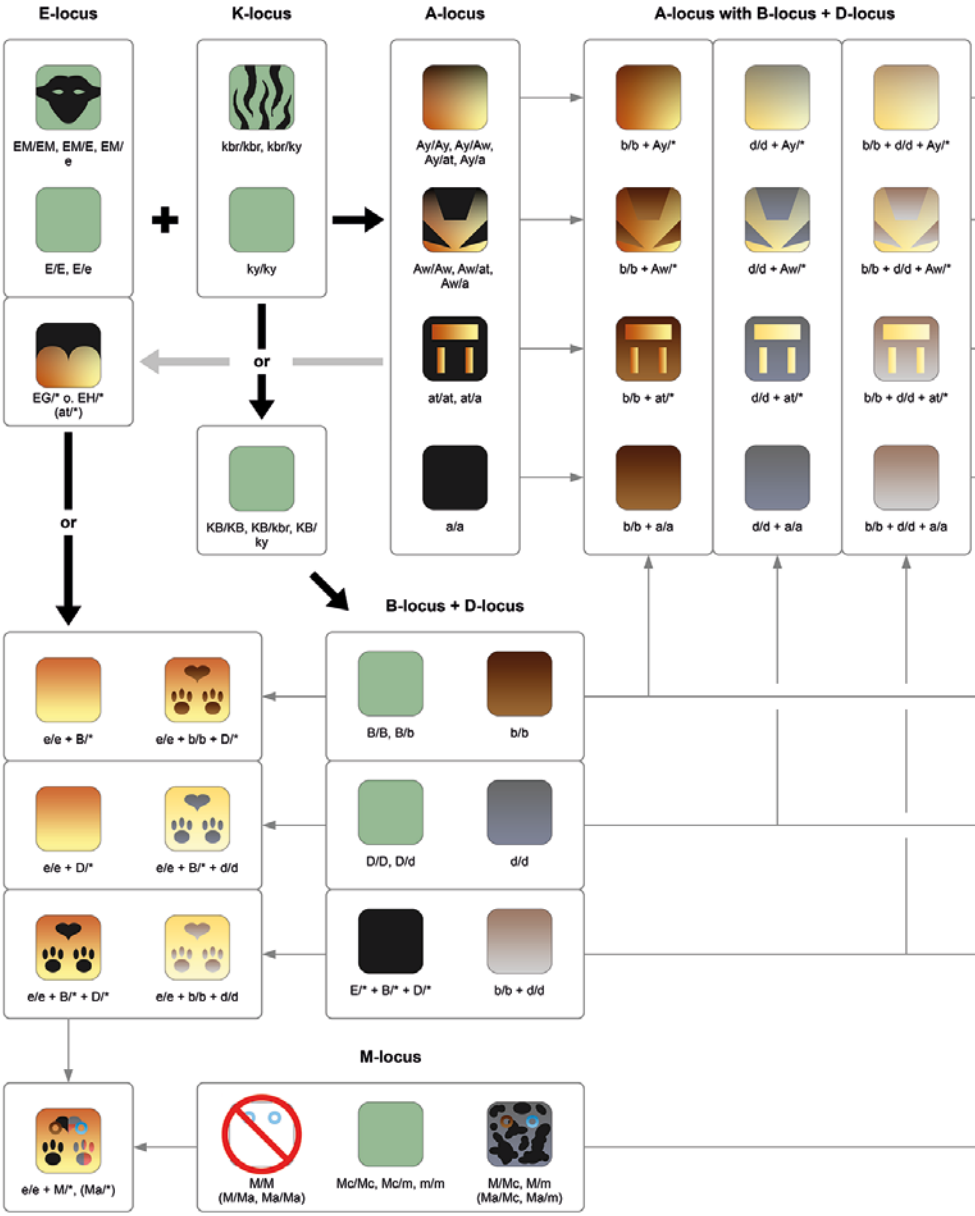
Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Note

In Australian Shepherds, Border Collies and other herding dogs, the colour variant "red" is detected by genetic testing of the B-locus.

E-locus e2 (rare variants)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Australian Cattle Dog
Duration	1–2 weeks


E-locus
K-locus
A-locus
A-locus with B-locus + D-locus
EM/EM, EM/E, EM/e
E/E, E/e
kbr/kbr, kbr/ky
ky/ky
Ay/Ay, Ay/Aw, Ay/at, Ay/a
Aw/Aw, Aw/at, Aw/a
at/at, at/a
a/a
b/b + Ay/*
b/b + Aw/*
b/b + at/*
b/b + a/a
d/d + Ay/*
d/d + Aw/*
d/d + at/*
d/d + a/a
b/b + d/d + Ay/*
b/b + d/d + Aw/*
b/b + d/d + at/*
b/b + d/d + a/a
EG/* o. EH/* (at/*)
or
KB/KB, KB/kbr, KB/ky
or
B-locus + D-locus
e/e + B/*
e/e + b/b + D/*
e/e + D/*
e/e + B/* + d/d
e/e + B/* + D/*
e/e + b/b + d/d
B/B, B/b
b/b
D/D, D/d
d/d
E/* + B/* + D/*
b/b + d/d
M-locus
e/e + M/*, (Ma/*)
M/M (M/Ma, Ma/Ma)
Mc/Mc, Mc/m, m/m
M/Mc, M/m (Ma/Mc, Ma/m)


Brindle
EM-locus
S-locus + T-locus
M-locus
kbr/* + Ay/*
EM/* + Ay/*
S/* + Ay/*
? + S/* + Ay/*
M/* + Ay/*
kbr/* + Aw/*
EM/* + Ay/*
S/* + Aw/*
? + S/* + Aw/*
M/* + Aw/*
kbr/* + at/*
EM/*, at/*
S/* + at/*
? + S/* + at/*
M/* + at/*
kbr/* + a/a
EM/* + a/a
S/* + a/a
? + S/* + a/a
M/* + a/a
b/b + kbr/*
b/b + EM/*
b/b + S/*
b/b + ? + S/*
b/b + M/*
d/d + kbr/*
d/d + EM/*
d/d + S/*
d/d + ? + S/*
d/d + M/*
b/b + d/d + kbr/*
b/b + d/d + EM/*
b/b + d/d + S/*
b/b + d/d + ? + S/*
b/b + d/d + M/*
M/*, (Ma/*) + S/*
M/*, (Ma/*) + ? + S/*

E-locus EG, EH, eA (special colours)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay (eA and EH) Sequencing (EG)
Breed	eA: all ("Husky colouring", similar to domino) EG: Afghan Hound (domino), Barzoi, Saluki (grizzle) EH: American Cocker Spaniel, English Cocker Spaniel (sable)
Duration	3–5 working days (eA, EH) 1–2 weeks (EG)

E-locus EM (melanistic mask)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Furnishing (long hair/wire hair)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

H-locus (harlequin)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Great Dane
Duration	3–5 working days

Phenotypic expression

The dominant harlequin allele modifies the merle pattern to white and leads to harlequin colouring with black patches on white background. Dogs with genotype H/H are not viable and die in utero.

Hairlessness (powderpuff)

Material	EB 1 ml, buccal swab
Method	FLP (Chinese Crested Dog, Mexican and Peruvian Hairless Dog) Sequencing (Deerhound)
Breed	Chinese Crested Dog, Deerhound, Mexican Hairless Dog (Xoloitz-cuintle), Peruvian Hairless Dog
Duration	1–2 weeks

Phenotypic expression

Dogs of the breeds Chinese Crested Dog and Mexican or Peruvian Hairless Dog which carry the heterozygous variant have sparse or no body hair, sometimes abnormal dentition and occasionally malformations of the pinna and the external auditory canal. Dogs without such a variant, on the other hand, have a normal coat and are called powderpuffs. Embryos with a homozygous genetic variant will already die during gestation.
In the Deerhound, another variant (in the SGK3 gene) may be associated with juvenile alopecia (loss of coat in the first weeks of life, permanent hairlessness).

I-locus (phaeomelanin intensity)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Improper Coat

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Portuguese Water Dog
Duration	1–2 weeks

K-locus (only alleles: KB, ky)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

K-locus (brindle)

Material	EB 1 ml, buccal swab
Method	Droplet digital PCR
Breed	All
Duration	1–2 weeks

M-locus: merle alleles (Mh, M, Ma+, Ma, Mc+, Mc, m and mosaics)

Material	EB 1 ml, buccal swab
Method	Droplet digital PCR
Breed	All
Duration	1–2 weeks

Phenotypic expression

Merle (M) is a coat pattern with sections of diluted colour pigments. It is caused by the gene variants M, Mh (harlequin merle) or Ma (atypical merle). Mc (cryptic merle) does not lead to any colour change. The 4 gene variants are inherited in an incomplete dominant manner to the normal form (non-merle, m).
The genotype M/M (double-merle) and all combinations of M or Mh with the alleles Mh, M or Ma can lead to severe malformations of the inner ear with hearing loss or deafness as well as to malformations of the eye and are therefore considered unacceptable from an animal welfare perspective. Such animals often display a very high amount of white or are completely white.

Risk Assessment of the Different Merle Allele Combinations in Dogs

Graphic modified from a an illustration by Corinne Benavides-Gyger (based on the research by Langevin et al. 2018)

S: safe; no pigment dilution to white and no merle-associated health impairments.
LR*: isolated cases of pigment dilution to white have been reported; therefore, impairments of hearing cannot, according to the current state of scientific knowledge, be ruled out with certainty.
LR: low risk; hearing impairment may occur.
MR: medium risk; hearing and vision impairments may occur.
HR: high risk; hearing and vision impairments are likely.

	m	Mc	Mc+	Ma	Ma+	M	Mh
m	S	S	S	S	S	S	LR
Mc	S	S	S	S	S	LR*	LR
Mc+	S	S	S	S	LR	LR	MR
Ma	S	S	S	S	LR	LR	HR
Ma+	S	S	LR	LR	MR	HR	HR
M	S	LR*	LR	LR	HR	HR	HR
Mh	LR	LR	MR	HR	HR	HR	HR

The expression of merle pattern can be limited to small areas (minimal merle) or may be masked by another colouration (hidden merle). A genetic test is therefore always advisable if merle is present or suspected in a breeding line.

Panda White Spotting

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	German Shepherd
Duration	1–2 weeks

Phenotypic expression

This form of white spotting with areas of unpigmented skin is inherited as an autosomal dominant trait; the homozygous mutation is lethal.

Ridge

Material	EB 1 ml, buccal swab
Method	Droplet digital PCR
Breed	Rhodesian Ridgeback
Inheritance	Autosomal dominant with incomplete penetrance
Duration	1–2 weeks

Disease

The ridge of the Rhodesian Ridgeback, a distinctive dorsal crest of hair growing in the opposite direction to the rest of the coat, is caused by a genetic variant in the so-called ridge gene. Genetic testing allows breeders to predict whether puppies without a ridge are to be expected from a planned mating. Undesirable variations in the appearance of the ridge may occur more frequently in homozygous dogs, although this has not yet been conclusively clarified.

S-locus (white spotting, piebald)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	All
Duration	1–2 weeks

Phenotypic expression

A severe form of spotting is often linked to deafness, which mainly occurs in animals where the white spotting covers the head and ears.

Saddle-tan

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Basset Hound, Welsh Corgi Cardigan, Welsh Corgi Pembroke
Duration	1–2 weeks

Shedding

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression
Shedding, in combination with other coat characteristics (furnishings and hair length), influences the degree of hair loss in dogs.

Ticking (roan, mottle, spotted)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression
Genetic testing for the Tr allele provides information on the inheritance of the ticking trait in unpigmented areas of white spotting, but does not indicate whether it manifests itself as roan, mottle, spots or flecks.

21.2.3 DLA Typing

DLA genes (**Dog Leukocyte Antigen**) encode proteins that belong to the MHC complex (major histocompatibility complex) class II and which play a central role in the immune response.
High genetic diversity in the DLA genes increases the effectiveness of the immune system and decreases the risk of autoimmune diseases. In many breeds, however, this diversity is significantly reduced by a limited breeding pool, repeated use of the same sires, etc. Depending on the breed, certain DLA gene combinations are associated with an increased or decreased risk of autoimmune diseases such as diabetes mellitus, hypothyroidism, exocrine pancreatic insufficiency and hypoadrenocorticism (Addison's disease).

DLA typing is used to analyse the specific DLA alleles present in an individual dog. This test can be used to select the ideal mating partners and thus ensure that the resulting offspring is as heterozygous as possible, thereby increasing genetic diversity. It also helps to avoid certain genetic combinations that are associated with an increased health risk.

