

Getting the most out of on-farm post-mortems

A guide for veterinary surgeons



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This manual has been designed to help **veterinary surgeons** achieve a diagnosis from post-mortem examinations (PMEs) performed on cattle and sheep on-farm.

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By law, diagnosing disease on post-mortem examination is an act of veterinary surgery.

The who's who of farm animal pathology

Veterinary Investigation Officers (VIOs)

- Work in the government laboratories (APHA, SRUC, AFBI)
- Perform post-mortem examinations and schedule/interpret ancillary test results to reach a diagnosis and provide advice to vets and farmers
- Play an important role in disease surveillance
- Often have extensive experience of farm animal practice
- Might have a specific area of expertise for example: pigs, parasitology or health schemes
- Receive extensive on-the-job training and ongoing support from colleagues
- Might also carry out histopathology
- Might have completed a pathology residency
- Might hold a range of further qualifications (e.g. DBR, Cert AVP, FRCPath)

Specialist veterinary pathologists

- Work in government organisations, universities and private laboratories
- Will have completed a period of structured pathology training, either as a three-year full-time residency or over five to six years as an alternative residency
- Training covers: gross pathology, histopathology, general pathology, disease pathogenesis, laboratory and research techniques and comparative aspects of disease development
- Will have passed the FRCPath, ECVP and/or the ACVP Board examinations
- Might have extensive experience of farm animal practice

Note: Some private enterprises and universities offer farm pathology services and veterinary surgeons working here will not be called VIOs although they may offer a similar service. If in doubt – ask.

Introduction

Post-mortem examinations (PMEs) are an important tool for the diagnosis and prevention of disease in farm animals and should form part of any herd or flock health plan. Interpreting findings from a PME involves a high level of skill; knowledge and experience are required to determine what is normal vs abnormal, autolysis vs disease, relevant vs incidental and to select the most appropriate samples and tests to reach a diagnosis.

In an ideal world, all PMEs should be carried out in a fully equipped PME facility by a Veterinary Investigation Officer (VIO) or pathologist, but this isn't always an available or cost-effective option. As the veterinary surgeon, you have the responsibility of deciding when you should or should not conduct a PME on farm. This manual has been designed to assist you with that decision and to help increase the chance of obtaining a diagnosis.

To keep this manual succinct, it has not been possible to include all thought processes on ruling in or out all diseases as the PME is performed, lists of differential diagnoses, or details on the pathology or presentation of diseases. This manual describes how to conduct a systematic PME to make sure the user has good information, photos and the correct samples that will allow an expert to assist in making a diagnosis where required. Calling upon a VIO, pathologist or local laboratory is a very helpful resource for further assistance and should be used when needed. This should be done **before** the carcass has been disposed of, so extra samples can be collected.

Know your limits

You need to be aware of the limitations of on-farm PME compared with sending the animal to a PME provider. Knowledge, expertise, time, equipment and facilities are all superior at a facility designed specifically for the job. For that reason:

- Be aware of who the PME provider is that serves your area and their hours of work
 - This may be a government, university or private enterprise, and may or may not offer a carcase collection service
- Establish a relationship, as their support will give you a better chance of getting good results
- Discuss the limitations of on-farm post-mortem examination with your client before getting started

Are you the best person for the job?

Your obligations as a veterinary surgeon

Under the RCVS Day One Competences, you should be able to:

- Perform a **systematic** gross post-mortem examination, record observations and sample tissues, store and transport them
- Be aware of the **limitations** of such investigations and the **potential conflict of interest** where you have been previously involved with the case
- Be able to **differentiate normal and abnormal**. Make sure that **good quality records and samples** are taken for further investigation by a pathologist, if necessary

You are not expected to be the pathologist, but a systematic approach will allow an expert to assist with the case after the event.

Under the RCVS Code of Conduct, you should also:

- Ensure that the client has been fully advised of the **scope** of the post-mortem **examination** and the **limitations**
- Ensure that the client understands the financial implications and that the findings may prove inconclusive
- Give the client the option of an examination by an independent veterinary surgeon

Before conducting a PME, consider whether you are the most appropriate person to perform a post-mortem on farm:

- We always advise that a PME should be conducted by a VIO or pathologist for the best chance of a diagnosis
- We stress the importance of a pathologist/VIO carrying out a post-mortem in the following cases:
 - Significant clinical importance (e.g. where a large number of animals have been lost or for high-value animals)
 - Presenting with unusual or unspecific clinical signs
 - Where notifiable or zoonotic diseases are suspected
 - Legal or forensic cases
 - Those associated with a client complaint
 - Where there may be a public health concern (e.g. open farm, lead toxicity)
 - Neurological, which may require brain and/or spinal cord removal (which is difficult in the field)
- You need to ensure the health and safety of yourself and any assistants on farm (consider pregnancy and immunocompromised individuals, for example)

- You may be more likely to conduct a post-mortem:
 - When your local post-mortem provider is closed
 - Where farmers are unable or unwilling to transport an animal, or pay for external services
 - For your own clinical interest



Figure 1. Does this animal need a post-mortem examination? Am I the most appropriate person for the job? Is this the best use of the farmer's time and money?

Charging for post-mortems

- This needs to be discussed within your practice and must be appropriate for the service you are able to deliver
- The cost of a PME at a post-mortem provider will include a full systematic post-mortem (this may include removal of brain and spinal cord), a full report and interpretation by an expert in the field. It may also include all further testing and disposal of the animal
- PMEs carried out as part of the scanning surveillance (at APHA or SRUC) are subsidised by Defra, which means the farmer pays only a proportion of the actual cost of a full PME
- The price you charge needs to consider not only the time it will take but also the information that will be gained for farmers
- Consider the cost of further testing before proceeding
- When all of this is taken into consideration, a field post-mortem may not be the most financially viable or productive option

Before getting started with an on-farm post-mortem

Make sure the client is aware of the limitations of performing the post-mortem on farm.

Consider the logistics:

- Do you have the right kit with you? (see kit list on page 6)
- Do you have **appropriate personal protective equipment (PPE)**?
- Is this the best place to do it? Could you perform the PME at the knacker's yard? Alternatively, at the practice?
- Is there good **lighting**?
- Is it **safe**? (this refers to kit and facilities available, as well as the risk of zoonotic diseases to you and the farmer, and the risk of infectious disease spreading to other animals)

- How will you make the procedure **biosecure**? How will you contain the fluids that will come out of the carcass, how will you wash down the area afterwards?
- How will the carcass be disposed of at the end? Which fallen stock collection service does the farmer use? Does the carcass need to be stitched up/can you bag it up and tie with cable ties?
 - The disposal of fallen stock is governed by the Animal By-Products (Enforcement) (England) Regulations 2013 (the regulations) and EC Regulations (EC) Nos. 1069/2009 and 142/2011
 - For more information on carcass disposal visit www.gov.uk/guidance/fallen-stock

Kit list

- Appropriate PPE that can be disinfected/disposed of afterwards
- Latex gloves, rectal gloves
- Anti-cut gloves (Kevlar)
- Face mask
- Knives (at least two sharp post-mortem knives)
- Disinfectant for cleaning up afterwards
- Thick, large water-proof bags or sacks, and cable ties
- Baler twine/old suture material to stitch up carcass, if needed
- Head torch
- Eye protection like safety goggles
- Scalpel blades and holder
- Rat-toothed forceps
- Burner and palatte knife
- Scissors
- Saw and/or long-handled pruning shears
- Bone cutters
- Needles and syringes, pipettes
- Blood tubes (plain, heparin and EDTA)
- Plain sample pots (e.g. milk sample pots)
- Suitable pen to label pots (e.g. permanent marker)
- Pots of 10% neutral buffered formalin with tape to make sure lids are secure for transport
- Sterile swabs for culture with transport medium
- pH meter or pH strips and urine analysis dipsticks
- Cutting board (optional – a chopping board can also be used)
- Camera
- Ruler



Figure 2. Post-mortem knives are available in different shapes and sizes – use what feels most comfortable. We suggest a straight blade



Figure 3. Knife sharpeners capable of keeping infrequently used knives sharp are available to buy online for a reasonable price



Figure 4. A selection of tools ready for a post-mortem

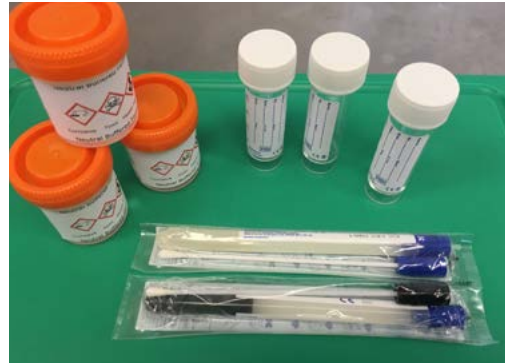


Figure 5. A selection of sample pots

Top tip

Have a bucket of water and paper towel next to you so you can wash and dry your gloves as you go, to save using multiple pairs of gloves.

Instruments and equipment must be cleaned and disinfected between post-mortems.

What makes an effective post-mortem examination?

The fresher the better

- Ideally, carcasses need to be examined within 24 hours of death
- In the summer, autolysis happens quickly. In winter, the carcass may have been frozen on farm which can affect histology



Figure 6. Multifocal gas bubbles in a lung with severe autolysis

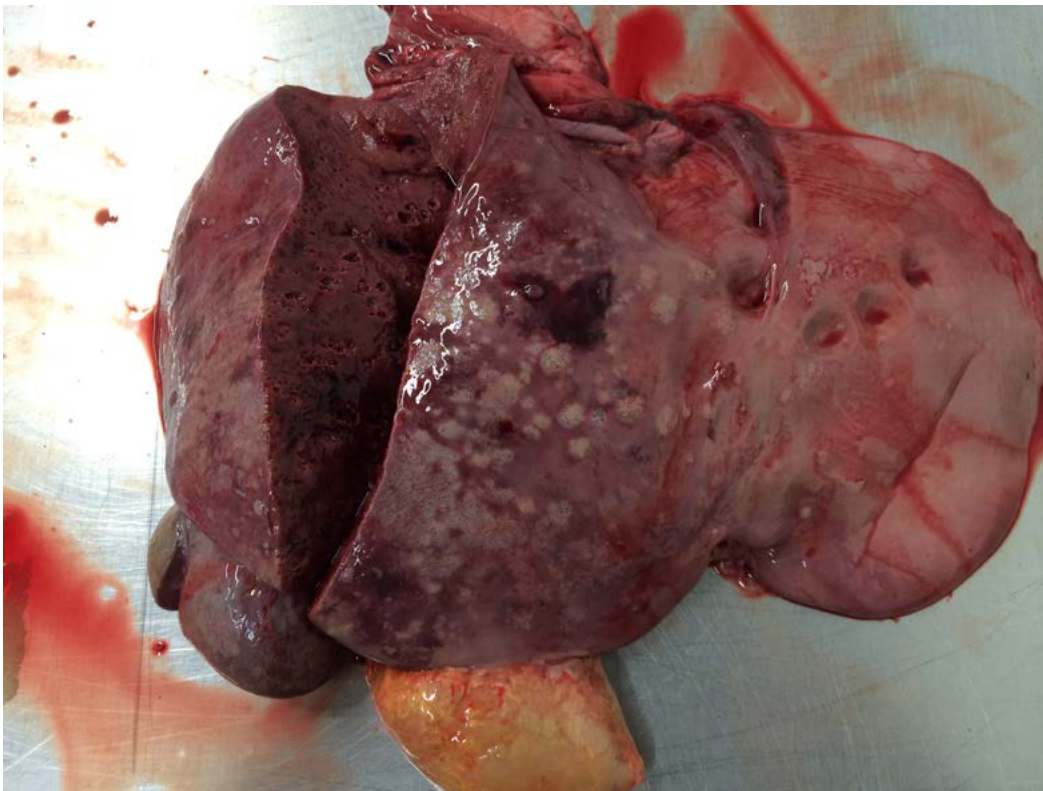


Figure 7. Loss of tissue structure and multifocal to coalescing gas bubbles in a liver as a result of autolysis

Good quality, appropriate kit

Good quality, sharp knives will dramatically improve the speed and quality of the PME. Knives should be fit for purpose and sharpened using a knife sharpener back at the practice after each PME.