Material	EB 1 ml, buccal swab
Method	Sequencing
Species	All
Duration	1–2 weeks

For further information and details of the tests included, please visit:
https://labogen.com/en/dog-leukocyte-antigens-dla/

21.2.4 LABOGenetics XXL Dog

The comprehensive test package LABOGenetics XXL Dog analyses over 340 genetic variants and provides information on hereditary diseases, genetic risk factors, coat colours and coat traits. It is suitable for both purebred dogs and mixed breeds, including those with an unknown genetic background.

LABOGenetics XXL Dog offers a number of benefits:
- **Comprehensive testing:** It provides detailed results for all genetic tests included.
- **Universally applicable:** It is recommended for dogs of all breeds as well as for mixed breeds whose genetic background is unknown, as it includes both breed-specific and cross-breed tests.
- **Bonus information:** Even if a specific part of the tests is of primary interest, choosing LABOGenetics XXL provides additional genetic information free of charge.

Material	EB 1 ml, special swabs on request
Species	Dog
Breed	All breeds and mixed breeds
Duration	10–14 working days

Please note: We also offer **LABOGenetics XXL Dog** in combination with the **Premium SNP DNA Profile (ISAG 2020)**.

For further information and details of the tests included, please visit:
https://labogen.com/en/labogenetics-xxl-dog/

21.3 Cat

21.3.1 Hereditary Diseases

Acrodermatitis Enteropathica (AE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Turkish Van
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

AE is caused by a variant in the SLC39A4 gene. This gene encodes an intestinal zinc transporter; a loss of function of this transporter leads to systemic zinc deficiency. Affected kittens show growth retardation and diarrhoea from 6–8 weeks of age onwards and suffer from severe, rapidly progressing dermatological signs such as scaling, alopecia, moist dermatitis, severe erosions and lesions on abdomen and limbs. Since there is another intestinal zinc transport pathway, zinc deficiency can be treated by high oral doses of zinc.

Alpha-Mannosidosis (AMD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Persian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Alpha-mannosidosis (AMD) is a lysosomal storage disease which causes clinical signs like malformations in bone structure as well as severe neurological signs such as ataxia, tremor and limited vision. Cats affected by this rare disease usually die after birth or in the first months of life.

Atherosclerosis (ATH)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Korat
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A variant in the LDLR gene is associated with atherosclerosis, which is characterised by severe hypercholesterolaemia and heart failure, ultimately leading to death. Atherosclerotic lesions are mainly found in large and coronary arteries and may result in thrombosis. Clinical signs do not appear until middle or older age.

Autoimmune Lymphoproliferative Syndrome (ALPS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	British Shorthair (BSH), Scottish Fold
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

In British Shorthair, ALPS has been found in cats in New Zealand and Australia. ALPS has an early onset, affected cats show signs of lymphadenopathy and splenomegaly during the first weeks with a rapidly progressive clinical course.

Blue Eyes

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Maine Coon
Inheritance	Autosomal dominant with incomplete penetrance
Duration	1–2 weeks

Disease
A variant in the PAX3 gene causes blue eyes in Maine Coons and is also associated with unilateral or bilateral deafness as well as minimal white spotting not explained by previously known variants. The homozygous presence of this variant seems to result in embryonic/foetal lethality. Carriers of this genetic variant should be excluded from breeding.

Congenital Hypothyroidism (CH)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	British Shorthair (BSH), Russian Blue
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A variant in the thyroperoxidase (TPO) gene causes CH in the breeds British Shorthair and Russian Blue. Affected cats show mild to severe disproportionate dwarfism and may also suffer from goitre, mental dullness, constipation and delayed dentition. Serum total T4 concentrations are low or within reference range while TSH concentrations are increases. CH is usually diagnosed in young animals. Treatment with thyroid hormones is possible and results in clinical improvement. There is evidence suggesting that some animals with congenital hypothyroidism may also present with less severe clinical signs.

Congenital Myasthenic Syndrome (CMS)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Devon Rex, Sphynx
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
CMS in cats leads to generalised amyosthenia in affected animals, especially after stress and agitation. Some animals exhibit a typical "squirrel-like" posture. First signs already appear at three weeks of age. Cats with CMS normally die within two years.

Cystinuria

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Cystinuria is an inherited metabolic disease with defective reabsorption of certain amino acids in the proximal renal tubule. This results in an increased urinary excretion of the amino acid cystine. Because of the excessive accumulation of cystine in the urine and its poor solubility in water, cystine crystallises and calculi are formed. These uroliths already occur at a young age.

Epileptic Encephalopathy (EE)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	1–2 week

Disease
A variant in the CAD gene was identified in a Bengal cat with EE. At just 3 months of age, one kitten developed generalised tonic seizures and abnormal behaviour. The seizures occurred while sleeping, lasted up to one minute and were characterised by sudden jumps, followed by opisthotonus, head swaying, lip smacking, chewing movements, facial twitches, salivation and impaired consciousness. The animal also displayed episodes of abnormal behaviour with impaired consciousness, agitation and biting the floor or its own paws. The cat only partially responded to antiepileptic drugs and was euthanised.

Factor XI Deficiency (F11)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Maine Coon
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Laboklin has identified a genetic defect in the F11 gene to be the cause of factor XI deficiency in Maine Coon cats. Diagnostically, factor XI deficiency manifests itself in a prolonged partial thromboplastin time while prothrombin time remains normal, and clinically, there is a tendency for haematoma and minor bleeding after trauma.

Factor XII Deficiency (F12)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Coagulation factor XII is involved in the intrinsic cascade of blood coagulation. Two different mutations have been described in the factor 12 gene that cause FXII deficiency. XII deficiency prolongs the partial thromboplastin time (PTT) in plasma without increasing the bleeding tendency in affected cats.

Gangliosidosis Type GM1, Type GM2

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Balinese, Burmese, Javanese, Korat, Oriental Shorthair (OSH), Peterbald, Seychellois, Siamese, Thai, Tonkinese
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Kittens affected by this lysosomal storage disease have head tremors at the beginning, later followed by impaired coordination of the limbs which eventually lead to paralysis. In GM2 gangliosidosis, clinical signs usually appear earlier (around the age of 2 months) and worsen more quickly. In GM1 gangliosidosis, the onset of neurological signs is a little later (3 months) and they progress more slowly.

Genetic Blood Group

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All, except for European Shorthair
Duration	3–5 working days

Disease
The genetic blood typing test looks for the genetic "b" allele which is necessary for the expression of the serological blood type B. If a female cat has blood type B, the male cat must also have blood type B to avoid neonatal isoerythrolysis in the kittens of the litter (see also Chapter 3.3, p. 47).

Glycogen Storage Disease Type IV (GSD4)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Norwegian Forest Cat
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Most affected kittens die at or soon after birth, presumably due to hyperglycaemia. Survivors of the perinatal period appear clinically unaffected until the onset of progressive neuromuscular degeneration about 5 months of age, which eventually leads to death.

Head Defect

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Burmese
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Cats with Burmese head defect have a severe craniofacial deformity and are not viable. One copy of the mutation does not cause any "malformation" but may lead to a shortened facial structure (brachycephaly).

Hypertrophic Cardiomyopathy (HCM1, HCM3, HCM4)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Maine Coon (HCM1, A31P mutation), Ragdoll (HCM3, R820W mutation), Sphynx (HCM4)
Inheritance	Autosomal dominant with incomplete penetrance
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

HCM is caused by two variants in the MYBPC3 gene (HCM1, HCM3) or one variant in the ALMS1 gene. In HCM1 and HCM3, there is an increased risk of phenotypic expression if the cat is homozygous for the mutation. So far, it is unclear whether the risk of HCM4 is higher in homozygous cats than in heterozygous ones. Furthermore, in the Sphynx, it is assumed that there is at least one other unknown variant that can cause HCM. Generally, not all genetically affected cats show clinical signs of HCM (incomplete penetrance).

Hypokalaemia

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Australian Mist, Burmese and its outcross breeds (e.g. Burmilla), Cornish Rex, Devon Rex, Singapura, Sphynx, Tonkinese
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Hypokalaemia, also known as familial episodic hypokalaemic polymyopathy, is characterised by episodes of skeletal muscle weakness. Affected cats have problems with walking, jumping and holding their head correctly.

Hypotrichosis and Short Life Expectancy

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Birman (Sacred Cat of Burma)
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Affected kittens have a thin downy coat that falls out within a week of birth. Regrowth of a thin coat may occur within the first two months in some animals. Other kittens are born completely bald. Other clinical signs include oily and crusty skin in the facial area and anomalies of the claws, tongue and whiskers. In some cases, the disease may cause stillbirths or death within the first few weeks of life due to impaired immune response.

MDR1 Gene Variant

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease

MDR1 is a drug transporter. It limits the entry of drugs across the blood-brain barrier into the brain and influences intestinal absorption and concentration in bone marrow cells. The MDR1 gene defect correlates with a disturbance in the metabolism of various pharmaceuticals such as antiparasitics (e.g. ivermectin) and possibly also antibiotics, cytostatics as well as analgesics and anaesthetics. There is an increased absorption of drugs from the intestine with simultaneously reduced excretion in the liver and kidneys. This leads to higher drug levels in the blood and corresponding signs of a toxic effect on the brain, liver, kidneys and the haematopoietic system. In heterozygous animals, too, it must be assumed that drug metabolism is impaired and tolerance is reduced.

Mucopolysaccharidosis Type VI (MPS6)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Balinese, Birman (Sacred Cat of Burma), European Shorthair, Javanese, Oriental Shorthair (OSH), Peterbald, Ragdoll, Seychellois, Siamese, Thai, Tonkinese
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

MPS6 is a lysosomal storage disease that occurs in two phenotypes and is characterised by severe abnormalities of the bone structure and the nervous system as well as dwarfism. First clinical signs of the severe phenotype appear after only a few weeks of life.

Mucopolysaccharidosis Type VII (MPS7)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

MPS7 is a rare lysosomal storage disease that leads to bone and cartilage malformation, corneal clouding and enlarged abdominal organs due to a dysfunction in the breakdown of mucopolysaccharides. This can already be seen from the age of two months onwards.

Myotonia congenita

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Myotonia congenita is a disease that affects the skeletal muscles. Signs of the disease are mainly stiff-legged gait as well as a protruding tongue and a mandible which can hardly be opened. Dysphagia and excessive salivation are often seen.

Osteochondrodysplasia (OCD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Scottish Fold
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

A mutation in the TRPV4 gene leads to the characteristic forward-folded ears in Scottish Fold. Furthermore, this mutation causes osteochondrodysplasia in this breed with deformities of the bones and joints of the distal limbs and tail. Homozygous affected cats develop severe malformations; in Germany, breeding homozygous animals is considered unacceptable from an animal welfare perspective, and mating two carrier animals is therefore prohibited by law.

Polycystic Kidney Disease (PKD)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Angora, Birman (Sacred Cat of Burma), British Longhair, British Shorthair (BSH), Chartreux, Colourpoint Shorthair, Exotic Shorthair, Persian, Ragdoll, Russian Blue, Scottish Fold, Selkirk Rex

Inheritance	Autosomal dominant
Duration	3–5 working days

Disease

In PKD, in addition to the formation of cysts in the liver and pancreas, fluid-filled cysts form in the kidneys which can eventually cause renal failure. It is caused by a variant in the PKD1 gene.

Polycystic Kidney Disease (PKD2)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Neva Masquerade, Siberian
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

Polycystic kidney disease is caused by a variant in the PKD2 gene. As with PKD1, renal cysts ultimately lead to renal failure.

Polydactyly

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease

Polydactyly can affect 1–4 paws, though the extra digits usually develop on the forelimbs or on all limbs. The number of extra toes varies as well. So far, two forms of polydactyly have been described. In cats with "mitten paw", the additional digits are shorter than the normal digits and they are further apart. In cats with "patty foot", the additional digits have the same length as the normal digits and the gaps are the same between all digits. The paw is broad and resembles a "burger patty". There are three responsible genetic variants which are located in a regulatory region of the Sonic Hedgehog (SHH) gene. They were first described in domestic cats in England (UK1 and UK2 variants) and in Hemingway cats in the USA (Hw variant).

Primary Congenital Glaucoma (PCG)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Siamese
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Cats with primary glaucoma often have congenital malformations in the eye causing increased intraocular pressure. This results in damage to the retinal ganglion cells and the optic nerve, which leads to blindness within the first months of life.