Good lighting and plenty of time

An efficient PME on a sheep will take approximately 30–45 minutes from start to finish, on a cow it may take 90 minutes. Be prepared and allow for this, do not rush, be thorough but, at the same time, remember that the farmer requires beneficial information for the time invested.

Taking a good history

History taking is as important as performing an effective PME and is necessary to guide sampling and interpret findings. With a full history, consider the clinical signs and then make a differential list before starting work.

The post-mortem

Notifiable diseases should always be your first consideration. If at any point you suspect a notifiable disease, stop the post-mortem and notify the Animal and Plant Health Agency (APHA) as soon as possible. In areas where Bovine TB is common, we advise wearing a face mask for post-mortems.

This section assumes that the carcass can be fully dissected and disposed of, according to **Animal By-Products (Enforcement) (England) Regulations 2013 (the regulations) and EC Regulations (EC) Nos.1069/2009 and 142/2011**. The procedure discussed here is suitable for **small ruminants** and **youngstock** up to approximately 100 kg. Specific advice for adult cattle post-mortems is included at the end of the section.

Background

- Know what's normal, know the anatomy and create a differential list before starting
- Be systematic – start to examine the carcass in the same order each time. This will prevent you from feeling lost if, for example, that guaranteed pneumonia case has normal lungs

Flow chart below (Figure 8) shows a suggested systematic approach to a sheep post-mortem. This is just one possible approach. The most important thing is to be **systematic** and **consistent** (note: spinal cord and tympanic bullae examination, as required)

- Incise all solid organs multiple times
 - Lesions may not be visible from the surface and may be focal, so make bread-slice cuts into all solid organs (e.g. the liver, lung, kidney and spleen) in multiple places
- Open all organs that have a lumen
 - This includes the heart, urinary bladder, uterus and gall bladder
 - The gastrointestinal tract should be opened in multiple places, including the entire length of the oesophagus
 - Consider if you require samples of the contents before these organs are opened and have labelled sample pots ready
- Note the appearance of the serosal surfaces of the thoracic and abdominal cavities and pericardial sac, and whether there is any fluid present
- Check size and colour of lymph nodes

- Take photos of observed lesions (see page 43 for tips)
 - This might include before you remove the organ from the carcass, once removed and/or once incised
- Avoid over-handling the tissues
 - Tissues such as the mucosal surfaces of the gut, the brain and the spinal cord are delicate and excessive handling can affect the histology
- Consider what samples you may need before starting and have collection pots ready. Collect samples for microbiology first before the tissue is handled too much. If it's a gastrointestinal problem, get the intestine samples for histology into formalin as soon as possible, ideally within 15 minutes of death
- Tools that cut through bone (e.g. when cutting through the rib cage or sawing through the skull) won't cut through soft tissue. Remove soft tissue first with a knife first and alternate tools when you meet soft tissue while cutting through the bone
- Be safe. Follow Health & Safety guidance
 - Handle knives carefully
 - Always wear a cutting glove on the non-cutting hand
 - Always place the scalpel back in a safe place
 - Consider the weight of the carcass/organs before lifting
 - Consider any possible zoonoses (including those that may not be significant to the post-mortem findings but could be significant to you, such as E.coli VTEC 0157)
 - Protect your eyes when cutting bone, cutting into pockets of fluid or when cutting into tissues that may contain cysts (e.g. liver and lung)

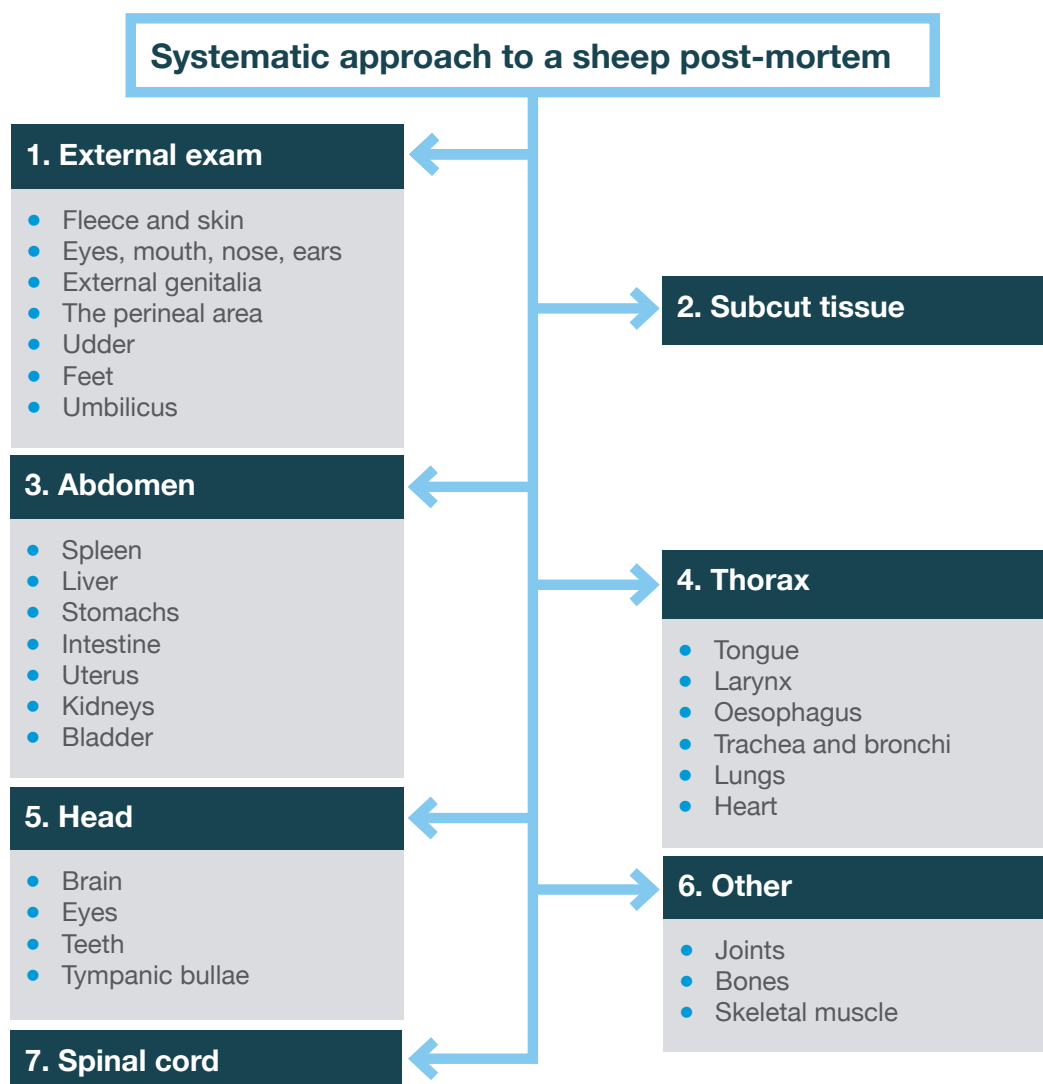


Figure 8. Suggested systematic approach to a sheep post-mortem

External examination and subcutaneous tissue

1. Examine the body condition of the carcase, the coat, skin and feet. Examine the head and look in the mouth. Check the perineal area and caudal hindlimbs for diarrhoea and remember to check the umbilicus in lambs and calves. Collect sample (vitreous or aqueous humour) from the eye.



Figure 9. Examining the udder as part of the external examination



Figure 10. Examining the feet as part of the external examination

2. Place the carcase on its back and reflect both front and hind limbs (cut through the hip joints) to stabilise.



Figure 11. Reflect the limbs to stabilise the carcase

3. Reflect the skin from the body walls, from the chin all the way to the pubis. Check the condition of the subcutaneous tissue – how much fat is present? What colour is it? Are there any subcutaneous haemorrhages?



Figure 12. Reflecting the skin allows the subcutaneous tissue to be assessed

The abdominal cavity

1. Open the abdominal cavity from the sternum to the pubis and reflect the muscle back by cutting along the caudal edge of the ribs. Check for presence of excessive and/or altered peritoneal fluid (a small amount of clear-straw coloured fluid is normal). Assess if any organs appear displaced and photograph if necessary.

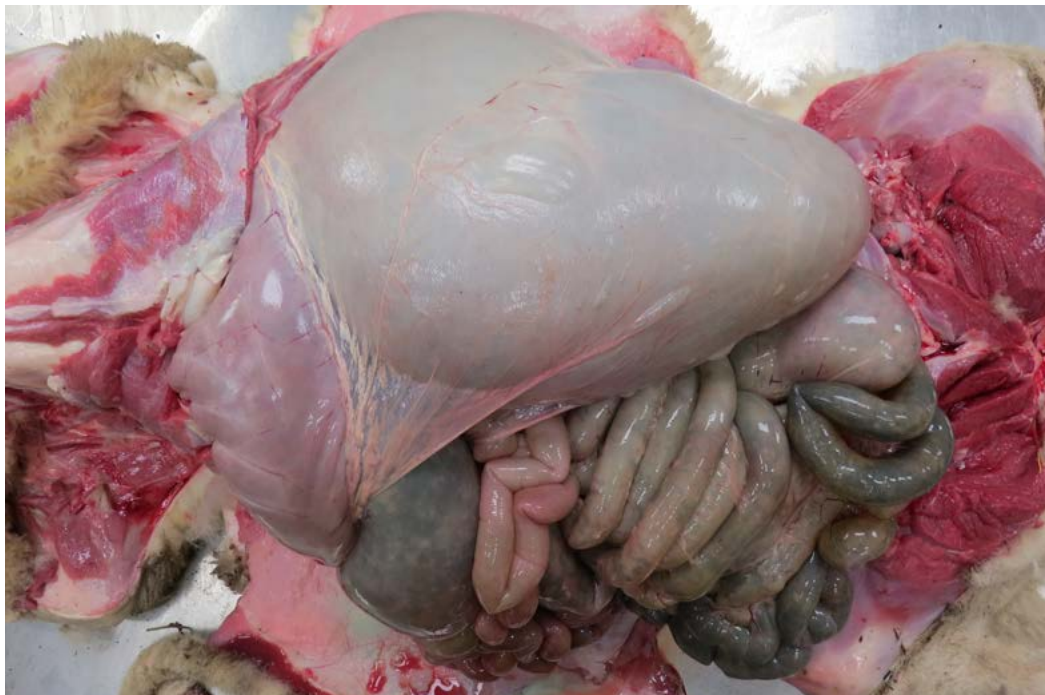


Figure 13. The abdominal cavity opened to reveal a gas-distended rumen and intestines (head to the left, tail to the right)

2. Check that the diaphragm is intact.
3. Pull the liver, spleen and GI tract to one side (easiest if pulled towards you) and cut behind them to remove as one, leaving behind the kidneys and bladder. Examine and collect the contents of the rectum at this point. Put to one side for further examination at a later stage.



Figure 14. The GI tract and liver have been removed from the abdominal cavity

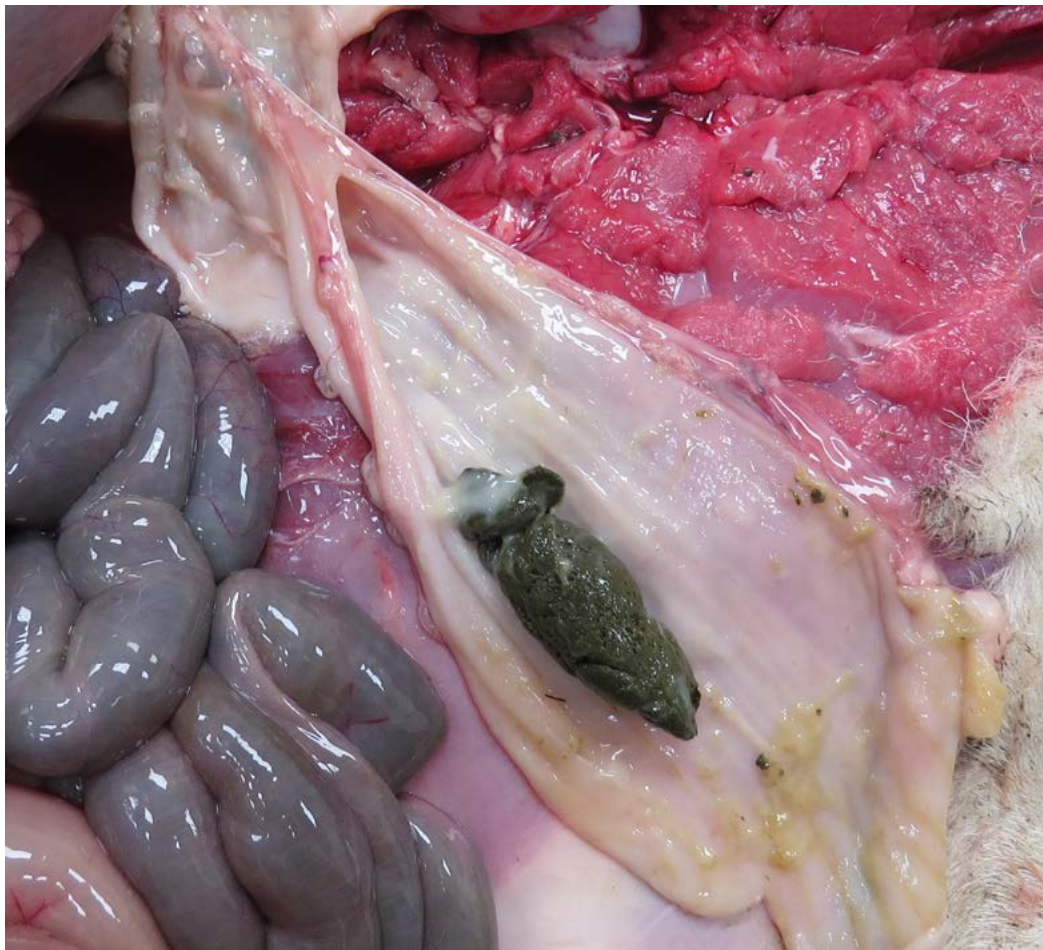


Figure 15. The rectum has been opened to reveal a small amount of dry and mucus-covered faeces

The thoracic cavity

1. Run the knife along either side of the mandible to free the tongue.



Figure 16. The knife is run along the lateral edges of the mandible on both sides to free the tongue

2. Cut the muscle at the most rostral part to pull the tongue out of the oral cavity. Pull the tongue down to visualise the joints of the hyoid apparatus. Cut through the joints – these look like pale nodules and this should be done easily with a scalpel or knife. If it's not working, check you are going through the joint and not trying to cut through the actual hyoid bone. Cut underneath the oesophagus and trachea all the way to the thoracic inlet.



Figure 17. The tongue, trachea and oesophagus are now free and ready to be removed with the lungs, once the chest is opened

3. Examine the thyroid glands. The thyroid glands are dark red and are found loosely adhered to the trachea caudal to the larynx.
4. Cut down either side to free the diaphragm from the rib cage, this will allow access to the caudal ribs. Cut through the ribs one by one from the back towards the front. This is most easily done by cutting through the costochondral junction, either with a knife (pictured below), saw or pruning shears. Once one side of the costochondral junction of the ribcage has been cut, reflect the ribs and remove the sternum by cutting through the opposite costochondral junction. Check for presence of excessive and/or altered thoracic fluid.



Figure 18. A knife is used here to cut through the costochondral junctions of the rib cage. Feel for the junction and if you cannot get your knife through, it means you are cutting in the wrong place. Do not blunt your knife by persisting – switch to using a saw or pruning shears, if you find this easier

5. Examine the thymus (if present; larger in younger animals). This lobular organ sits just cranially to the heart.
6. Remove the pluck (here we mean this to include the tongue, trachea, oesophagus, lungs and heart as one) from the thoracic cavity with firm traction (you may need to cut through the soft tissue connections at the thoracic inlet with a knife). Be careful to keep the pericardium intact.
7. Open the oesophagus along the whole length using a knife or pair of scissors.



Figure 19. The oesophagus is opened along its entire length

8. Open the trachea along the whole length and incise right into each bronchus. Look carefully for lungworm here. It is normal to find a small to moderate amount of foam or ruminal contents in the trachea or bronchi (agonal changes). 'Foam' filling more than the caudal third of the trachea would usually be interpreted as abnormal.



Figure 20. The trachea has been opened along its length and a small amount of froth is seen

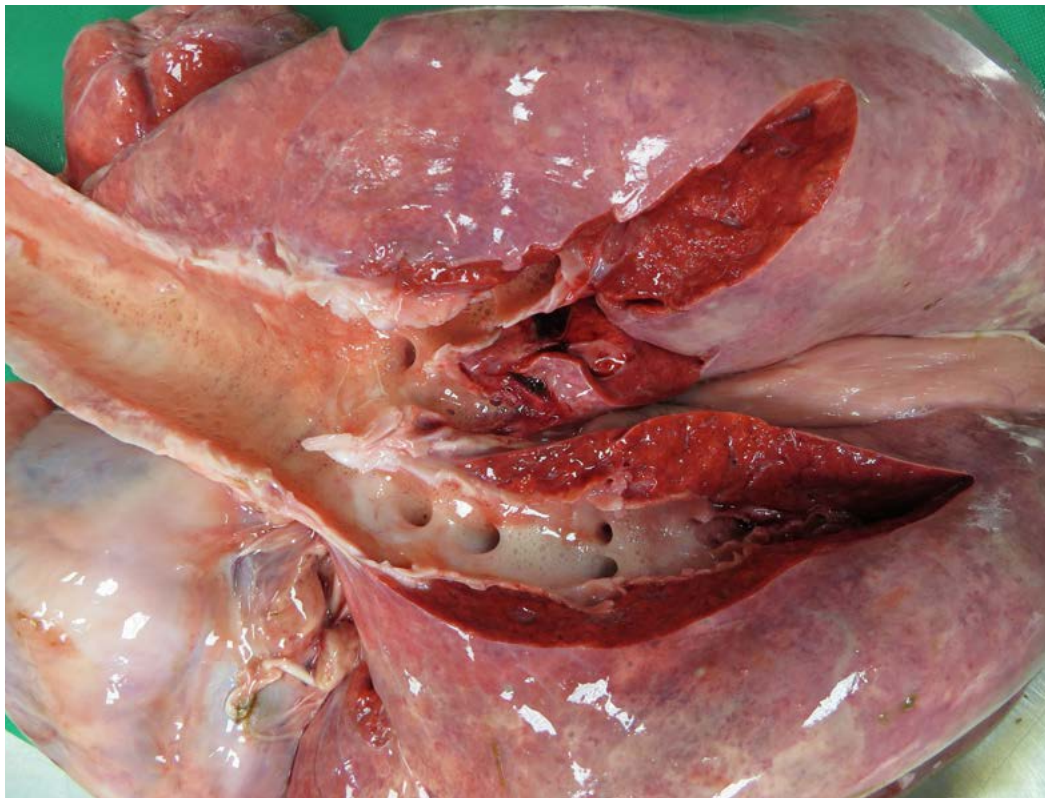


Figure 21. Open the trachea all the way to the bifurcation and continue with cuts into each bronchus

9. Examine the lungs by both looking at and feeling each lobe; make multiple cuts into the surface.



Figure 22. Bread-slice cuts into each lung

10. Carefully remove the pericardium from the heart and examine the pericardial contents. Check for presence of excessive and/or altered pericardial fluid (a small amount of clear-straw coloured fluid is normal). Examine the fat in the coronary sulcus – Figure 24 is from an animal in good condition (moderate – large amounts of fat in the coronary groove).

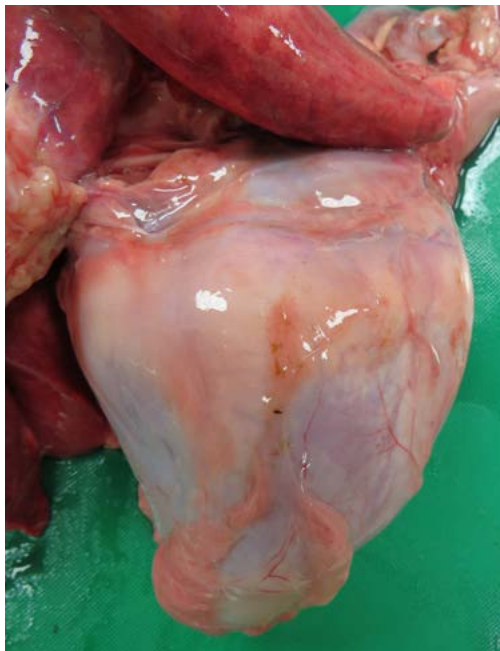


Figure 23. A heart with the pericardium still intact



Figure 24. A heart with the pericardium removed

11. Cut into either side of the heart to open all four heart chambers and examine the atrio-ventricular and aortic valves. The aortic valve sits behind the mitral valve, it is visualised by cutting through the left leaflet. The pulmonary valve is on the upper right hand side of the right ventricle when opened. Check for any septal defects – ventricular septal defects are a common heart lesion in cattle.