Progressive Retinal Atrophy (PRA)

b-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Bengal
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
Bengal progressive retinal atrophy causes destruction of the retinal photoreceptors from about 7 weeks of age onwards and leads to a dilation of the pupils. b-PRA progresses slowly until the cat already has very limited vision at about 2 years of age. Time varies until complete blindness develops.

pd-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Angora, Birman (Sacred Cat of Burma), British Longhair, British Shorthair (BSH), Chartreux, Colourpoint, Exotic Shorthair, Persian, Ragdoll, Russian Blue, Scottish Fold, Selkirk Rex
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
Progressive retinal atrophy (pd-PRA) causes photoreceptor degradation in affected animals already at 5 weeks of age, leading to complete blindness by 16 weeks of age. The main signs are uncoordinated eye movements. The ocular fundus shows increased reflectivity.

rdAc-PRA

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Abyssinian, American Curl, American Wirehair, Balinese, Bengal, Colourpoint, Cornish Rex, Javanese, Munchkin, Ocicat, Oriental Shorthair (OSH), Peterbald, Seychellois, Siamese, Singapura, Somali, Thai, Tonkinese
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
The onset of clinical signs is usually at the age of 1.5 to 2 years (so-called late onset). At the final stage of the disease, usually at the age of 3–5 years, the photoreceptors are completely destroyed and the cat becomes totally blind.

rdy-PRA

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Abyssinian, Ocicat, Somali
Inheritance	Autosomal dominant
Duration	1–2 weeks

Disease
Already at the age of about three weeks, retinal malformations are visible during examinations (so-called early onset); affected cats usually go almost completely blind at the age of about seven weeks.

Pyruvate Kinase Deficiency (PK)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	Abyssinian, Angora, Bengal, Egyptian Mau, European Shorthair, LaPerm, Maine Coon, Norwegian Forest Cat, Ocicat, Savannah, Siberian, Singapura, Somali
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
PK is characterised by chronic regenerative haemolytic anaemia. Severe haemolytic crises also occur, especially in case of stress or infections. Occasionally, an enlarged spleen is palpable.

Skeletal Dysplasia (SD)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	British Shorthair (BSH), Scottish Fold
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
A mutation in the LTBP3 gene causes skeletal dysplasia, which is associated with paralysis of the hind legs, lordosis and scoliosis, myelopathy and motility disorders of the gastrointestinal tract. The first signs were seen at 8 weeks of age. In affected kittens, deformation of several thoracic vertebral bodies, spinal stenosis, compression of the spinal cord and coprostasis occurred, resulting in the kittens being euthanised.

Spinal Muscular Atrophy (SMA)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	Maine Coon
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

SMA is characterised by muscle atrophy and muscle weakness which are associated with the degeneration of spinal motoneurons and already occur at the age of about 12 weeks.

21.3.2 Coat Colour/Coat Structure Cat

Coat Colour Amber

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	Norwegian Forest Cat
Duration	3–5 working days

Coat Colour Brown (chocolate/cinnamon)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Coat Colour Copal

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Kurilian Bobtail
Duration	1–2 weeks

Coat Colour Russet

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Burmese
Duration	1–2 weeks

Coat Colour Variant Agouti

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Coat Colour Variant Albino

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Coat Colour Variant Charcoal

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bengal
Duration	1–2 weeks

Coat Colour Variant Colourpoint (Siam/Mink/Burma)

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	All, except for Bengal
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Coat Colour Variant Dilution

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Coat Colour Variant Gold (copper/sunshine)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	British Shorthair (BSH), Kurilian Bobtail, Sibirian
Duration	1–2 weeks

Phenotypic expression

The colour variant gold is a modification of the tabby pattern. There are three variants of the CORIN gene known that cause the colours "copper", "sunshine" and "extreme sunshine".

Coat Colour Variant Snow

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Bengal
Duration	1-2 weeks

Note
Snow is the name for colourpoint colouration in Bengals.

Coat Colour Variant Tabby (mackerel, blotched)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Coat Colour Variant Ticked

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay, if necessary sequencing
Breed	All
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Coat Colour Variant White (dominant white/white spotting)

Material	EB 1 ml, buccal swab
Method	FLP
Breed	All
Duration	1–2 weeks

Phenotypic expression
White spotting (ws) and dominant white (W) are caused by insertions of the endogenous retrovirus FERV1 in the KIT gene; ws is a complete insertion, W is a partial insertion. W is dominant over ws and both are dominant over the wild type (w+). Hearing loss or deafness always occur in the genotype WW, and sometimes occur in Wws and Ww+. The W allele also leads to a typical blue colouration of the iris; in Wws and Ww+, again, penetrance is incomplete.

Coat Length (long or short hair)

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Note
This test detects all five known alleles for long hair.

Coat Variant Curly in Selkirk Rex

Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Selkirk Rex
Duration	1–2 weeks

Coat Variant Sphynx/Devon Rex

Material	EB 1 ml, buccal swab
Method	TaqMan SNP assay and FLP
Breed	Devon Rex, Sphynx
Duration	1–2 weeks

21.3.3 LABOGenetics XXL Cat

LABOGenetics XXL Cat analyses over 50 genetic variants. It provides information on hereditary diseases, genetic risk factors, coat colours, coat characteristics and the genetic blood group.

The benefits of LABOGenetics XXL Cat are clear:

- **Comprehensive testing:** It provides detailed results for all genetic tests included.
- **Universally applicable:** It is recommended for cats of all breeds as well as for mixed breeds whose genetic background is unknown, as it includes both breed-specific and cross-breed tests.
- **Bonus information:** Even if a specific part of the tests is of primary interest, choosing LABOGenetics XXL provides additional genetic information free of charge.

Material	EB 1 ml/ special swabs on request
Species	Cat
Breed	All breeds and their mixes
Duration	10–14 working days

Please note: We also offer **LABOGenetics XXL Cat** in combination with the **Premium SNP DNA Profile (ISAG 2020)**.

For further information and details of the tests included, please visit:
https://labogen.com/en/labogenetics-xxl-dog/

21.4 Rabbit

21.4.1 Hereditary Diseases

Megacolon (MC)	
Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	Flemish Giant
Inheritance	Autosomal recessive with incomplete penetrance
Duration	1–2 weeks

Disease

Congenital megacolon is a disease that is characterised by a dilated colon, impaired intestinal motility and digestive problems and results in reduced viability. A mutation in the KIT gene is responsible for the disturbed intestinal peristalsis. The disease is associated with spotting in rabbits.

21.4.2 Coat Structure Rabbit

Rex Shorthair	
Material	EB 1 ml, buccal swab
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression

There are three known loci that are associated with the development of the very soft, short Rex coat in rabbits. The r1 mutation is caused by a change in the LIPH gene and is the most common variant of the Rex coat.

21.5 Horse

21.5.1 Hereditary Diseases

Androgen Insensitivity Syndrome (AR1)	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Quarter Horse and related breeds
Inheritance	X-linked recessive
Duration	1–2 weeks

Disease
In androgen insensitivity syndrome, XY (genetically male) horses have a female phenotype (female external genitalia) and internal testes. These horses often behave like stallions, but are not capable of reproduction.

Androgen Insensitivity Syndrome (AR2, AR3, AR4, AR5)

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Tennessee Walking Horse, thoroughbreds, warmbloods
Inheritance	X-linked recessive
Duration	4–6 weeks

Disease
see AR1

Cerebellar Abiotrophy (CA)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Arabian
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
CA is a neurological disease in which affected foals are born without symptoms; the first signs usually appear at the age of 6 weeks (up to 4 months): neurological deficits such as head shaking, ataxia and other deficiencies can occur in varying degrees of severity.

Congenital Stationary Night Blindness (CSNB2)

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Missouri Fox Trotter, Standardbred, Tennessee Walking Horse
Inheritance	Autosomal recessive
Duration	4–6 weeks

Disease
In congenital stationary night blindness (CSNB), affected animals cannot see in low light or darkness. CSNB is not progressive. Some typical signs of CSNB are fear of unfamiliar places in the dark, difficulty finding food or water buckets at night, or being prone to injuries at night-time. CSNB in horses is often not detected by the owner. The definitive diagnosis of CSNB is made by electroretinogram.
Similar to humans and other animals, there are probably several different genes that contribute to this disease in horses, and these genes are thought to be breed-specific. Based on population screening, it is estimated that one in one hundred Tennessee Walking Horses is homozygous for this variant and therefore presumed to be night blind.

Congenital stationary night blindness can also be caused by a homozygous mutation in the leopard gene. To test for the presence of this mutation, the Leopard Complex test should be requested (see Chapter 21.5.2, p. 452).

Distichiasis

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Friesian
Inheritance	Autosomal recessive with incomplete penetrance
Duration	4–6 weeks

Disease

Abnormal growth of eyelashes from the Meibomian glands leads to misplaced eyelashes. They can cause irritation and inflammation of the cornea, excessive tearing, squinting and pain up to ulceration and scarring of the cornea. Loss of vision may occur or the eye may need to be removed. In some horses, there are no signs of abnormal growth of the eyelashes, so it may remain undetected that these horses will transmit this genetic variant in any case.

Dwarfism

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Friesian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Dwarfism in Friesian horses is characterised by growth retardation of the ribs and limbs, while the head and back appear normal. Hyperextension of the fetlock joints is particularly noticeable. The flexor tendon becomes longer. This leads to an abnormal gait with extreme rotation at the carpus and hocks. The ribcage is wider than normal with a thickening of the costochondral junction (Th 10–16). The back appears disproportionately long, but the legs are significantly shorter. The abdomen is usually rounded, the muscles of the whole body are only poorly developed.

Dwarfism (ACAN, Chondrodysplasia)

Material	EB 1 ml, hair roots
Method	Sequencing
Breed	American Miniature Horse, Shetland Pony
Inheritance	See information below
Duration	1–2 weeks

Disease
Dwarfism is most common in Shetland Ponies and Miniature Horses. Phenotypic features include deformed mouths and cleft palates (respiratory problems), limb deformities, a disproportionately large head, a short neck and abdominal hernia. Four different mutations in the ACAN gene (D1, D2, D3, D4), which are inherited in an autosomal recessive manner, can also cause disease in a compound heterozygous form, i.e. two different heterozygous mutations of the same gene are present. Compound heterozygous variants combined with the D1 variant (except for N/D1) often lead to death. A combination with the D2 variant is considered to be the mildest form.

Equine Juvenile Spinocerebellar Ataxia (EJSCA)

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Quarter Horse
Inheritance	Autosomal recessive
Duration	4–6 weeks

Disease
In this neurological disease, first identified in 2020, foals developed ataxia and coordination deficits between the 1st and 4th week of life, with the hind limbs being particularly affected. As the disease progressed, the foals turned their hind limbs to the side while their forelimbs remained firmly on the ground, which made them appear to walk sideways. Within a few days, the animals were unable to stand on their own and had to be euthanised. Common findings were elevated glucose and γ-GT concentrations. Post-mortem examination revealed pronounced lesions in the spinal cord.

Equine Malignant Hyperthermia (EMH)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal dominant
Duration	3–5 working days

Disease
The clinical signs appear after halothane anaesthesia or succinylcholine injection and include hyperthermia (> 40 °C) and metabolic acidosis. The animals show generalised spasms of the skeletal muscles, followed by cardiac arrhythmia and renal dysfunction.

Foal Immunodeficiency Syndrome (FIS)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Dales Pony, Fell Pony, Tinker Horse/Gypsy Cob
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Foals with FIS are born apparently healthy but as they lack immunity, they develop a number of diseases, especially pneumonia and diarrhoea, at a few weeks of age. Foals also suffer from severe progressive anaemia and usually die before the age of three months.

Glycogen Branching Enzyme Deficiency (GBED)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Appaloosa, Paint Horse, Quarter Horse and related breeds
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Clinical signs of GBED are abortion, stillbirth or birth of weak foals, sudden cardiac death (especially on the pasture) or death caused by seizures, high respiratory frequency due to weakened respiratory muscles or general weakness (especially when getting up).

Hereditary Equine Regional Dermal Asthenia (HERDA)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Appaloosa, Paint Horse, Quarter Horse and related breeds
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
The skin of affected horses is hyperextensible, scarred, and often shows severe lesions.

Hereditary Myotonia

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay, if necessary sequencing
Breed	German Riding Pony, New Forest Pony
Inheritance	Autosomal recessive
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Disease
The first signs of congenital myotonia already appear at a few weeks of age. Foals have a stiffed-legged gait, are recumbent and have considerable difficulty getting back on their feet after a long period of lying.

Hoof Wall Separation Disease (HWSD)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	American Miniature Horse, Connemara Pony, German Riding Pony

Inheritance	Autosomal recessive
Duration	3–5 working days

Disease

Hoof wall separation disease (HWSD) is characterised by a very unstable hoof wall which can crack and break without any particular strain. Signs already appear in the first weeks of life and can be of varying severity.

Hydrocephalus

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Friesian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Hydrocephalus in Friesian horses often results in stillbirth of affected foals and dystocia in dams.

Hyperkalaemic Periodic Paralysis (HYPP)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Appaloosa, Paint Horse, Quarter Horse and related breeds
Inheritance	Autosomal dominant
Duration	3–5 working days

Disease

The horses are usually very well-muscled and can be successful show/sport horses between episodes of illness with general weakness, muscle spasms and fasciculations. The first episodes of illness are often observed at the age of 3 to 7 years. Life-threatening complications are cardiac arrhythmia (secondary to hyperkalaemia) and danger of suffocation by laryngospasm.

Hypertriglyceridaemia-induced Pancreatitis (HIP)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Freiberger
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

The genetic variant HIP causes a metabolic disorder – the loss of function of an important enzyme involved in fat metabolism which is responsible for breaking down ingested fats. If this enzyme is absent, triglycerides accumulate in the blood, which in turn causes acute pancreatitis. Affected foals show signs such as inappetence, diarrhoea, fever and apathy. These foals usually die within the first few weeks of life or have to be euthanised.

Idiopathic Hypocalcaemia

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Thoroughbred
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

Foals affected by the lethal hypocalcaemic syndrome suffer from muscle spasms, stiff gait and increased sweating. They die soon or are euthanised within a few weeks.
A genetic variant in the RAPGEF5 gene is inherited homozygously and associated with hypoparathyroidism. The reduced PTH production leads to calcium deficiency. Since the breed is used for improvement breeding, it cannot be ruled out that this hereditary disease is bred into other breeds.

Immune-Mediated Myositis & MYH1 Myopathy (MYHM)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Appaloosa, Paint Horse, Quarter Horse and related breeds
Inheritance	Autosomal dominant with incomplete penetrance
Duration	1–2 weeks

Disease

A variant in the gene MHY1 inhibits the function of the myosin protein and is associated with muscle diseases known as MYH1 myopathy (MYHM). This genetic variant leads to 2 clinical pictures – immune-mediated myositis (IMM) in 8- to 17-year-old horses and non-exertional rhabdomyolysis in young horses.
IMM is a muscular autoimmune disorder with mainly lymphocytic infiltration into muscle fibres and surrounding blood vessels. IMM can lead to weakness, stiffness and severe muscle atrophy with loss of up to 40% of muscle mass in 72 hours. In addition to the genetic disposition, further adverse factors are important triggers. For example, about 39% of IMM-affected horses have suffered from infections like Streptococcus equi subsp. equi or EHV4 for a long time.
In young Quarter Horses, **non-exertional rhabdomyolysis** causes severe, sudden muscle damage which occurs without any physical exertion and is not necessarily associated with muscle atrophy.
Inheritance is autosomal dominant with incomplete penetrance. Thus, not all horses that have one or two copies of the genetic variant will suffer from the disease. Horses with two copies may be more severely affected.

Junctional Epidermolysis Bullosa (JEB1)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Belgian Draft

Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease
Shortly after birth, foals lose skin parts on the head, neck and trunk. The hoof horn also separates from the hoof corium.

Junctional Epidermolysis Bullosa (JEB2)

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	American Saddlebred
Inheritance	Autosomal recessive
Duration	4–6 weeks

Disease
see JEB1

Lavender Foal Syndrome (LFS)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Arabian
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
Affected foals show a range of neurological signs, including convulsive seizures, opisthotonus or nystagmus. They are normally unable to stand and nurse from their mother and are usually euthanised if they do not die immediately after birth.

Lethal White Foal Syndrome (LWO)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Appaloosa, Paint Horse, Quarter Horse
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
LWO (also called overo lethal white syndrome OLWS) mainly occurs when mating frame overo horses. Affected foals are born completely white and die within 24–48 hours after birth due to intestinal aganglionosis and the resulting ileus.

Multiple Congenital Ocular Anomalies Syndrome (MCOA) ➢ Silver Dapple, p. 453

Naked Foal Syndrome (NFS)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Akhal-Teke
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

NFS is a genodermatosis in which foals are born with almost no hair. They show a mild form of ichthyosis and mostly die in the first weeks after birth. So far, the reason for the early death is unknown; only few horses reach an age of up to 2.5 years.

Occipitoatlantoaxial Malformation (OAAM)

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Arabian
Inheritance	Autosomal recessive
Duration	4–6 weeks

Disease

OAAM is characterised by a fusion of the occipital bone with the atlas. An additional malformation of the axis with an accompanying shortened dens can cause an unstable connection between the atlas and axis. Subluxation of the atlantoaxial joint is also possible. The resulting compression of the spinal cord can cause neurological signs. Affected horses show an abnormal head and neck posture and reluctance to move the neck. Clinical signs range from weakness of the limbs to progressive ataxia. In addition to the deletion in the homeobox gene cluster (HOX), several mutations seem to be the cause of OAAM in Arabian horses.

Ocular Squamous Cell Carcinoma (SCC)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Belgian Draft (Ardennais, Brabant), Belgian Warmblood, Connemara Pony, Haflinger, Holsteiner, Rocky Mountain Horse
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

A variant in the DDB2 gene was detected as a genetic risk factor (R) for squamous cell carcinoma of the limbus or the third eyelid in Haflingers and related breeds. Homozygous horses (R/R) develop SCC 5.6 times (Haflinger) or 4.0 times (Belgian Draft) more often than horses with one copy (R/N) or no copy (N/N). This risk factor does not explain all cases of SCC, but seems to be a significant contributor in Haflingers and Belgian Drafts.

Furthermore, the homozygous genotype was found in horses of the breeds Rocky Mountain Horse, Connemara Pony and in a Holsteiner/Belgian Warmblood cross breed, which were diagnosed with ocular squamous cell carcinoma. In homozygous horses (R/R), routine eye examinations and UV protection are advisable.

Overo Lethal White Syndrome ➢ **Lethal White Foal Syndrome, p. 447**

Polysaccharid Storage Myopathy Type 1 (PSSM)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Inheritance	Autosomal dominant
Duration	3–5 working days

Disease

The clinical signs are similar to those of sporadic exertional rhabdomyolysis and include the entire spectrum from reluctance to move to muscle tremor, muscle stiffness, sweating, shifting lameness, stretching of the hind limbs up to immobility. Episodes usually begin after 10–20 minutes of light exercise.
Laboklin owns the exclusive license to perform this genetic test.

Severe Combined Immunodeficiency (SCID)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	FLP
Breed	Arabian
Inheritance	Autosomal recessive
Duration	1–2 weeks

Disease

SCID is a primary, lethal immunodeficiency disease characterised by the inability to produce B and T lymphocytes. Affected foals are extremely susceptible to infections.

SynchroGait (DMRT3) ➢ **see Chapter 21.5.3, p. 455**

Tiger Eye ➢ **see Chapter 21.5.2, p. 454**

Warmblood Fragile Foal Syndrome (WFFS)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Appaloosa, Thoroughbred, Haflinger, Mustang, Paint Horse, Quarter Horse, Warmblood
Inheritance	Autosomal recessive
Duration	3–5 working days

Disease
WFFS is an inherited connective tissue disorder; its signs are similar to those of Ehlers-Danlos syndrome in humans. The skin is extremely fragile and tears at even the slightest touch. Not all foals are born after a normal period of gestation; premature births and miscarriages due to WFFS are also known.
In Germany, Laboklin owns the exclusive license to perform this genetic test.

21.5.2 Coat Colour/Coat Structure Horse

Agouti (Bay/Black)	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	FLP
Breed	All
Duration	1–2 weeks

Appaloosa Pattern 1 (PATN1)	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Brindle 1	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Camarillo White – W4	
Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	All
Duration	4–6 weeks

Champagne	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Chestnut

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Cream

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	All
Duration	3–5 working days

Curly

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Inheritance	See information below
Duration	1–2 weeks

Phenotypic expression

Curly Coat leads to a curly coat structure. Curly horses are popular because this coat structure causes milder or no symptoms in many horse-allergic people. Curly is caused by variants in the genes KRT25 and SP6, which are both separately examined in the test. Horses with variants in both genes or only in KTR25, do not only have curly coat but also develop hypotrichosis. Horses which only have a variant in SP6 just have a curly coat.

Dominant White W5, W10, W13, W20, W22

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	All
Duration	4–6 weeks

Dun

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay and FLP
Breed	All
Duration	1–2 weeks

Incontinentia Pigmenti

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression

IP is an ectodermal dysplasia in which pruritic, exudative skin lesions occur soon after birth, sometimes developing into verrucous lesions. There may be areas with alopecia where woolly hair might re-grow. From birth, affected horses show stripes in the coat and can also develop dental, hoof and ocular abnormalities. Due to the X-linked dominant inheritance, IP signs can only be seen in mares (affected male embryos die in utero).

Leopard Complex

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay, if necessary sequencing
Breed	All
Duration	3–5 working days (1–2 weeks in the case of sequencing)

Phenotypic expression

The leopard gene (LP) is inherited in a dominant manner and is responsible for the leopard pattern. From birth, homozygous carriers of the gene (LP/LP) are almost always affected by congenital stationary night blindness (CSNB).

Mushroom

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Shetland Pony
Duration	1–2 weeks

Pearl

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Roan Zygosity

Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	On request
Duration	4–6 weeks

Sabino-1

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Silver Dapple (MCOA)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Phenotypic expression

The dominantly inherited silver dapple gene leads to the dilution of black and bay hair, especially on mane and tail. There is a connection between this mutation and ocular malformations. These are more pronounced in homozygous animals than in heterozygous animals, where they can also remain undetected. The silver variant is also associated with multiple congenital ocular anomalies (MCOA) syndrome.

Snowdrop

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Tinker Horse/Gypsy Cob
Duration	1–2 weeks

Splashed White (SW 1–4)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing and FLP
Breed	All
Duration	1–2 weeks

Phenotypic expression

Splashed White is characterised by an extremely wide blaze, or bald face, often with blue eyes and bright white legs. So far, 4 causative mutations have been identified (SW1 to SW4), which are inherited in a dominant manner. Some horses with this pattern are deaf, especially if the ears are also white. SW2 and SW3 seem to be homozygous lethal.

Splashed White (SW 5–8)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	All
Duration	4–6 weeks

Phenotypic expression
Just like SW1–SW4, SW5–SW8 also cause splashed white markings with a similar phenotype, but the extent of the white pattern is variable. It is thought to be controlled by other genes, some of them known, some unknown. It is not known whether the mutations are homozygous lethal. However, due to the nature of the mutation and the role the MITF gene plays in development, it is assumed that SW6/SW6 may be embryonically lethal. Horses carrying combinations of the splashed white mutations, tobiano or overo lethal white may have extensive white markings or their coats may be completely white.

Sunshine	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	All
Duration	1–2 weeks

Tiger Eye	
Material	Only 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Paso Fino
Inheritance	Autosomal recessive
Duration	4–6 weeks

Tobiano	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	FLP
Breed	All
Duration	1–2 weeks

21.5.3 Performance Horse

Predictive Height Test	
Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	TaqMan SNP assay
Breed	Warmblood
Duration	3–5 working days

The height of warmblood horses is influenced by a variant in the LCORL gene in addition to factors such as feeding, husbandry and how young horses are reared. If the genotype is known, the height of the horse can be estimated. When mating, the chance of the desired phenotype (withers height) can be increased if, at best, the genotype of both parents is known.

Speed Gene (Myostatin Mutation)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	Thoroughbred
Duration	1–2 weeks

The protein myostatin is responsible for inhibiting muscle growth. Variants in the myostatin gene MSTN influence the development of different muscle types (proportion of muscle mass in relation to total weight). The test provides information about which racing distance is the best for the horse being tested, but does not provide any information about whether the horse is actually suitable as a racehorse.

SynchroGait (DMRT3)

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Partner laboratory
Breed	American Bashkir Curly Horse, American Miniature Horse, American Saddlebred, Appaloosa, Icelandic Horse, Kentucky Mountain Saddle Horse, Mangalarga Marchador, Missouri Fox Trotter, Morgan Horse, Paint Horse, Paso Fino, Paso Peruano, Quarter Horse, Scandinavian Coldblood Trotter, Trotter, Tennessee Walking Horse
Inheritance	Autosomal recessive
Duration	4–6 weeks

SynchroGait is a diagnostic DNA test for a genetic variant (A) that has a major impact on the gait and coordination of horses. The mutation facilitates lateral gates, which is a basic requirement for pace, and inhibits the transition from trot or pace to canter. AA horses have a natural talent for pace and excellent leg coordination in trot at high speed. In Icelandic Horses, AA horses have a predisposition to perform five gaits (incl. tölt and pace). CA and CC Icelandic Horses are more likely to perform only four gaits (tölt, but no pace).