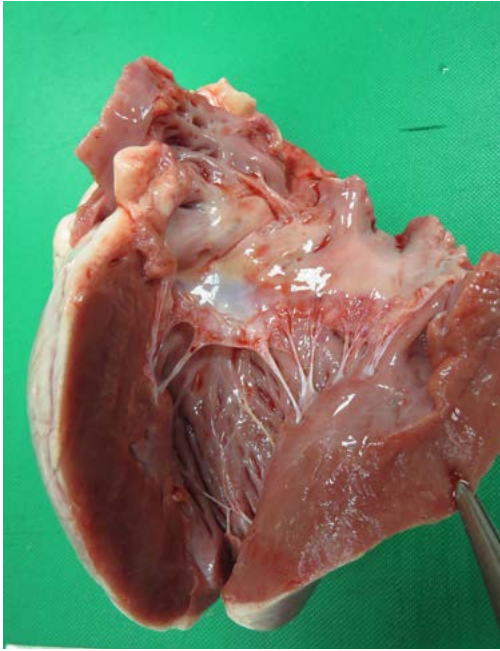


Figure 25. The left atrioventricular valves

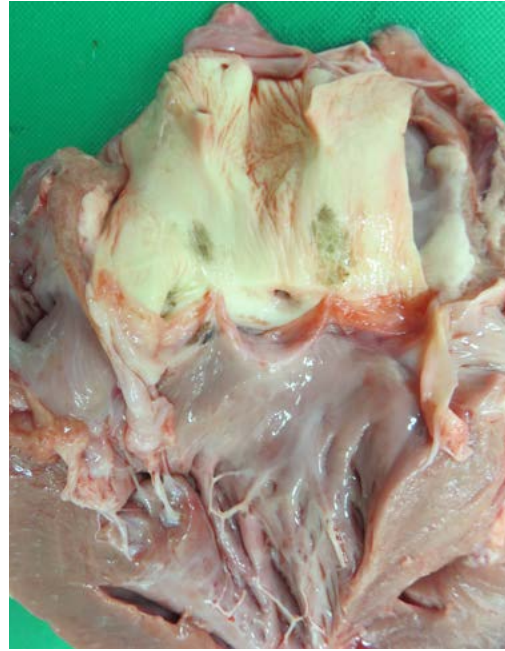


Figure 26. Examination of the aortic valves

Abdominal organs

1. Separate the liver from the intestines, incise in multiple places and open the gall bladder. Examine the spleen and incise.



Figure 27. A normal sheep liver. Photos showing the whole organs can provide useful information if you need to seek assistance in making a diagnosis at a later time.



Figure 28. A normal sheep spleen

2. Open the rumen, reticulum, omasum and abomasum. Examine the contents thoroughly, empty and then examine the mucosae.



Figure 29. An opened rumen showing the contents

3. Open the rumen and carefully sieve through the contents (even a few sprigs of yew, for example, can be enough to kill a cow). You can collect a sample of ruminal fluid by squeezing the content into a pot for pH measurement.
4. Examine the walls of the stomachs. The mucosa will shed and detach as part of autolysis, but it can still be useful to include in histology samples.



Figure 30. An empty rumen allows the examination of the mucosa. Fully open all luminal organs to allow examination of the entire internal surface



Figure 31. The 'honeycomb' wall of the reticulum



Figure 32 An opened omasum



Figure 33. An opened abomasum from a sheep, showing contents considered normal for a grazing animal

5. Examine the contents of the abomasum and then the mucosa. *Haemonchus contortus* (the 'Barber's pole' worm) may be found here. The contents can be used for total worm counts which may be worth discussing with your local laboratory to see if it might be applicable to your case.
6. Open multiple sections of each segment of the small intestines (duodenum, jejunum and ileum) and large intestines (caecum and colon) and examine the contents and the mucosae. Caecal contents can be collected if faeces are not available.
7. Remove the kidneys and make a 'sandwich' cut to maximise the surface for examination. Open the urinary bladder.

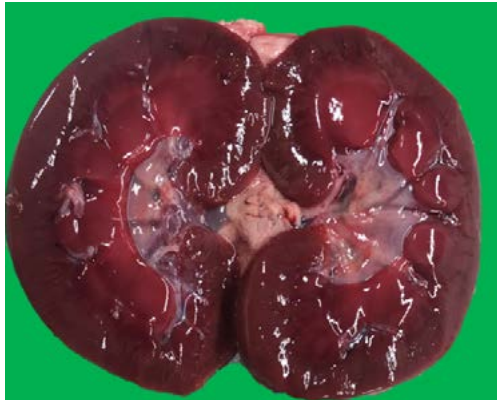


Figure 34. A sheep kidney. This cut allows examination of the cortex, medulla and renal pelvis



Figure 35. The bladder opened to examine the mucosa

Musculoskeletal system

1. Make multiple cuts into the skeletal muscle of the front and hindlimbs.
2. Incise the stifle joints and elbow joints and more if indicated (e.g. if you find cloudy synovial fluid).

Nervous system

1. To remove the brain, the head must be disarticulated at the base of the skull. This is most easily done by hanging the head over the end of a table, cutting behind the occipital condyles and applying firm downward pressure (Figure 36). This should expose the spinal cord, cut through this and apply further pressure (Figure 37a). If a brain swab for culture is required, collect once the head has been removed; insert a swab through the foramen magnum onto the surface of the brain. Remember that fallen stock cattle over 48 months need their brainstem tested for BSE.
2. Cut through all of the surrounding soft tissue and skin to remove (Figure 37b).

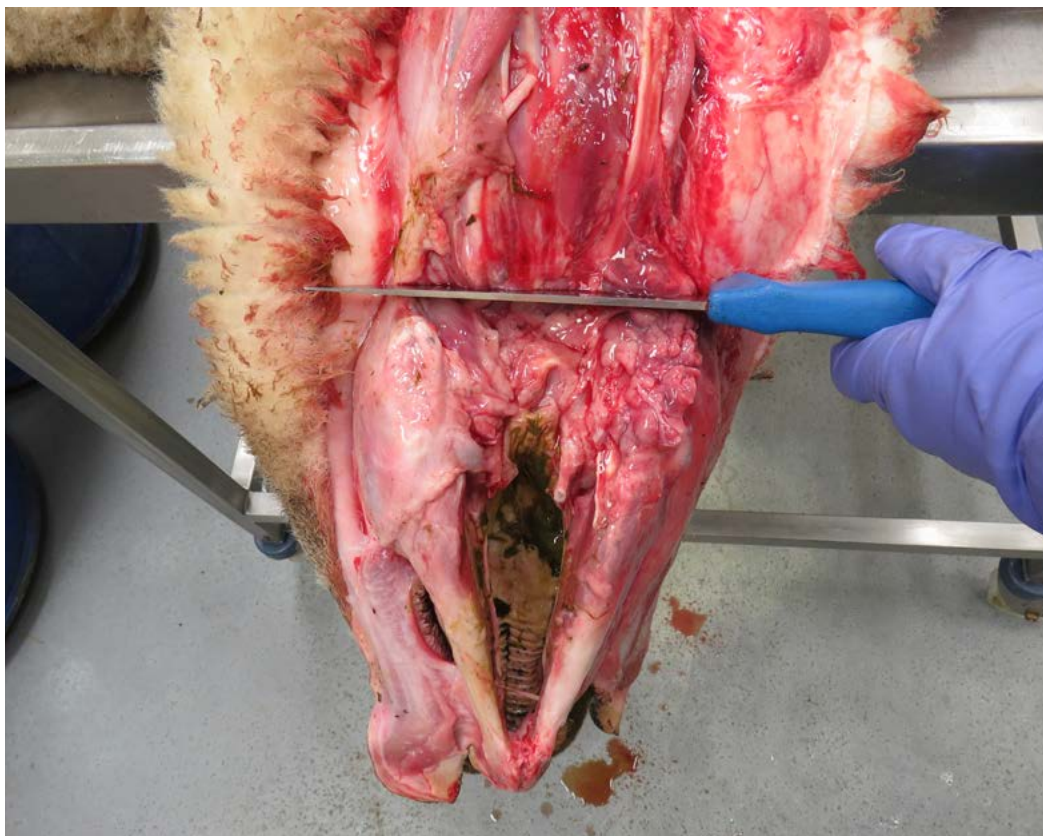


Figure 36. Hang the head over the end of the table, cut behind the occipital condyles and apply downward pressure

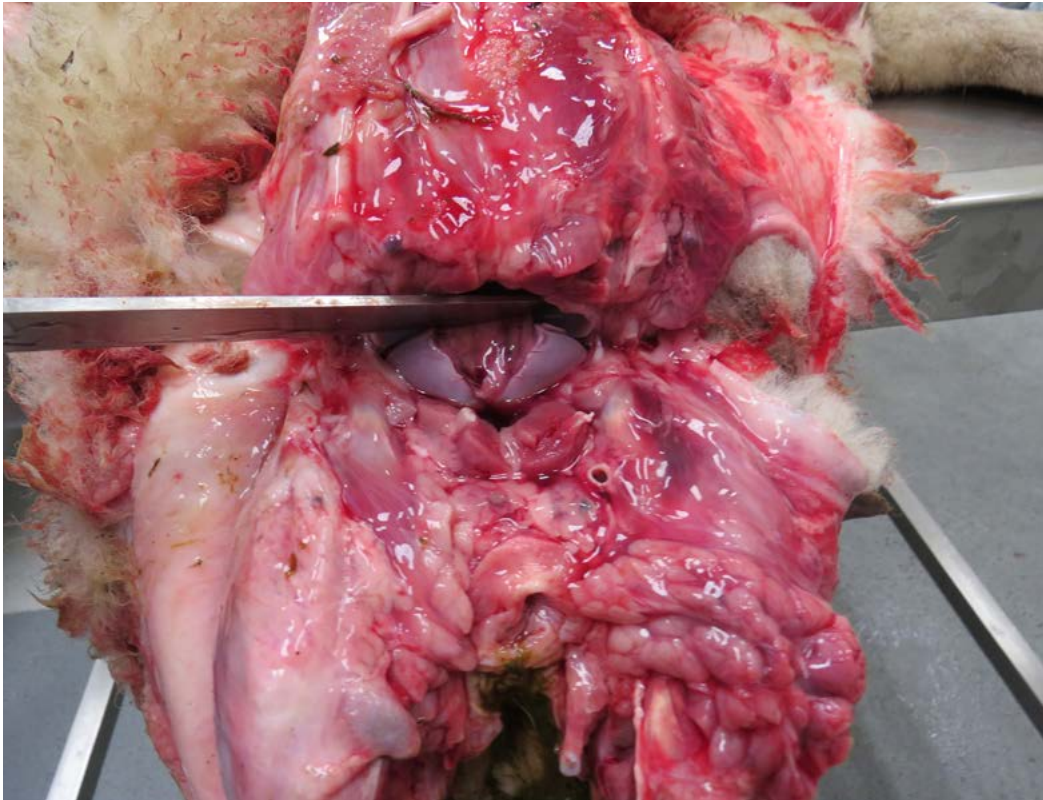


Figure 37a. You should now see the spinal cord in the spinal canal. Cut through this and apply further pressure