Tractability

Material	EB 1 ml, 20–30 hair roots from mane or tail
Method	Sequencing
Breed	Thoroughbred
Duration	1–2 weeks

The test is intended to show a horse's willingness to learn and perform. Tractability is influenced by anatomical conditions and diseases, so the genotype does not necessarily have to match the phenotype.

21.6 Cattle

Sampling instructions
There should **not** be any **blood samples** sent in for **cattle from multiple births** because of a possible blood chimerism, but if the test allows it, hair roots, sperm or tissue samples can be used. One exception to this is the **free martin test,** for which a **blood sample is mandatory.**

21.6.1 Hereditary Diseases

Arachnomelia (spider limbs)	
Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	Brown Swiss, Fleckvieh
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease
Hereditary arachnomelia of Fleckvieh cattle and Brown Swiss is passed on in an autosomal recessive manner. It is characterised by a developmental disorder of the skeletal system leading to the birth of dead or malformed calves and an increased risk of injury to the mother.

Bovine Leukocyte Adhesion Deficiency (BLAD)	
Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	Holstein Friesian
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks

Disease
BLAD is a lethal autosomal recessive disease of the immune system in Holstein cattle. Affected calves suffer from immunodeficiency and die before reaching sexual maturity. Clinical signs include recurrent non-specific infections of the respiratory system and the gastrointestinal tract, delayed wound healing and reduced weight gain as well as leukocytosis with granulocytosis and lymphopenia as laboratory findings.

Bovine Progressive Degenerative Myeloencephalopathy (Weaver Syndrome)	
Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	Brown Swiss
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease
Weaver syndrome is a hereditary CNS disease in Brown Swiss. At the age of a few months, the first signs appear as weakness of the hind legs, problems getting up and unsteady gait. Disorders are progressive and, after 1–3 years, lead to recumbency and death.

Chondrodysplasia

Material	EB 1–2 ml, about 30 hair roots, tissue, sperm
Breed	Dexter, Scottish Highland
Inheritance	Autosomal dominant with incomplete penetrance
Duration	Approx. 3 weeks (partner laboratory)

Disease

In Dexter and Scottish Highland cattle, if the chondrodysplasia gene is inherited from both parents, the calf will suffer from disproportionate dwarfism (bulldog calves). The animals are generally not viable which leads to abortion or stillbirth. The test covers only the BD1 variant, not the less common BD2 variant.

Complex Vertebral Malformation (CVM)

Material	EB 1–2 ml, about 30 hair roots, tissue, sperm
Breed	Holstein Friesian
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease

CVM is a disorder affecting (Holstein) cattle and is caused by a genetic variant that leads to abnormal bone formation and impaired skeletal development, reduced weight and, in some cases, cardiac abnormalities. Affected foetuses are resorbed or calves are stillborn. The disease occurs in many breeding lines.

Factor XI Deficiency

Material	EB 1–2 ml, about 30 hair roots, tissue, sperm
Breed	Holstein Friesian, Sahiwal (zebu)
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease

Factor XI deficiency causes coagulopathy, which manifests as an increased bleeding diathesis and other signs caused by coagulation.

Freemartins

Material	EB 1 ml
Breed	All
Duration	ersetzen durch: 3–5 working days (partner laboratory)
Test principle	Testing for the presence of sex chromosomes

Note

In case of twins of different sexes, about 90% of infertile, externally female calves occur during gestation, so-called freemartins, due to the transfer of male cells to the female embryo. Already in newborn twins of different sexes, the phenotypically female calves can be examined to see whether they develop as free martins.

Spinal Dysmyelination (SDM)

Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	Brown Swiss
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease

SDM leads to insufficient myelination, especially in the spinal cord.
After birth, calves lie down in a lateral position with their limbs stretched forward. The head is often in a "moon-gazing position"; sometimes hyperreflexia can be observed. The animals are usually euthanised shortly after birth.

Spinal Muscular Atrophy (SMA)

Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	Brown Swiss
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease

SMA leads to the destruction of motor neurons and, at the age of a few weeks, to spinal muscular atrophy. The animals are recumbent, usually without losing their appetite. Spinal reflexes are reduced, pumping respiration is seen, and the animals often develop secondary pneumonia and die after a few weeks.

21.6.2 Breed Characteristics Cattle

Double Muscling

Material	EB 1–2 ml, about 30 hair roots, tissue, sperm
Breed	Aberdeen Angus, Asturian cattle, Belgian Blue, Blonde d'Aquitaine, Braford, Charolais, Devon, Gasconne, Limousin, Maine-Anjou, Marchigiana, Parthenais, Piedmontese
Duration	Approx. 3 weeks (partner laboratory)
Test principle	Risk analysis based on the variant present

Phenotypic expression

In cattle, a variety of recessive mutations in the myostatin gene (MSTN) lead to muscle hypertrophy, also known as double muscling. Double-muscled cattle have unusually large muscles, which are often associated with lower fat content in their meat and, depending on the variant present, an increased risk of dystocia. Accurate testing for these mutations can be important for meat yield and quality in livestock production.

Milk Protein

The composition of milk proteins is of considerable importance for further milk processing. In particular, the cheese-making properties of the milk strongly depend on the milk composition. 90% of the proteins in milk consist of the six proteins αS1-casein, αS2-casein, β-casein, kappa-casein, α-lactalbumin and β-lactoglobulin.

β-Casein

Material	EB 1–2 ml, about 30 hairs with roots, tissue, sperm
Breed	All
Inheritance	Autosomal co-dominant
Duration	3–5 working days

Phenotypic expression

The genetic variants A1 and A2 β-casein can be detected. Due in part to its different behaviour during digestion, so-called A2 milk is said to be better tolerated by people with milk allergies.

Kappa-Casein

Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	All
Inheritance	Autosomal intermediate
Duration	Approx. 3 weeks (partner laboratory)

Phenotypic expression

The kappa-casein gene influences important parameters for milk processing. Kappa-casein variant B is particularly favourable for further processing.

β-Lactoglobulin

Material	EB 1–2 ml, about 30 hair roots, tissue, sperm
Breed	All
Inheritance	Autosomal intermediate
Duration	Approx. 3 weeks (partner laboratory)

Phenotypic expression

β-lactoglobulin is an important component of whey. A high content of β-lactoglobulin is associated with increased milk yield and whey protein.

Polledness

Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	All
Inheritance	Autosomal (polled dominant over horned)
Duration	Approx. 3 weeks (partner laboratory)

Phenotypic expression

In polled cattle, the painful procedure of dehorning is no longer required. Reservations regarding loss of performance in polled lines have largely been eliminated. However, the test cannot evaluate the genetic predisposition for scurs and has not been validated for zebu cattle.

Red Factor	
Material	EB 3–5 ml, about 50 hair roots, tissue, sperm
Breed	All
Inheritance	Autosomal recessive (red recessive, black dominant)
Duration	Approx. 3 weeks (partner laboratory)

Phenotypic expression

Black pied cattle of the breed Holstein Friesian with a predisposition for a red coat ("red factor") are popular crossbreeds in red pied breeding. The MC1R gene (melanocortin 1 receptor gene) regulates the production of red and black coat pigments in cattle. Cattle carrying the dominant black allele are solid black or black-spotted; the wild type has a reddish-brown to brownish-black base colour; two copies of the recessive red allele result in a red coat colour.

21.7 Small Ruminants and South American Camelids

21.7.1 Hereditary Diseases

Arachnomelia (spider lamb syndrome)	
Material	20–30 hairs with roots
Species	Sheep of all breeds
Inheritance	Autosomal recessive
Duration	3–4 weeks (partner laboratory)

Disease

Hereditary chondrodysplasia leads to underdeveloped muscles in the lamb and, at about 4–6 weeks of age, to skeletal deformities of the head, spine, ribs and abnormally long and bent/twisted limbs (spider lambs). The disease is caused by a mutation in the gene FGFR3 (Fibroblast Growth Factor Receptor 3).

Freemartins	
Material	EB 3–6 ml
Species	Sheep, goat, llama, alpaca
Duration	3–4 weeks (partner laboratory)
Test principle	Testing for the presence of sex chromosomes

Note

In case of twins of different sexes, the transfer of male cells to the female embryo during gestation can result in infertile, externally female animals, so-called freemartins. In llamas and alpacas, the risk is 90%, for sheep and goats < 1%, but increases with multiple gestations with four or more foetuses. Already in newborn twins of different sexes, the phenotypically female calves can be examined to see whether they develop as freemartins.

Microphthalmia (sheep)

Material	EB 1–2 ml, buccal swab, tissue
Breed	Texel
Inheritance	Autosomal recessive
Duration	Approx. 3 weeks (partner laboratory)

Disease

Microphthalmia results in extremely reduced or absent globes. Affected lambs are blind.

Scrapie Susceptibility – Risk Assessment

Material	EB 1–2 ml
Species	Sheep, goat
Duration	1–2 weeks

Disease

Scrapie is a transmissible prion disease in sheep and goats. Prions are proteins. If they are pathologically altered, they induce their own proliferation and the vacuolation of nerve cells, especially in the brain stem. Initially, affected animals are lethargic, later they show increasing excitability and an unnatural gait and die within six months after the onset of the disease.

In sheep and goats, there is a genetic predisposition to the classical form of scrapie. Genotype classes are distinguished according to the amino acid pattern. The risk of scrapie varies from an extremely low ("resistant") to a very high risk depending on the genotype class.

21.7.2 Breed Characteristics Small Ruminants

Milk Protein αS1-Casein

Material	20–30 hairs with roots
Species	Goats of all breeds
Inheritance	Autosomal intermediate
Duration	3–4 weeks (partner laboratory)

Phenotypic expression

The αS1-casein gene influences the casein and fat content of goat milk. A high content of αS1-casein is positive for cheese production, a low content is beneficial for people with milk intolerance. The gene variants A and B are associated with high αS1-casein contents, while only little αS1-casein is formed in E, F and N.

21.8 Pig

Malignant Hyperthermia (MH)	
Material	EB 3–5 ml, 50 hair roots, tissue
Species	Pig
Duration	Approx. 2 weeks (partner laboratory)

Disease

MH or porcine stress syndrome (PSS) is inherited in a recessive manner and is mainly found in breeds with increased muscle mass and reduced amount of fat. The disease is caused by a mutation in the ryanodine receptor in skeletal muscle, which leads to a disturbance of the Ca^2 ion exchange and a lowered threshold for muscle cell contraction. It is accompanied by hypermetabolism and increased body temperature caused by inhalation anaesthetics, muscle relaxants and stress. Damage to nerve, liver and kidney tissue occurs.

22 DNA Profile, Breed, Species

22.1 Identity and Parentage

The DNA profile of an animal is also called genetic fingerprint. In contrast to other marking methods, like microchips or tattoos, it cannot be manipulated or destroyed by external factors, such as injuries. It remains unchanged for a lifetime.
On the one hand, a DNA profile provides a lifelong, doubtless identification of the animal. On the other hand, parentage (fatherhood or parenthood) can be proven with certainty by comparing the genetic fingerprints of the family members.

Comparison of DNA Profiles (parentage/paternity test)	
Material	The test is based on the DNA profiles of the parents and offspring, which must be obtained in advance (see below).
Method	Microsatellite analysis (STRs)
Species	Dog, cat, horse, donkey, cattle, sheep, goat, llama, alpaca, water buffalo, pig
Duration	1–2 weeks 4–5 weeks (donkey, sheep, goat, alpaca, llama, water buffalo, pig) (partner laboratory)
Note	The proof of parentage (paternity test) makes it possible to check which parents the offspring has. **What is important to know:** Even if only the paternity should be clarified, please send in samples from both parents. In dogs, this applies to the Classic STR DNA profiles (ISAG 2006). The Premium SNP DNA profile (ISAG 2020) in dogs has the potential to solve parentage cases for which only one parent is available (breeds on request).

DNA Profile (ISAG 2006) **Dog: Classic STR DNA Profile (ISAG 2006)**	
Material	EB 1 ml, buccal swab **Horse, donkey, sheep, goat, pig, water buffalo:** 20–30 hairs with roots **Cattle:** EB 1 ml, 20–30 hairs with roots (for animals from twin gestations: hairs only – no blood!) **Llama, alpaca:** buccal swab
Method	Microsatellite analysis (STRs) (according to ISAG 2006)
Species	Dog, cat, horse, donkey, cattle, sheep, goat, llama, alpaca, water buffalo, pig
Duration	1–2 weeks (dog, cat, horse, cattle) 3–5 weeks (all other species; partner laboratory)

Note

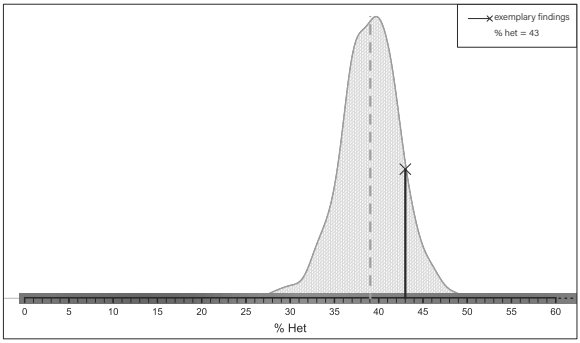
To create a DNA profile, we test so-called microsatellite markers (e.g. 22 markers in dogs), recommended in 2006 by the "International Society for Animal Genetics (ISAG)". The DNA profiles we generate are internationally comparable with laboratories working according to the recommendations of ISAG.
Dog: Classic STR DNA Profiles (ISAG 2006) and Premium SNP DNA Profiles (ISAG 2020) are not compatible and cannot be used simultaneously within the same parentage analysis.

Premium SNP DNA Profile (ISAG 2020)

Material	EB 1 ml, also possible from special swabs (see Chapter 1.7, p. 26)
Method	SNP analysis
Species	Dog (all breeds), cat (all breeds)
Duration	10–14 working days

Note

The Premium SNP DNA Profile follows the recommended 2020 ISAG guidelines (International Society for Animal Genetics) by analysing 230 SNPs (single nucleotide polymorphisms) and allows international comparability between laboratories. Test reliability and power of exclusion for parentage analysis are well above 99.99%.
The Premium SNP DNA profile also has the potential to solve parentage cases for which only one parent is available (breeds on request).
Furthermore, the Premium SNP DNA Profile **Dog** includes an analysis of the genetic variability (**heterozygosity**, see figure). Animals with a high heterozygosity are less affected by inbreeding than animals with a low heterozygosity.
Please note: Premium SNP DNA Profiles and Classic STR DNA Profiles are not compatible and cannot be used simultaneously within the same parentage analysis.
The Premium SNP DNA Profile **Dog** also includes the **Diversity Check** – see diversity.labogen.com.



Heterozygosity
grey shaded area:
genetic variability of the entire breed population which has been examined (n > 100);
dashed line:
mean value of the breed;
cross/solid line:
tested dog (value in the example: 43% het.)

Biostatistical Calculation (relationship analysis)

Material	EB 1 ml, buccal swab
Method	Microsatellite analysis (STRs) + database analysis
Species	Dog
Duration	2–3 weeks
Note	If only one parent (e.g. the father) is available for a proof of parentage, this test allows to calculate a so-called probability value ("likelihood"). Values can also be determined to evaluate full or half siblings if only samples of the potential siblings are available. **What is important to know:** The test is limited to the breeds in our database. Please contact us before sending your sample; we will be happy to assist you.

22.2 Breed and Species

Breed Determination (database analysis)

Material	EB 1 ml, buccal swab
Method	Microsatellite analysis (STRs) + database analysis
Species List	Dog, cat
Duration	3–4 weeks
Note	The genetic breed determination provides the statistical calculation of a matching probability to breeds in our database. The test can be used to verify purity of breeding as well as to detect first-generation mongrels. Thus, the test primarily allows to identify genetic proportions from specific breeds or the detection of non-purebred animals. Among others, the DNA profile of the animal serves as a basis for the test. **What is important to know:** The test is limited to the breeds in our database (current information can always be found on our website: https://labogen.com/en/breed-determination/).

Species Differentiation, Molecular Biological

Material	Various (possibly consultation by telephone)
Method	Sequencing and database analysis
Duration	2–3 weeks
Note	This method allows, for example, to assign certain signs to an animal species, because it is rarely possible to draw conclusions about the origin of samples such as faeces, trails of blood, etc. with the naked eye or with the help of common laboratory methods. In this test, a specific region of mitochondrial DNA is duplicated by PCR, sequenced and its origin analysed. Since this is a comparatively sensitive method, even the smallest sample quantities can be assigned (e.g. blood spatter). The differentiation of animal species using the latest molecular biological methods can be applied to a large number of questions, e.g. "Does the neighbour's dog/cat do its business in our garden?" We would be pleased to inform you in advance by telephone in order to clear up any confusion regarding the test.

23 Aquarium/Pond Water

Laboklin can test the water used to keep freshwater and saltwater fish as well as invertebrates.

Combi **Water Profile + Bacteriology (aerobic)**	
Material	500 ml water (cooled, if possible) + swab with medium (e.g. gills, wounds), tissue
Parameter	pH, total hardness (fresh water), conductivity (salt water), carbonate hardness, nitrate, nitrite, phosphate, copper, ammonium, bacteriology (aerobic)
Note	See Large Water Profile.

Large **Water Profile**	
Material	500 ml water (cooled, if possible)
Parameter	pH, total hardness (fresh water), conductivity (salt water), carbonate hardness, nitrate, nitrite, phosphate, copper, ammonium
Note	▪ Please indicate whether it is a freshwater or a saltwater sample. ▪ Determination of the essential chemical water parameters of an aquarium/pond. ▪ To clarify intoxications, for differential diagnosis if infectious fish diseases are suspected or for setting ideal husbandry/breeding conditions. ▪ Assessment of the acid-base balance (e.g. pH, carbonate hardness), the organic load of the water (e.g. ammonium, nitrite, nitrate) and the purification capacity of the filter. ▪ Determination of phosphate and copper is indicated in case of algae problems or suspected copper intoxication, especially in invertebrates.

Small **Water Profile**	
Material	500 ml water (cooled, if possible)
Parameter	pH, total hardness (fresh water), conductivity (salt water), carbonate hardness, nitrate, nitrite, ammonium
Note	See bullet points 1–4 of the Large Water Profile.

24 Hygiene Examinations

The quality and effectiveness of hygiene measures should therefore be assessed at regular intervals by means of appropriate methods.

Please only use printed submission forms to **order** hygiene tests (no online orders yet). You can request hygiene submission forms from Laboklin or print them out yourself (PDF in MyLab). We are also happy to take your orders over the phone (+49971/72020) or by e-mail (hygiene@laboklin.com).

The **test materials** for the following tests will be sent to you after we have received your order. With the exception of the test kits for instrument cleaning and disinfection devices, you have until the expiry date of the test kit to take samples, provided that this kit is stored in accordance with the specifications in the accompanying documents. For more information on pre-analytics, see Chapter 1.3, p. 22. The invoice will be issued after receipt of the order.

Hygiene tests are **not offered** in **Switzerland** (test materials (bioindicators) are only delivered within the EU).

24.1 Profiles Hygiene

Hygiene Monitoring – Steriliser + Surface Disinfection Efficacy Testing	
Material	Bioindicators + contact plates
Method	Culture
Duration	7 working days
Note	▪ Monitoring of a steriliser (heat or steam) + monitoring of 3 surfaces (with contact plates) after disinfection ▪ For information on pre-analytics, see Chapter 1.3, p. 22. ▪ If you participate regularly (2 x per year), you will get a certificate stating the successful annual monitoring of the disinfection performance of your steriliser and the surface disinfection test. ▪ This test is not available to third countries.

24.2 Single Tests

Disinfectant Testing

Material	Screw cap containers with disinhibitor solution broth
Method	Culture
Duration	3 working days
Note	For testing the sterility of disinfectant preparations or solutions

Endoscope Control, Culture

Material	2 swab with medium, 2 rinse samples, 1 water sample from the endoscopy water bottle
Method	Culture
Duration	3–5 working days
Note	For information on pre-analytical details, see Chapter 1.3, p. 22.

Endoscope Control, Qualitative Protein Detection

Material	Sterile brush
Method	Colour indicator
Duration	1 working day
Note	▪ This test is used to detect protein residues in endoscope channels and can identify even the smallest amounts. It is a dye-based method, which is also used in clinical chemistry as a method for measuring proteins. ▪ Please only request this test for **endoscopes** or **TEE probes** that cannot be tested using another method.

Heat Steriliser Control

Material	Bioindicators (contaminated with Bacillus atrophaeus)
Method	Culture
Duration	7 working days
Note	▪ For information on pre-analytical details, see Chapter 1.3, p. 22. ▪ If you participate regularly (2 x per year), you will get a certificate stating the annual monitoring of the disinfection performance of your heat steriliser. ▪ This test is not available to third countries.

Ozone Steriliser Control

Material	Bioindicators (contaminated with Bacillus atrophaeus)
Method	Culture
Duration	7 working days
Note	▪ For information on pre-analytical details, see Chapter 1.3, p. 22. ▪ If you participate regularly (2 x per year), you will get a certificate stating the annual monitoring of the disinfection performance of your steriliser. ▪ This test is not available to third countries.

Steam Steriliser Control (autoclave)

Material	Bioindicators (contaminated with Geobacillus stearothermophilus)
Method	Culture
Duration	7 working days
Note	▪ For information on pre-analytical details, see Chapter 1.3, p. 22. ▪ If you participate regularly (2 x per year), you will get a certificate stating the annual monitoring of the disinfection performance of your autoclave. ▪ This test is not available to third countries.

Surface Contamination Testing

Material	Contact plates
Method	Culture
Duration	2–3 working days
Note	▪ The surface is tested without prior disinfection. ▪ For information on pre-analytics, see Chapter 1.3, p. 22. ▪ This test is also suitable for testing hand contamination. ▪ Where applicable, the following multidrug-resistant pathogens can be identified: MRSA (methicillin-resistant Staphylococcus aureus) and/or MRSE (methicillin-resistant Staphylococcus epidermidis) and/or ESBL (pathogens that produce extended-spectrum β-lactamase). For this, additional costs will be incurred. ▪ For testing surface contamination after disinfection, the service "Surface Disinfection Efficacy Testing" is available.

Surface Disinfection Efficacy Testing

Material	Contact plates
Method	Culture
Duration	2–3 working days
Note	▪ This test is also suitable for testing the effectiveness of hand disinfection. ▪ Where applicable, the following multidrug-resistant pathogens can be identified: MRSA (methicillin-resistant Staphylococcus aureus) and/or MRSE (methicillin-resistant Staphylococcus epidermidis) and/or ESBL (pathogens that produce extended-spectrum β-lactamase). For this, additional costs will be incurred. ▪ For information on pre-analytics, see Chapter 1.3, p. 22. ▪ If you participate regularly (2 x per year), you will get a certificate stating the annual monitoring of the disinfection performance of your surface disinfection test. ▪ For testing the initial contamination, see the service "Surface Contamination Testing".

Testing of Air Settlement Plates

Material	Air settlement plate
Method	Culture
Duration	2–3 working days
Note	For monitoring the microbiological air quality in practice rooms. This test is not suitable for examinations of barns and stables!

Testing of Cleaning and Disinfection of Surgical Instruments

Material	Bioindicators incl. transport controls (screws with blood and/or semolina and E. faecium)
Method	Culture
Duration	3–7 working days
Note	▪ For information on pre-analytics, see Chapter 1.3, p. 23. ▪ If you participate regularly (2 x per year), you will get a certificate stating the annual monitoring of the disinfection of your device. ▪ This test is not available to third countries.