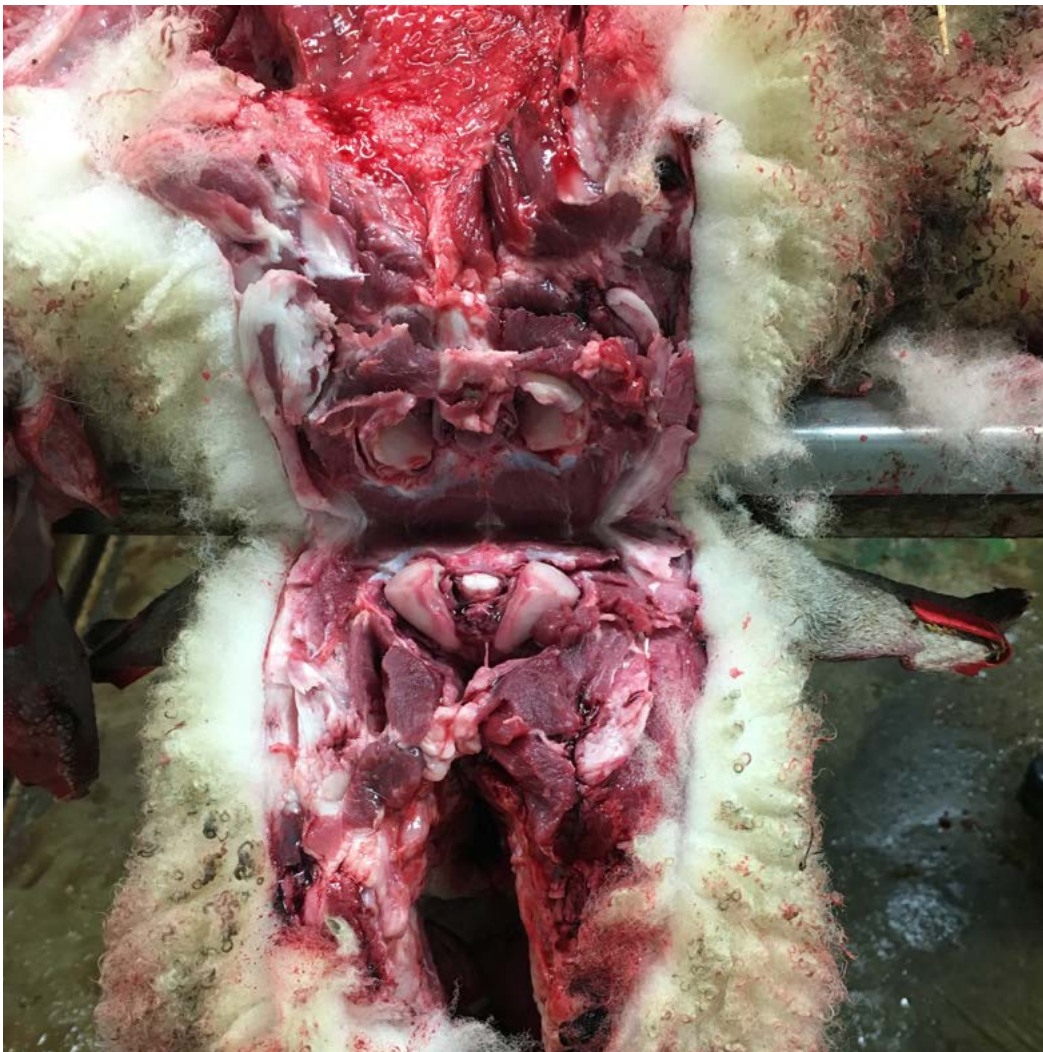


Figure 37b. Cut through the remaining soft tissue and muscle attachments to remove the head

- Secure the head by placing in a table bench vice clamp. Reflect and remove the skin. Saw the skull in half (Figure 38), or remove the top of the skull (Figures 39a, 39b, 40) with a hand saw or oscillating saw to remove the brain. Handle the brain carefully when removing it from the skull; cut through spinal nerves with a scalpel and use the rounded end of a scalpel handle to carefully remove the brain.

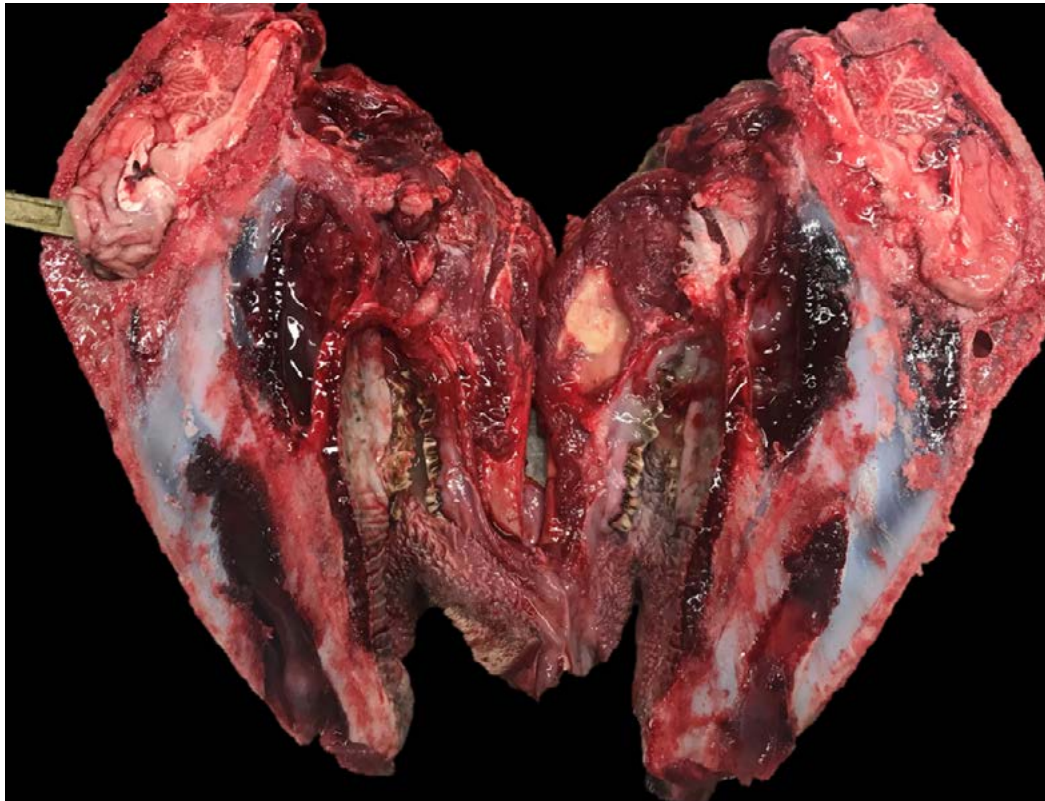


Figure 38. The brain can be removed for histology by sawing the skull in half longitudinally where it is not possible to remove it an alternative way

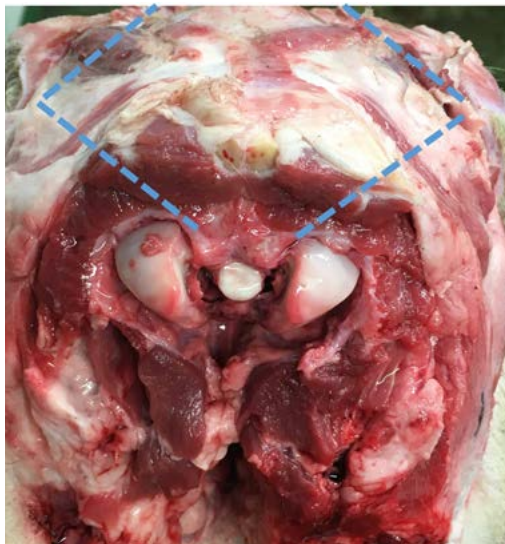


Figure 39a. View from the caudal skull looking cranially. Place the skull in a vice, remove the temporal muscles and from the foramen magnum cut towards the medial canthus of the eye on the same side, then cut medially. Consider the anatomy of the sinuses

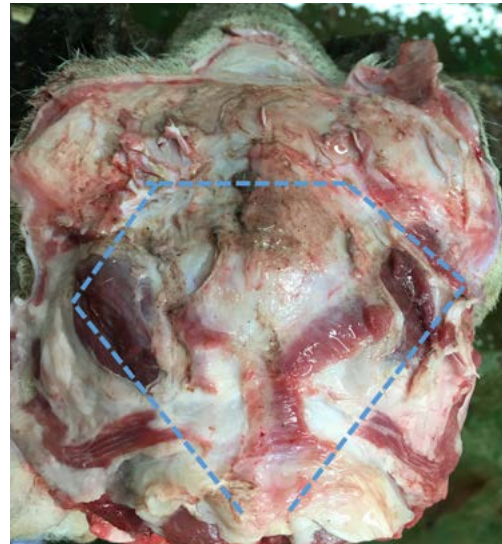


Figure 39b. A picture (looking down on the caudal end of the skull, the nose is at the top of the photo) to demonstrate the cuts that should be made to allow removal of the brain intact. Depending on the size of the animal, the medial cuts may join, or you may need to make a transverse cut to join them up

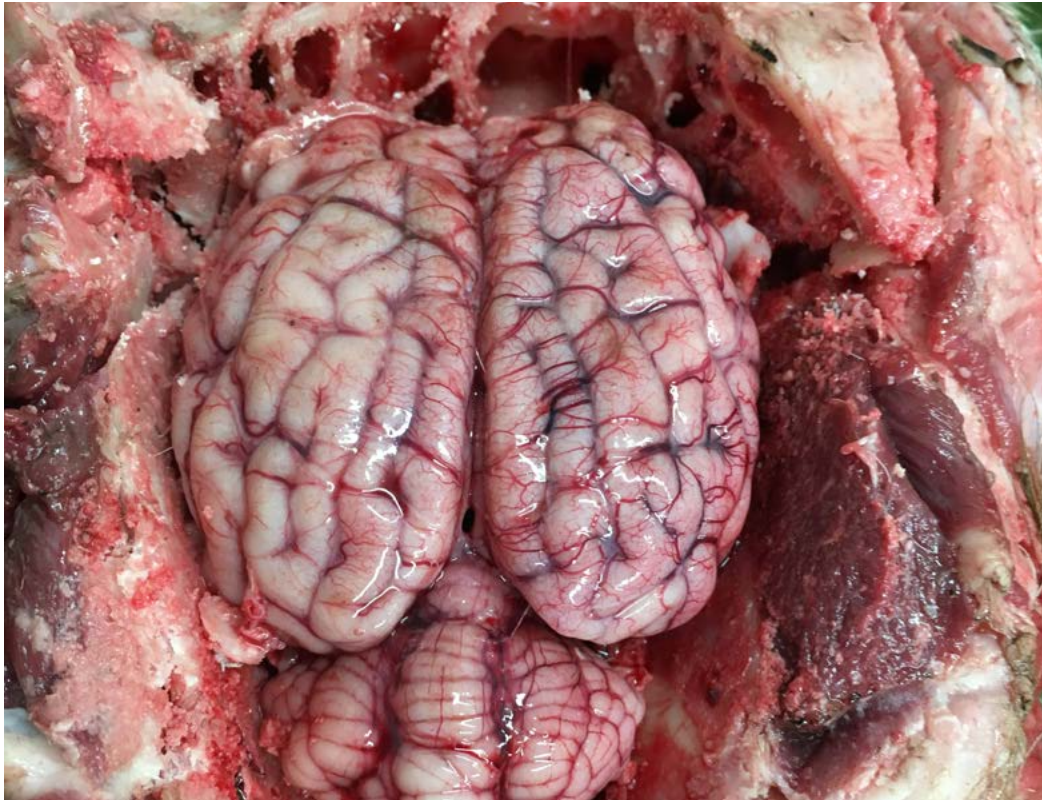


Figure 40. The top of the skull has been cut away and the brain is ready to be carefully removed