25 Reference Ranges

25.1 Dog, Cat, Horse

25.1.1 Clinical Chemistry

	unit	dog	cat	horse
Enzymes 37 °C				
ALT (GPT)	U/l	< 88	< 99	-
α-Amylase	U/l	< 1650	< 1850	< 50
AP	U/l	< 147	< 65	< 352
AST (GOT)	U/l	< 51	< 58	< 568
Cholinesterase	U/l	1347–2269	1000–2000	> 2344
CK	U/l	< 200	< 398	< 452
GLDH	U/l	< 8	< 10	< 13
γ-GT	U/l	< 10	< 5	< 44
α-HBDH	U/l	< 65	< 55	< 221
LDH	U/l	< 91	< 108	< 455
Lipase (DGGR)	U/l	< 120	< 26	< 20
Substrates				
Albumin	g/l	25–44	26–56	25–54
Albumin/globulin (A/G) ratio		> 0.59	> 0.6	> 0.7
Bile Acids	µmol/l	< 20 post-prandial < 40	< 20 post-prandial < 40	< 12
Bilirubin, total	µmol/l	< 3.4	< 3.4	8.6–59.9
Cholesterol	mmol/l	3.1–10.1	2.1–7.7	1.8–4.7
Creatinine	µmol/l	< 125	< 168	71–159
Fructosamines	µmol/l	< 374	< 340	< 360
Globulins	g/l	< 45	< 55	< 51
Glucose	mmol/l	3.05–6.1	3.1–6.9	3.1–5.0
β-HBA	mmol/l	< 0.6	< 0.75	< 0.6
Lactate	mmol/l	0.5–3.0	< 1.0	0.5–2.0
NEFA	mmol/l	0.1–0.5	0.1–0.5	0.1–0.5
Protein (total)	g/l	54–75	57–94	55–75
SDMA	µmol/l	< 0.65	< 0.75	< 0.75
Triglycerides	mmol/l	< 3.9	< 1.14	< 0.97
Urea	mmol/l	3.3–8.3	5.0–11.3	3.3–6.7
Electrolytes and Trace Minerals				
Calcium	mmol/l	2.3–3.0	2.3–3.0	2.5–3.4
Chloride	mmol/l	96–113	110–130	95–105
Copper	µmol/l	15.7–18.9	13.4–16.9	7.9–21.0
Iron	µmol/l	15–45	8–31	17.9–64.5
Magnesium	mmol/l	0.6–1.3	0.6–1.3	0.5–0.9
Manganese	µg/l	< 20	< 20	1.11–2.96
Phosphate	mmol/l	0.7–1.6	0.8–1.9	0.7–1.5
Potassium	mmol/l	3.5–5.1	3.0–4.8	2.8–4.5
Selenium	µg/l	80–250	80–250	100–200
Sodium	mmol/l	140–155	145–158	125–150
Zinc	µmol/l	7.7–19.9	12.2–15.3	5.0–14.4

Selenium horse: Up to 40 µg/l are marginal, more than 250 µg/l high/critical. Foals and Icelandic horses are sometimes well below these levels.

	unit	dog	cat	horse
Further parameters				
PLI	µg/l	< 180 (questionable: 180–310)	< 3.0 (questionable: 3.0–4.0)	-
TLI	µg/l	10.9–50.0*	12.0–82.0	-
Vitamin B12	pg/ml	300–800	300–800	-
Folic Acid	ng/ml	3.0–10.0	3.0 (4.0)–10.0	-
SAA	µg/ml	-	< 0.75	< 7.0

* Canine TLI: < 5.5 µg/l: consistent with exocrine pancreatic insufficiency (EPI),
5.5–10.9 µg/l: equivocal range,
> 10.9 µg/l: exocrine pancreatic insufficiency unlikely
> 50 µg/l: suggestive of acute or chronic pancreatitis or renal insufficiency;
recommendation: additional measurement of cPLI

25.1.2 Haematological Reference Ranges Dog, Cat, Horse

	unit	dog	cat	horse
Erythrocytes	T/l	5.5–8.5	5.0–10.0	6.0–12.0
Haematocrit	l/l	0.44–0.52	0.3–0.44	0.30–0.50
Haemoglobin	g/l	150–190	90–150	110–170
Leukocytes	G/l	6–12	6–11	5–10
Segmented	%	55–75	60–78	45–70
Lymphocytes	%	13–30	15–38	20–45
Monocytes	%	0–4	0–4	0–5
Eosinophils	%	0–6	0–6	0–4
Basophils	%	0	0–1	0–2
Unsegmented	%	0–4	0–4	0–6
Hypochromasia		neg.	neg.	neg.
Anisocytosis		neg.	neg.	neg.
Platelets	G/l	150–500	180–550	90–300
Differential blood count (absolute numbers)				
Segmented	G/l	3–9	3–11	3–7
Lymphocytes	G/l	1–3.6	1–4	1.5–4
Monocytes	G/l	0.04–0.5	0.04–0.5	0.04–0.4
Eosinophils	G/l	0.04–0.6	0.04–0.6	0.04–0.3
Basophils	G/l	< 0.04	< 0.04	0–0.15
Unsegmented	G/l	< 0.5	< 0.6	0–0.6
Reticulocytes	/nl	< 110	< 60	-

25.1.3 Hormones Dog, Cat, Horse

	unit	dog	cat	horse
ACTH	pg/ml	6–58	< 110	**November:** Negative: < 15 Equivocal: 15–50 Positive: > 50 **Dec. to Jun.:** Negative: < 15 Equivocal: 15–40 Positive: > 40 **July:** Negative: < 15 Equivocal: 15–50 Positive: > 50 **August:** Negative: < 20 Equivocal: 20–75 Positive: > 75 **Sep. to Oct.:** Negative: < 30 Equivocal: 30–90 Positive: > 90
Anti-Müllerian Hormone	ng/ml	m-neutered: < 0.1 m-intact: > 2.0 f-neutered: < 0.06 f-intact: > 0.09	m-neutered: < 0.1 m- intact: > 4.8 f-neutered: < 0.01 f-intact: > 2.59	ovariectomised mare: < 0.1 mare intact: < 4 mare/borderline: 4–7 mare with granulosa theca cell tumour: > 7 male neutered: < 0.1 male/borderline: 0.1–2 male intact: > 2
Cortisol	ng/ml	5–65	3–50 (130)	30–70
Insulin	µU/ml	8–25	10–30	< 15.0
Oestradiol	pg/ml	prooestrus: 25–65 oestrus: < 25 anoestrus: < 30 neutered: < 10 males: < 15 Sertoli cell tumour: > 30	interoestrus: < 20 oestrus: 20–60 - - - -	prooestrus: 1.2–6.2 oestrus: 7.1–13.0 dioestrus: 3.7–5.0 - - -
Progesterone	ng/ml	prooestrus: < 1.0 oestrus: < 30 ovulation*: 4.0–8.0 anoestrus: < 1.0	preov: < 1.0 postov: > 1.0 - -	luteal activity: > 1*** - - -
Testosterone	ng/ml	m: 1.5–8.5 f: < 0.4 m-neutered: < 0.5	m: 2.5–7.0 - m-neutered: < 0.5	stallion: 1.0–5.0 gelding: < 0.04 mare: < 0.04**
TSH	ng/ml	< 0.6	-	-
TSH	µU/ml	-	> 0.04	-
T3	ng/dl	20–206	33–167	25–180
f**T3**	pmol/l	3.7–9.2	0.8–1.4	1.1–7.2
r**T3**	pg/ml	107–542	130–475	-
T4	µg/dl	1.3–4.5	0.9–2.9	1.3–4.1
f**T4**	pmol/l	7.7–47.6	6.4–33.3	9.0–44.9

* Time of mating for female dogs: Optimum 24 to 48 hours, maximum 96 hours after ovulation
** Testosterone mare: Increased levels indicate a granulosa theca cell tumour.
*** Concentrations ≥ 1 ng/ml indicate corpus luteum function.
The test does not differentiate between cyclic and pregnancy-related corpora lutea.

25.2 Reference Ranges Rabbit, Guinea Pig and Ferret

25.2.1 Clinical Chemistry

	unit	rabbit	guinea pig	ferret
Enzymes 37 °C				
ALT (GPT)	U/l	< 113	< 113	< 450
α-Amylase	U/l	< 459	< 3159	< 62
AP	U/l	< 640	< 674	< 228
AST (GOT)	U/l	< 64	< 205	< 324
Cholinesterase	U/l	< 5569	< 12581	< 1590
CK	U/l	< 2281	< 5102	< 1740
GLDH	U/l	< 31	< 27	< 4
γ-GT	U/l	< 23	< 23	< 25
LDH	U/l	< 519	< 468	< 1619
Lipase (DGGR)	U/l	< 1587	< 152	< 351
Substrates				
Albumin	g/l	-	-	28–44
Bile Acids	µmol/l	0.76–19.63	< 84.5	< 28.9
Bilirubin	µmol/l	0.3–2.5	< 1.6	< 3.3
Cholesterol	mmol/l	0.3–2.7	0.3–1.7	2.4–7.1
Creatinine	µmol/l	51.4–154.4	< 77	23–77
Fructosamines	µmol/l	248.1–501.4	< 271	121–202
Glucose	mmol/l	5.8–14.8	5.0–16.0	3.0–8.5
Protein (total)	g/l	47.7–73.6	44–66	55–78
SDMA	µmol/l	0.20–0.89	-	0.14–0.38
Triglycerides	mmol/l	0.5–3.4	0.3–2.4	0.5–2.8
Urea	mmol/l	2.6–10.3	3.3–10.3	4.8–16.9
Electrolytes				
Calcium	mmol/l	3.0–4.3	2.4–3.1	2.0–2.6
Iron	µmol/l	20–59	26–76	12–56
Magnesium	mmol/l	0.7–1.5	1.0–2.6	0.9–1.6
Phosphate	mmol/l	0.5–2.2	1.0–7.0	1.0–3.1
Potassium	mmol/l	3.5–6.0	4.5–8.8	3.9–5.9
Sodium	mmol/l	132.6–154.0	130–150	140.1–169.7
Hormones				
Androstenedione	ng/dl	-	-	< 428
Anti-Müllerian Hormone	ng/ml	f-neutered: < 0.07* f-intact: > 1.53* m-neutered: < 0.07 (prel.)	-	-
17-OH Progesterone	ng/dl	-	-	< 26.1

	unit	rabbit	guinea pig	ferret
Oestradiol	pg/ml	-	-	5.0–16.5
T4	µg/dl	0.6–1.98	1.1–5.2	1.1–2.8
f**T4**	pmol/l	< 20 (30)	15.9–32.3	-

* Values in the questionable range should be retested, but may occur if small amounts of residual ovarian tissue are present.
prel. = preliminary reference range

25.2.2 Haematological Reference Ranges Rabbit, Guinea Pig, Ferret

	unit	rabbit	guinea pig	ferret
Erythrocytes	T/l	4.4–7.4	4.51–6.36	7.4–13.0
Haematocrit	l/l	0.28–0.48	0.39–0.55	0.4–0.7
Haemoglobin	g/l	89.6–153.8	117–169	139–219
Leukocytes	G/l	2.7–12.2	2.9–14.4	3.0–16.8
Segmented	%	32–64	12–62	17–82
Lymphocytes	%	13–54	28–84	13–81
Monocytes	%	3–14	< 9	1–7
Eosinophils	%	< 3	< 14	< 6
Basophils	%	< 9	< 2	< 1
Unsegmented	%	0	< 1	< 1
Reticulocytes	/nl	59.1–302.2	11.0–241.7	-
Hypochromasia		neg.	neg.	neg.
Anisocytosis		neg.	neg.	neg.
Platelets	G/l	225.5–905.3	273–745	172–1281
Differential blood count (absolute numbers)				
Segmented	G/l	0.9–7.8	0.9–5.1	0.9–7.4
Lymphocytes	G/l	0.4–6.6	1.4–10.7	0.6–10.5
Monocytes	G/l	0.08–1.7	< 0.7	< 0.5
Eosinophils	G/l	0.07–0.2	< 1.5	< 0.7
Basophils	G/l	0.06–1.1	< 0.11	< 0.2
Unsegmented	G/l	0	< 0.07	< 0.1

25.3 Reference Ranges Birds

25.3.1 Clinical Chemistry

	unit	parakeets	amazon parrots	parrot
Enzymes 37 °C				
ALT (GPT)	U/l	5–11	5–11	5–12
α-Amylase	U/l	205–490	205–510	210–530
AP	U/l	20–250	15–150	20–160
AST (GOT)	U/l	160–383	141–437	109–305
Cholinesterase	U/l	450–3200	780–6180	710–12450
CK	U/l	58–245	125–345	228–322
γ-GT	U/l	1–30	–	1–10
LDH	U/l	120–455	155–425	145–465
Lipase (DGGR)	U/l	30–280	35–225	35–350
Substrates				
Bile acids	µmol/l	44–108	33–154	12–96
Cholesterol	mmol/l	3.63–9.32	4.66–7.90	4.14–11.01
Creatinine	µmol/l	7.63–30.5	7.63–30.5	7.63–30.5
Glucose	mmol/l	13.82–20.15	12.27–16.76	11.43–15.26
Protein (total)	g/l	24–48	30–52	32–52
Triglycerides	mmol/l	0.51–2.26	0.55–2.15	0.51–1.64
Urea	mmol/l	1.04–1.78	–	1.07–1.93
Uric acid	µmol/l	210–650	120–520	160–520
Electrolytes				
Calcium	mmol/l	1.82–2.67	2.05–2.73	1.93–2.83
Phosphate	mmol/l	1.03–1.55	1.0–1.78	1.03–1.74
Potassium	mmol/l	2.4–4.6	3.0–4.5	2.9–4.6
Sodium	mmol/l	130–153	125–155	157–165

25.3.2 Haematological Reference Ranges Birds

	unit	parakeet	amazon parrots	parrot
Erythrocytes	T/l	3.1–4.4	2.45–3.18	2.84–3.62
Haematocrit	l/l	0.43–0.57	0.41–0.53	0.45–0.53
Haemoglobin	g/l	102–147	122–159	127–159
Leukocytes	G/l	5–11	6–17	6–13
Heterophils	%	46–72	31–71	45–73
Lymphocytes	%	26–60	20–54	19–50
Monocytes	%	0–1	1–3	0–2
Eosinophils	%	0–2	1–3	0–1
Basophils	%	0–1	0–1	0–1
Unsegmented	%	0	0	0
Hypochromasia		neg.	neg.	neg.
Anisocytosis		neg.	neg.	neg.