4. Removal of the spinal cord takes time and is a skilful procedure, especially in adult animals.

We strongly advise that you submit animals showing neurological signs, especially where a spinal lesion is suspected, to a post-mortem provider

5. Remove all four legs, the skull and surrounding soft tissue from the spinal column.

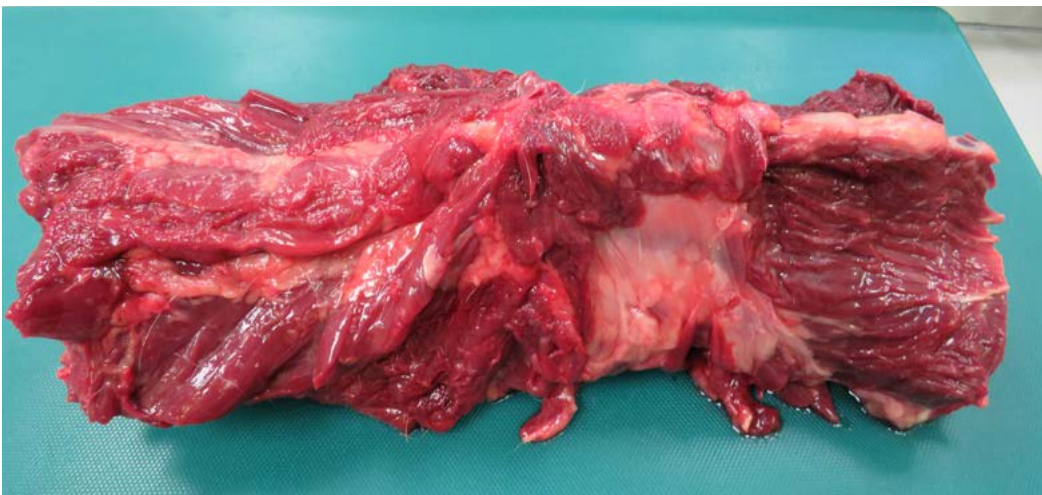


Figure 41. Part of the spinal column ready to be dissected

6. Remove all of the peri-vertebral muscles as you need to be able to clearly see the vertebrae. The tools that cut bone are not good at cutting soft tissue.



Figure 42a. Peri-vertebral muscles removed

7. Then either saw the spinal column in half (Figure 42b), taking care to go through the spinal canal but not to saw through the spinal cord (this is difficult). Or you can use bone choppers or an oscillating saw to carefully cut away at either side of the vertebrae so you can lift off the top part of the canal (Figure 43).



Figure 42b. Vertebral canal sawn in half with spinal cord still intact ready for removal

Note: You can easily damage the spinal cord using this approach



Figure 43. In this approach the top of the spinal column has been removed to allow subsequent removal of the spinal cord

8. Bone choppers (as seen in Figure 43) can be used to take the bone away. In this photo, an oscillating saw was used, hence the straight edges. You can also take a ventral approach and instead remove the vertebral bodies to access the cord – a similar method is used.
9. Once the spinal cord is fully exposed, carefully remove it from the canal by cutting through the peripheral nerves with small sharp scissors, or a scalpel. Try to keep a portion of the peripheral nerve attached to the spinal cord as it is useful for histology.

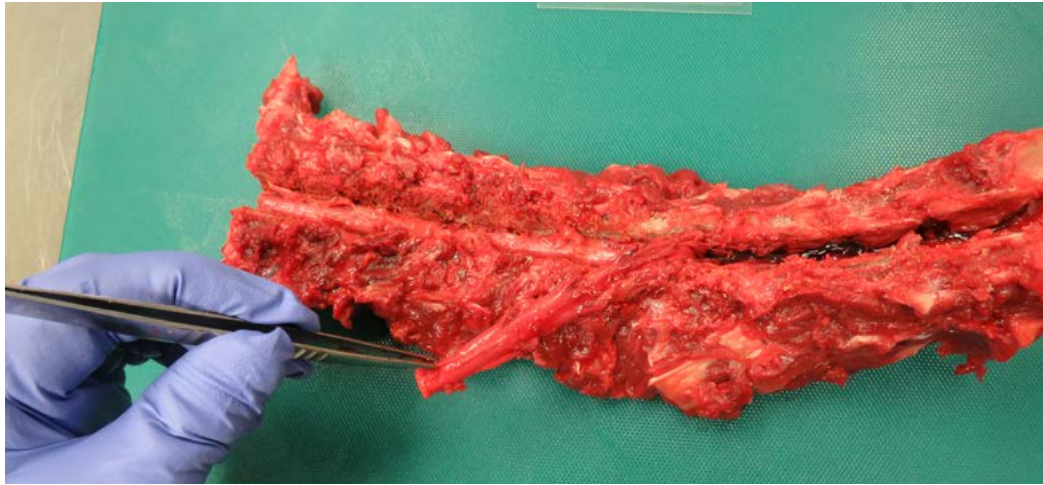


Figure 44. Removal of the spinal cord

Note: This spinal column had been frozen so the spinal cord is redder than normal. In a fresh animal, it will be white. Handle the cord carefully, it has been pulled back here to demonstrate the peripheral nerves for the photo but, when collecting for diagnostic purposes, do not apply any pressure when removing, as it can affect the histology

10. Once the spinal cord has been removed, carefully cut through the thick dura mater (this looks like a jacket on the cord) along the length of the cord. This allows the formalin into the cord for full fixation. Place in formalin to fix.

Teeth

1. This can be done before or after the skull is removed from the body:
 - Make a straight cut from the corners of the lips and incise the masticatory muscles to fully open the mouth
 - This is especially important in thin older animals and is an important differential for the thin ewe
2. Check the incisors, examine the lateral view of the cheek teeth and then incise through the corners of the lips and the jaw muscles, prise the jaw apart and fully examine the molars.



Figure 45a. Irregular wear in the molars of a ewe creating a 'wave mouth'



Figure 45b. Check the incisors for wear, and you can use them to estimate age in sheep



Figure 45c. Open the mouth to allow a full examination of the cheek teeth

Adult cattle post-mortems

We strongly advise that you submit adult cattle to a PME provider where the PM can be conducted in appropriate facilities with suitable equipment

If you are conducting the PME of an adult cow yourself, we strongly recommend doing it at a fallen stock yard where the carcass can be hoisted up and the debris cleaned up afterwards. You will easily use two sharp knives to complete a full cow post-mortem. Do not underestimate the time and effort required to do a post-mortem on an adult bovine.

If carrying out on-farm, the carcass can be lifted using a tractor with a front loader. Carefully consider the safety and biosecurity before starting and discuss all risks with the farmer. You will need to do this in an area that can be cleaned down thoroughly afterwards.

We strongly advise against performing post-mortems on adult bulls on-farm, due to their size

It is easiest to remove the organs by using gravity to your advantage; hang the carcass from the hindleg to remove the guts and then from the front legs to remove the lungs. Adjusting the position of the carcass will take longer, but it will make it easier, so consider this before starting.

1. Hang the carcass by a back leg so the tail is approximately level with your head.



Figure 46. A carcass hung up by the hindleg ready for PME

2. Check all four quarters of the udder, remove the udder from the carcass and incise all four quarters.
3. Examine the external genitalia. Incise the prepuce to examine the penis and remove and incise the testicles.
4. Make an incision through the ventral midline skin and reflect back, making note of the subcutaneous tissue.
5. Cut through the abdominal muscle and peritoneum along the midline from the pubis to the sternum. Reflect these layers back by cutting laterally on both sides near the hind legs and along the caudal edge of the ribs.
6. With these incisions, the rumen and intestines will drop down towards the floor. This will allow you to identify, remove and incise the urinary bladder, the uterus and the kidneys.



Figure 47. Hanging the carcass up from a hindleg allows gravity to help you remove the abdominal contents

7. Remove the gastrointestinal tract as one – incise through the rectum, cut behind the attachments to the rumen and intestines. As the rumen falls out of the carcass, it will allow you to check for adhesions between the reticulum and the body wall, which may indicate a wire.
8. Examine and remove the gastrointestinal tract. Incise into the spleen and liver. Open the gall bladder.
9. Open the rumen, examine the contents and the wall. Measure the pH or sample, if required.
10. Open the reticulum, omasum and abomasum, examine the contents and the mucosa.
11. Examine the small and large intestine, caecum and associated lymph nodes.
12. The easiest way to proceed is to turn the cow up the other way, as it is more difficult hung up by a back leg. Lower the carcass and hang up by a front leg. Free the tongue as described above and reflect the trachea and oesophagus. At the thoracic inlet, incise around the trachea and thread the trachea and oesophagus into the thoracic cavity.



Figure 48. Hung up by front leg

13. Free the trachea and oesophagus and post back into the thoracic cavity.
14. Using the trachea as an anchor and maintaining tension on it, cut behind the lungs and heart, pulling on the trachea as you go to remove the pluck.



Figure 49. Pulling the trachea down

15. Examine the walls of the ribcage, once the pluck has been removed.
16. Examine the pluck, musculoskeletal system and nervous system as described above.

Samples to take for common diseases

The following tables show samples required for some of the common presentations and/or diseases. Some diseases/presentations listed have many suggested tissues to collect for a range of different tests. **Not all samples and tests listed will be required to achieve a diagnosis in every case.**

Diagnostic test selection will depend on factors associated with the individual case and economics.

If you are unsure which tests to run, phone your laboratory to discuss the best way to proceed.

If an animal is examined alive before euthanasia and post-mortem, it may be beneficial to collect a plain, heparin and EDTA blood sample before death. Also consider a video of clinical signs. This can be especially helpful in cases of neurological disease.

In cases of sudden death, speak to the APHA to discuss anthrax testing before proceeding. Where lightning strike is suspected, note the location of where the body was found (e.g. under a tree, beside a metal fence or gate, near water); examine the carcass for scorch marks and record if there has been a recent storm. There are no diagnostic tests available to confirm lightning strike and often very few post-mortem changes are seen. The body may undergo rapid rigor mortis and then rapid autolysis, and you might see haemorrhages and petechiation on the outer and inner surface of the heart. Blood is said to be poorly clotted. Consider a full sample collection if other diseases need to be ruled out.

With reference to the tables below:

- Fresh tissues can be used for a range of tests including virus isolation, mineral analysis and culture
- Samples for histopathology can all go in to the same pot of formalin except, for example, where the location of the lesion is important in which case separate pots may be used

Table 1. Bovine and ovine abortion and stillbirths

Disease/ scenario	Sample				
	Fresh samples (Collect samples of tissues into separate plain pots (e.g. milk sampling pots). Freeze if applicable, or refrigerate and send directly)	Histopathology (1 cm ³ pieces of tissue into formalin, except brain and eyes which should be whole)	Foetal fluids (pipette fluid from the thorax/abdomen into a plain blood tube)	Foetal stomach contents (use vacutainer and plain blood tube to collect stomach contents)	Other
Ovine abortion	Placenta (at least two cotyledons included) Brain (1 cm ³ from the cerebral cortex) Spleen	Placenta, liver, heart, lung, brain	✓	✓	N/A
Stillborn lamb	Placenta (at least two cotyledons included) Brain (1 cm ³ from the cerebral cortex) Spleen	Placenta, liver, heart, lung, brain, thyroid	✓	✓	Confirm stillborn and not dystocia or neonatal death. Has the lamb walked/sucked colostrum/taken a breath?
Bovine abortion	Placenta (at least two cotyledons included) Brain (1 cm ³ from the cerebral cortex) Spleen	Placenta, liver, heart, lung, brain	✓	✓	N/A
Stillborn calf	Placenta (at least two cotyledons included) Brain (1 cm ³ from the cerebral cortex) Spleen	Placenta, liver, heart, lung, brain, thyroid	✓	✓	Confirm stillborn and not dystocia or neonatal death. Has the calf walked/sucked colostrum/taken a breath? Weigh thyroid and check for congenital defects

Note: Different laboratories may use different samples for the same diagnostic test. This list should include any sample that may be required by any lab, but we advise confirming with your laboratory which samples they require which will allow you to save on sample pots and time

Table 2. Infectious and unknown cause of death/no visible lesions

Disease/ scenario	Sample						
	PM blood (into plain blood tube)	Ocular fluid (into plain blood tube)	Faecal/ caecal sample (collect from the rectum or caecum)	Fresh samples (Collect samples of tissues into separate plain pots. (e.g. milk sampling pots). Freeze if applicable, or refrigerate and send directly)	Swab for culture (Refrigerate and send directly)	Histopathology (1 cm ³ pieces of tissue into formalin, except brain and eyes which should be whole)	Other
No visible lesions on post mortem, unsure of diagnosis	✓	✓	✓	Liver, kidney, spleen, brain (1 cm ³ of cerebral cortex), small intestinal contents	Any visible lesions/as applicable	Heart, lung, liver, gall bladder, spleen, kidney, small intestine, large intestine, uterus, urinary bladder, brain, lymph nodes, thymus (calves/lambs), skeletal muscle	Rumen pH, rumen sample, urine dipstick for glucose
OPA in sheep	N/A	N/A	N/A	N/A	N/A	Lung	N/A
Johne's	✓	N/A	✓	N/A	N/A	Jejunum and ileum (especially where visibly thickened), mesenteric LNs	Can make deep mucosal smear of intestine
Listeriosis	N/A	N/A	N/A	N/A	Brain stem, liver lesions	Brain (neurological), liver (systemic)	N/A
Black leg	N/A	N/A	N/A	Sample the lesion (skeletal muscle and/or heart)	N/A	Of lesion (skeletal muscle and/or heart)	3 x air dried impressions of affected muscle for FAT
Black disease	N/A	N/A	N/A	Liver	N/A	Liver	3 x air dried impressions of liver for FAT
Malignant oedema	N/A	N/A	N/A	The lesion	N/A	The lesion	3 x air dried impressions of lesion for FAT
Pulpy kidney	N/A	N/A	N/A	Small intestinal contents (fill pot to exclude air)	N/A	Brain	Urine distick for glucose. Look for fibrin clot in the pericardial sac
Lamb dysentery	N/A	N/A	N/A	Small intestinal contents (fill pot to exclude air)	N/A	Small intestine	N/A
Botulism	✓	N/A	50 g	Rumen contents, intestinal contents (2 x 50 ml), liver (50 g)	N/A	Brain (to rule out differentials)	Call your local Veterinary Investigation Centre if suspected. Clinical signs and history are vital in making a diagnosis. Collect feed (approx 5 kg) and water samples for analysis
BVD/BDV	✓	N/A	N/A	Spleen, ear notch	N/A	Lymph node, spleen, ileum. Sample any lesions in the mouth, tongue, oesophagus, rumen, abomasum, caecum, colon or skin	N/A
MCF	✓	N/A	N/A	Spleen, lymph node	N/A	Brain, lymph node, spleen, kidney, liver, urinary bladder. Lesions in the respiratory tract, GI tract or skin. Eye(s) if affected	N/A

Table continues on the next page.

Table 2. Infectious and unknown cause of death/no visible lesions (continued)

Disease/ scenario	Sample						
	PM blood (plain tube)	Ocular fluid (plain tube)	Faecal/ caecal sample (collect from the rectum or caecum)	Fresh samples (Collect tissues in to separate plain pots. Freeze if applicable, or refrigerate & send directly)	Swab for culture (Refrigerate and send directly)	Histopathology (tissue into formalin)	Other
Pasteurellosis in sheep	N/A	N/A	N/A	N/A	Lung, spleen	Lung	Look for subcutaneous haemorrhages around the neck and shoulders, and oesophageal ulceration. Consider underlying diseases e.g. mineral imbalances or PGE
Maedi-Visna	✓	N/A	N/A	N/A	N/A	Lung, udder, brain	Check joints
Salmonellosis	N/A	N/A	✓	Intestinal contents, liver, gall bladder, kidney, lung	Liver	Intestines, liver	N/A
Louping ill	✓	N/A	N/A	N/A	N/A	Brain	N/A
Tick-borne fever	N/A	N/A	N/A	Spleen	N/A	N/A	N/A
<i>Histophilus somni</i>	N/A	N/A	N/A	Lung, brain	N/A	Brain, lung, heart	N/A
IBR	✓	N/A	N/A	Lung, trachea	N/A	Trachea, lung, brain	N/A

Table 3. Parasitology

Disease/scenario	Sample		
	Faecal sample (collect from the rectum and caecum)	Histopathology (1 cm ³ tissue into formalin)	Other
Liver fluke	40 g	Liver	Thickened bile ducts on PM, fluke in ducts and/or gall/bladder
Lungworm	50 g	Lung	Look for thread like white worms in the caudal trachea and down into the bronchi
Nematodirus	✓	Small intestine	Look for small white worms in the small intestine that look like cotton wool
Haemonchosis	✓	Abomasum	Look very closely for barber's pole worms in the abomasum. Consider TWC, as discussed below.
PGE	✓	Abomasum, small intestine and large intestine	Consider TWC, as discussed below.
Coccidiosis	✓	Ileum, caecum, colon	Can make impression smear of intestine
Babesiosis	N/A	N/A	Blood smear

Note: You may not get a high worm egg count (WEC) if animals are clinically affected in the pre-patent period. In fresh sheep carcasses, you can do a total worm count (TWC), which involves washing the abomasum and small intestines to collect and count adult worms and immature larvae. If a pre-patent worm infestation is a differential, contact your local laboratory for more details on how to do a TWC.

Table 4. Syndromes

Disease/scenario	Sample						
	PM blood (into plain blood tube)	Ocular fluid (into plain blood tube)	Faecal sample (collect from the rectum or caecum)	Fresh samples (Collect samples of tissues in to separate plain pots. (e.g. milk sampling pots). Freeze if applicable, or refridgerate and send directly)	Swab for culture (Refridgerate and send directly)	Histopathology (1 cm ³ pieces of tissue into formalin except brain and eyes which should be kept whole)	Other
Pneumonia	✓	N/A	N/A	Lung (multiple pieces), trachea	Lung, tracheal bifurcation	Lung (from all lung lobes of both lungs, included affected and edge areas)	Consider underlying diease such as BVD/BDv or mineral deficiencies
Neurological signs	✓	✓	N/A	Kidney, (for lead)	Brain swab	Brain, spinal cord if signs localise to there, liver	N/A
Skin lesions	N/A	N/A	N/A	N/A	Depending on lesion	Skin	Skin scrapings/ hair plucks
Mastitis	N/A	N/A	N/A	Milk sample (collect aseptically)	Udder	Udder	N/A
Diarrhoea	✓	N/A	✓	Intestinal contents, spleen	Small intestine	Abomasum, small intestine, large intestine, kidneys	Rumen pH if acidosis suspected

Table 5. Miscellaneous

Disease/scenario	Sample					
	PM blood (into plain blood tube)	Ocular fluid (into plain blood tube)	Faecal sample (collect from the rectum or caecum)	Fresh samples (Collect samples of tissues in to separate plain pots. (e.g. milk sampling pots). Freeze if applicable, or refrigerate and send directly)	Histopathology (1 cm ³ pieces of tissue into formalin except brain and eyes which should be kept whole)	Other
Copper, lead, selenium, cobalt, vitamin A and vitamin E analysis (toxicity or deficiency)	N/A	N/A	N/A	Liver and kidney (min 10 g each)	Liver and kidney	N/A
White muscle disease	N/A	N/A	N/A	Liver	Skeletal muscle, heart, diaphragm, intercostal muscle	N/A
Milk fever/staggers/twin lamb disease/ketosis/nephrosis in lambs	N/A	✓	N/A	N/A	Liver and kidney	N/A
Bovine neonatal pancytopenia	N/A	N/A	N/A	N/A	Bone marrow (section the first two sterabrae and place in formalin)	N/A
Closantel toxicity	N/A	N/A	N/A	N/A	Brain, eye	N/A
Fog fever	N/A	N/A	N/A	N/A	Lung	N/A
CCN	N/A	N/A	N/A	N/A	Brain	N/A
Plant poisoning	N/A	N/A	N/A	Rumen contents	Liver, kidney, lung, urinary bladder	Check rumen contents thoroughly
Neoplasia	N/A	N/A	N/A	N/A	Multiple sections of the lesion – especially the edge	N/A

Rumen pH

- Measure the pH of the ruminal contents using a pH meter or pH test strips
- A pH <5 suggests acidosis
- The pH of the rumen will move towards neutral (pH 7) the longer the animal has been dead

Ocular fluid

1. Collect from dead animals only, using a 16 gauge needle and a 2 ml syringe, ideally within 24 hours of death. Vitreous humour is stable for some time after death and is, therefore, useful for analysis.