25.4 Reference Ranges Farm Animals

25.4.1 Clinical Chemistry

	unit	cattle	sheep	goat	pig	alpaca	llama
Enzymes 37 °C							
ALT (GPT)	U/l	< 93	< 33	< 32	< 126	< 93	<93
α-Amylase	U/l	< 161	< 120	< 120	< 3500	< 161	< 161
AP	U/l	< 484	< 359	< 1942	< 274	< 269	< 192
AST (GOT)	U/l	< 182	< 126	< 135	< 80	< 370	< 330
Cholinesterase	U/l	78–156	78–156	78–156	317–788	78–156	78–156
CK	U/l	< 595	< 208	< 268	< 4769	< 238	< 238
GLDH	U/l	< 48	< 76	< 20	< 6	< 50	< 50
γ-GT	U/l	< 88	< 63	< 63	< 79	< 75	< 45
α-HBDH	U/l	< 909	< 700	< 909	< 390	< 700	< 700
LDH	U/l	< 1364	< 1325	< 972	< 545	< 900	< 700
Lipase (DGGR)	U/l	2–8	-	2–8	-	2–8	2–8
Substrates							
Albumin	g/l	30–40	24–30	30–40	18–31	29–43	29–50
Bile acids	µmol/l	15–80	< 10	-	-	-	-
Bilirubin, total	µmol/l	< 5.0	< 8.5	< 8.5	< 4.3	< 6.8	< 8.6
Bilirubin, direct	µmol/l	< 3.4	< 3.4	< 3.4	< 1.7	< 3.4	< 3.4
Cholesterol	mmol/l	2.07–3.88	1.2–1.9	2.07–3.88	2.0–3.3	0.4–2.3	0.34–2.3
Creatinine	µmol/l	88–177	50–120	50–120	40–130	88–212	80–248
Globulins	g/l	< 48	< 48	< 48	< 64	< 31	< 32
Glucose	mmol/l	1.94–3.05	2.2–5.2	2.2–5.2	3.9–6.4	5.7–8.3	5.7–7.0
Haptoglobin	g/l	< 0.35	< 0.35	< 0.27	< 0.68	-	-
β-HBA	mmol/l	0.2–1.0	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6
Lactate	mmol/l	0.5–3.0	1–1.4	1–1.4	-	0.5–3.0	0.5–3.0
NEFA	mmol/l	< 0.8	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Protein (total)	g/l	60–80	50–70	60–80	55–86	57–72	47–73
SAA	µg/ml	< 6.5	-	-	-	< 6.4	< 6.7
Triglycerides	mmol/l	0.17–0.51	0.06–0.34	0.17–0.51	< 0.5	< 0.6	< 0.27
Urea	mmol/l	< 8	4.5–10.7	4.5–10.7	3.3–8.3	3.6–10.1	3.2–12.8
Electrolytes and Trace Minerals							
Calcium	mmol/l	2.3–2.8	2.1–2.7	2.2–2.8	2.4–3.5	2.1–2.5	1.9–2.7
Chloride	mmol/l	90–110	75–114	97–110	102–106	109–141	105–130
Cobalt	µg/l	1.0–3.5	1.0–3.5	1.0–3.5	-	1.0–3.5	1.0–3.5
Copper	µmol/l	8–24	7–24	16–32	16–39	2.1–12.5	6.1–7.9
Iron	µmol/l	20–40	20–30	16–35	16.7–35.3	18.8–37.4	18.6–30.8
Magnesium	mmol/l	0.8–1.3	0.8–1.0	0.8–1.0	1.1–1.5	0.7–1.0	0.8–1.1
Manganese	µg/ml	3.5–20	< 20	< 20	-	< 20	< 20
Phosphate	mmol/l	1.1–2.4	1.2–2.5	1.61–2.26	2.1–3.3	1.1–2.5	1.5–3.6
Potassium	mmol/l	3.5–4.5	3.5–4.5	4.5–6.5	4.0–5.0	4.0–5.7	3.6–6.2
Selenium	µg/l	40–85	55–170	62–158	100–200	> 99	> 99
Sodium	mmol/l	135–145	145–155	135–157	140–160	146–155	148–158
Zinc	µmol/l	8–24	11.0–20.5	10.7–19.9	10–20	3.0–14.6	4.1–12.4

	unit	cattle	sheep	goat	pig	alpaca	llama
Vitamins							
β-carotene	µg/l	> 2500	-	-	-	-	-
Vitamin A	µg/l	130–380	-	600–1500	-	-	-
Vitamin B12	pg/ml	> 100	> 100	100–1500	300–800	95–1192	-
Vitamin D (25OH)	nmol/l	75–125	-	-	-	-	-
Vitamin E	mg/l	> 3	> 3	> 3	1.6–4.6	> 3	-
Hormones							
Insulin	µU/ml	< 5	-	-	-	-	-
Progesterone	ng/ml	follicular phase: < 1 corpus luteum*: 1–10	-	-	-	not pregnant: < 1 questionable: 1–2 pregnant: > 2**	-
T4	µg/dl	3.4–8.2	-	-	-	6.7–20.6	6.6–19.3
f**T4**	pmol/l	-	-	-	-	14.0–32.0	12.1–29.2
T3	ng/dl	78–150	-	-	84–156	77.4–361.3	67.1–298.8
f**T3**	pmol	-	-	-	-	3.5–10.9	2.8–9.2
Other values							-
Haptoglobin	g/l	< 0.35	< 0.35	< 0.27	< 0.68	< 2.05	< 1.93
IgG (young animal)	mg/dl	> 800	> 800	-	-	> 800	> 800

* Values over 1.0 indicate luteal activity. It is not possible to differentiate between pregnant and non-pregnant by looking at the progesterone level. Between days 17–19, progesterone levels > 1 ng/ml indicate a lack of luteolysis, which is indicative of early pregnancy. The determination of PAG (pregnancy-associated glycoprotein) is recommended to diagnose pregnancy.

** Pregnancy determination by measuring progesterone from 3 weeks after mating. Results that are within the questionable range should be checked again after 2–3 weeks, as spontaneous ovulation can occur without successful conception. During the last 7–10 days before giving birth, the progesterone level drops significantly.

25.4.2 Haematological Reference Ranges Farm Animals

	unit	cattle	sheep	goat	pig	alpaca	llama
Erythrocytes	T/l	5.0–10.0	7.3–11.3	8–18	5.8–8.1	9.4–18.1	9.9–17.7
Haematocrit	l/l	0.28–0.38	0.29–0.38	0.24–0.48	0.33–0.45	0.22–0.45	0.25–0.46
Haemoglobin	g/l	90–140	80–120	80–120	108–148	102–193	115–195
Leukocytes	G/l	4–10	4–10	4–13	10–22	7.1–18.6	8.9–22.4
Segmented	%	25–45	10–50	30–48	10–39	49–65	49–65
Lymphocytes	%	45–65	40–80	50–70	49–85	21–25	21–25
Monocytes	%	2–6	0–15	0–4	2–4	0–5	0–5
Eosinophils	%	1–10	0–8	1–8	0–6	6–22	6–22
Basophils	%	0–2	0–4	0–1	0–5	0–0.5	0–1
Unsegmented	%	0–3	0–4	0–2	0–7	0	0–1
Platelets	G/l	300–800	200–800	200–800	175–580	200–600	200–600

	unit	cattle	sheep	goat	pig	alpaca	llama
Differential blood count (absolute numbers)							
Segmented	G/l	1.0–3.5	0.7–4.0	1.2–6.2	1.0–8.2	3.5–12.1	4.6–16
Lymphocytes	G/l	2.5–5.5	2.0–4.0	2.0–8.0	6.0–16.0	1.5–4.7	0.7–4.8
Monocytes	G/l	0–0.33	0–0.7	0–0.4	0–1.0	0–0.9	0–1.0
Eosinophils	G/l	0.3–1.5	0.1–1.0	0.05–0.6	0–1.3	0.4–4.0	0–3.3
Basophils	G/l	0–0.1	0–0.3	0–0.12	0–0.05	0–0.1	0–0.3
Unsegmented	G/l	0–0.2	0–0.2	0–0.2	0–1.5	0	0–0.15

25.5 App for Reference Values

The **LaboRef app** provides frequently required reference values, sorted by category and animal species, and can be accessed anytime and anywhere. Please find more information in the App Store and the Play Store.

26 Conversion Table for Laboratory Diagnostic Parameters

On the diagnostic findings compiled by us, you will find the measured values as well as information on the standard ranges in the internationally valid SI units. During follow-up checks, you may want to compare the measured values of different findings using identical units of measurement. The conversion factors for the parameters for which we have changed the unit of measurement are listed below.

To convert from one unit of measurement to the other, the corresponding measured value must be multiplied with the conversion factor (e.g. bilirubin in mg/dl x 17.104 = bilirubin in µmol/l).

26.1 Clinical-chemical Parameters

	Old unit	Conversion factor to SI unit	SI unit	Conversion factor to old unit
Substrates				
Albumin	g/dl	144.9	µmol/l	0.0069
Bilirubin	mg/dl	17.104	µmol/l	0.0585
Cholesterol	mg/dl	0.0259	mmol/l	38.664
Creatinine	mg/dl	88.402	µmol/l	0.0113
Fibrinogen	mg/dl	0.01	g/l	100
Glucose	mg/dl	0.0555	mmol/l	18.016
Lactate	mg/dl	0.111	mmol/l	9.0080
Protein (total)	g/dl	10	g/l	0.1
Triglycerides	mg/dl	0.0114	mmol/l	87.500
Urea	mg/dl	0.1665	mmol/l	6.0060
Uric acid	mg/dl	59.48	µmol/l	0.0168
Electrolytes and Trace Minerals				
Calcium	mg/dl	0.2495	mmol/l	4.0080
Chloride	mg/dl	0.2821	mmol/l	3.5453
Copper	µg/dl	0.1574	µmol/l	6.3532
Iron	µg/dl	0.1791	µmol/l	5.5847
Magnesium	mg/dl	0.4113	mmol/l	2.4312
Phosphate	mg/dl	0.3229	mmol/l	3.0974
Potassium	mg/dl	0.2557	mmol/l	3.9102
Sodium	mg/dl	0.4350	mmol/l	2.2989
Zinc	µg/dl	0.1530	µmol/l	6.5370

26.2 Blood Parameters

	Old unit	Conversion factor to SI unit	SI unit	Conversion factor to old unit
Erythrocytes	Mio/µl	1	T/l	1
Haematocrit	%	0.01	l/l	100
Haemoglobin	g/dl	10	g/l	0.1
Leukocytes	1/µl	0.001	G/l (= 109/l)	1000
Platelets	1/µl	0.001	G/l (= 109/l)	1000
Reticulocytes	%	0.001	1	1000

You will find a converter for easily comparing diagnostic findings with parameters in different units – our **SI calculator** – on our website www.laboklin.com under the menu item "specialist information".

27 Courier Service

LABOKLIN offers courier services in most EU countries. The samples are generally delivered to LABOKLIN within 24/48 hours. For more information, including prices and the possibilities of sample collection in your area, please contact our Service Department or your local LABOKLIN office.

Our contacts: see p. 8 and following.

28 Invoicing

All prices listed on the submission forms are quoted without the applicable Value Added Tax (VAT). To receive VAT-free invoices, please provide your international tax number (EU only). We issue invoices at the beginning of the next month with detailed information on costs per sample and tests performed in the previous month, together with animal and owner name. If an invoice is to be sent to the owner, we invoice with a factor 1.273 to 1.4 (depending on the test) plus applicable VAT. This is mostly possible for genetic tests and when the owners' signature and complete data are supplied.

There are discounts available to veterinarians depending on the monthly invoice revenue: For more information, please contact us or your local LABOKLIN office.

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