Figure 50. Collecting ocular fluid. The needle has been tilted for the photo to show the position of the tip which hasn't yet been advanced through to the vitreous chamber (behind the lens)

2. Advance the needle directly into the eye and towards the back, perpendicular to the surface of the cornea, and draw back, once the tip is in the vitreous chamber. The sample can also be collected by inserting the needle from above, straight into the vitreous chamber, entering perpendicular to the sclera.

Note: The sample should be transparent; the more contamination, the less chance of achieving a diagnosis.



Figure 51. A sample of ocular fluid should be transparent

3. Collect into a plain tube and send for biochemistry (BHB, Ca, Mg and Urea).

Taking samples for culture

Give consideration to the cost-benefit of bacteriology, which often does not materially alter the outcome or the suspected diagnosis. This is especially so in the field, where contamination is likely. Contaminated swabs/samples cost just as much as those where a pure culture of a likely pathogen is obtained.

1. Place the tissue sample on a non-flammable surface (e.g. a foil tray, concrete flooring).



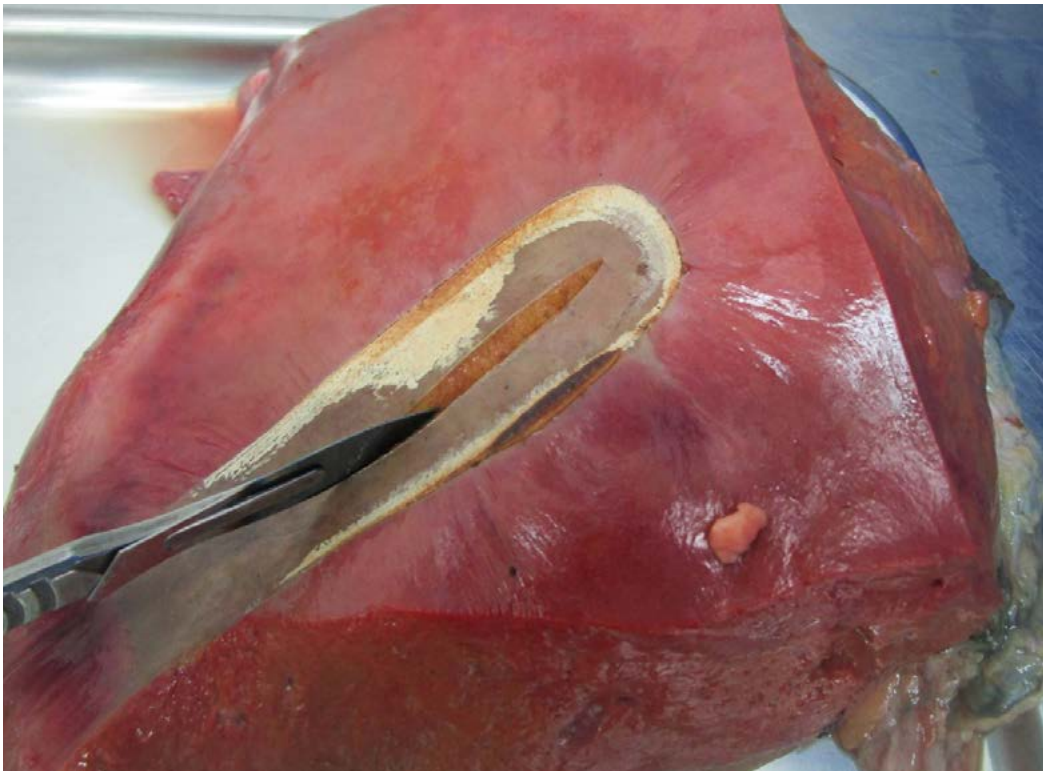
2. Heat a metal object (such as a dehorning iron or a palette knife) over a naked flame (e.g. a Bunsen burner or a dehorning flame).



3. Press the hot metal object onto the surface of the tissue to sear.



4. Use a clean (sterile) scalpel blade to cut into the surface.



- Using a charcoal swab, swab the tissue. Label the swab appropriately and keep refrigerated before posting.



- If you do not have access to a flame, you can sample tissue without searing the surface first. However, you will only stand a chance of getting useful results if you have not contaminated the organ to be sampled. **This is difficult in an on-farm post-mortem situation and should only be attempted in clean environments.** To do this, you would need to decide to collect samples for culture **before** touching the organ. If sampling the lung, for example:
 - Open the thorax
 - Do NOT touch the lung tissue
 - Use a brand new scalpel and make a cut into the lung tissue
 - Take a swab. **Charcoal swabs** will reduce the risk of contaminant overgrowth in the post

It should be noted this approach has a high risk of growing contaminants and not producing any meaningful results. Consider whether this is a useful way to spend the farmer's money and interpret any findings carefully.

Taking samples for histology

- Tissue pieces should be no bigger than 1 cm³ and placed in 10 times their volume of 10% neutral buffered formalin
- Different tissues can be placed in the same pot. Label the pot to advise of the contents. Use separate pots if the location is vital to the diagnosis
- Take at least two to three samples from each organ and always sample the margin of normal and abnormal tissue where you can see gross lesions. When sampling the gut, take multiple samples of each section (stomachs, small intestine, large intestine and caecum) and open the sections before placing in formalin
- Place tissues in formalin at the time of the PME. This may mean that you need to carry some pots of formalin with your PM kit in your car. If you carry the sample around in your car, autolysis will keep occurring until the samples are in formalin
- You can allow formalin to fix the tissues for 48 hours and post the samples in a smaller volume of formalin after this period. Keep formalin-fixed samples at about 22°C while fixing. Do **NOT** put formalin-fixed samples in the fridge

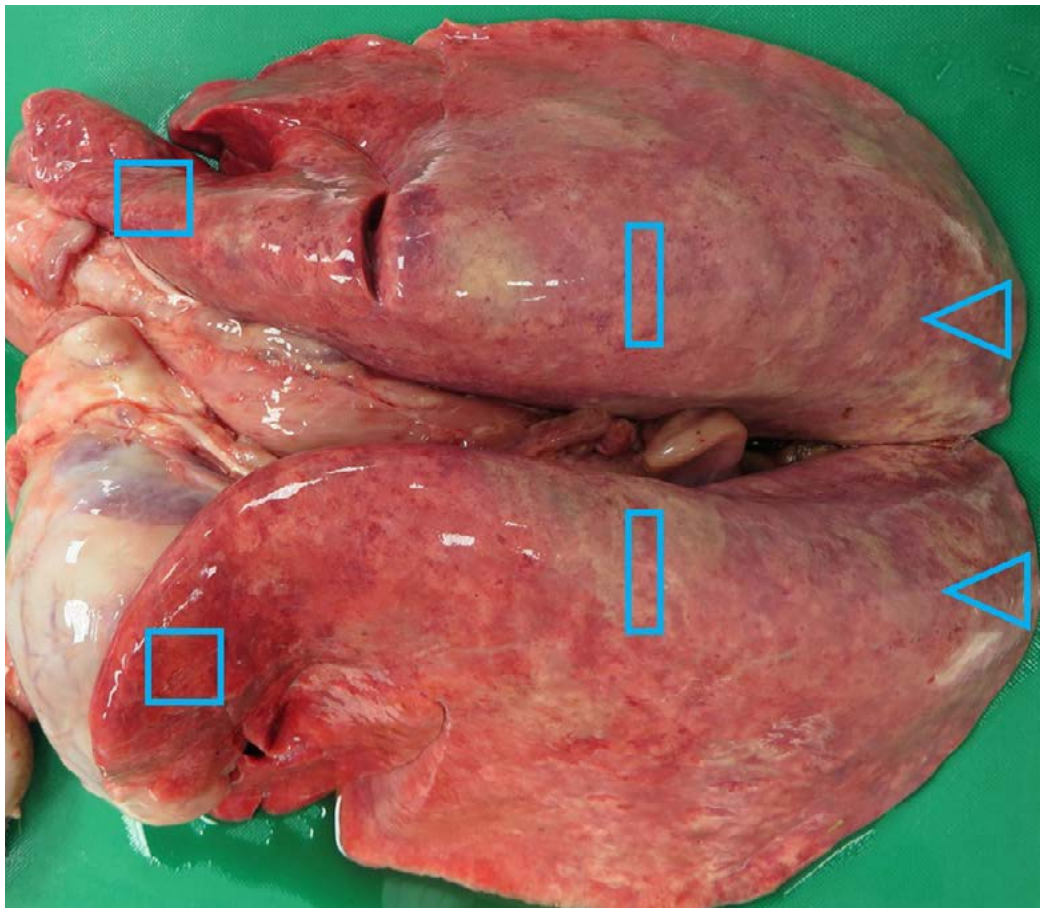


Figure 52. Histopathology sampling sites from the lungs

- Sample each lung in three different places on each side, cut a different shape from each area so the location is known. If there are changes in the lung, also collect the margin of normal and abnormal tissue
- Intestines – these must be taken as soon as possible after death, ideally within 15 minutes. If you are concerned about an intestinal problem and are euthanasing an animal, have pots of formalin ready, open the abdomen and get the intestine samples into formalin as soon as possible
- Brains should be fixed whole in 10 times the volume of 10% neutral buffered formalin. After 48 hours, it can be placed in a reduced amount of formalin for posting. Or, fix for seven days and then wrap and place in a rigid pot with padding to send

For more detailed information on sampling, see: [Livestock & Wildlife Disease Diagnosis at APHA Guidance on sample and test selection](#) or speak to the laboratory where you plan to send your samples.

Posting samples

Samples posted to an external laboratory should be correctly packaged and labelled

- Tissue samples should be submitted in a sealed, primary container. This should be wrapped in absorptive material and packaged into a sealed secondary container or bag before being placed in the packaging for postage. Paperwork should be placed in a separate sealed plastic bag to protect from any leakage
- Packaging should conform to the P650 packing instructions. Click [here](#) for more information
- Fill in the submission form as fully as possible. The more information given, the better the laboratory can interpret the results and the more chance you have of getting a diagnosis



Figure 53. An example of bad packaging – no absorptive material was used. The formalin leaked out of the primary container, through the plastic bag and was leaking through the postal envelope. The primary container and amount of formalin was also excessive for the two small samples submitted

Photographs

Good photographs of lesions are invaluable when it comes to asking for a second opinion on a case, but they are also a useful record for you and the farmer.

To take a good photo of a lesion:

- Put the lesion in the centre of the photo
- Take a photo of the entire organ and then a closer photo of the affected part
- Take a photo of the cut surface of the lesion, including the border between normal and abnormal tissue
- Hold the camera perpendicular to the organ. Avoid taking photos on an angle (imagine you are taking a radiograph)
- Label left and right, where necessary
- Label the photo with animal ID, where necessary
- Take a photo of an unaffected comparison, where applicable (e.g. left and right kidney)
- Use the ruler on the end of the scalpel handle to record size, where necessary

Solid organs

Liver



Figure 54. Lymphoma in a calf. This photo could have been taken from further away to show the massive increase in size of the liver, or could have included a ruler



Figure 55. The cut surface of the same liver provides extra information. Lymphoma was confirmed on histology

Lungs

Photos taken from the sides and above provide the most information. Including the whole organ allows the distribution of the lesion to be assessed, which is especially important in the lungs.

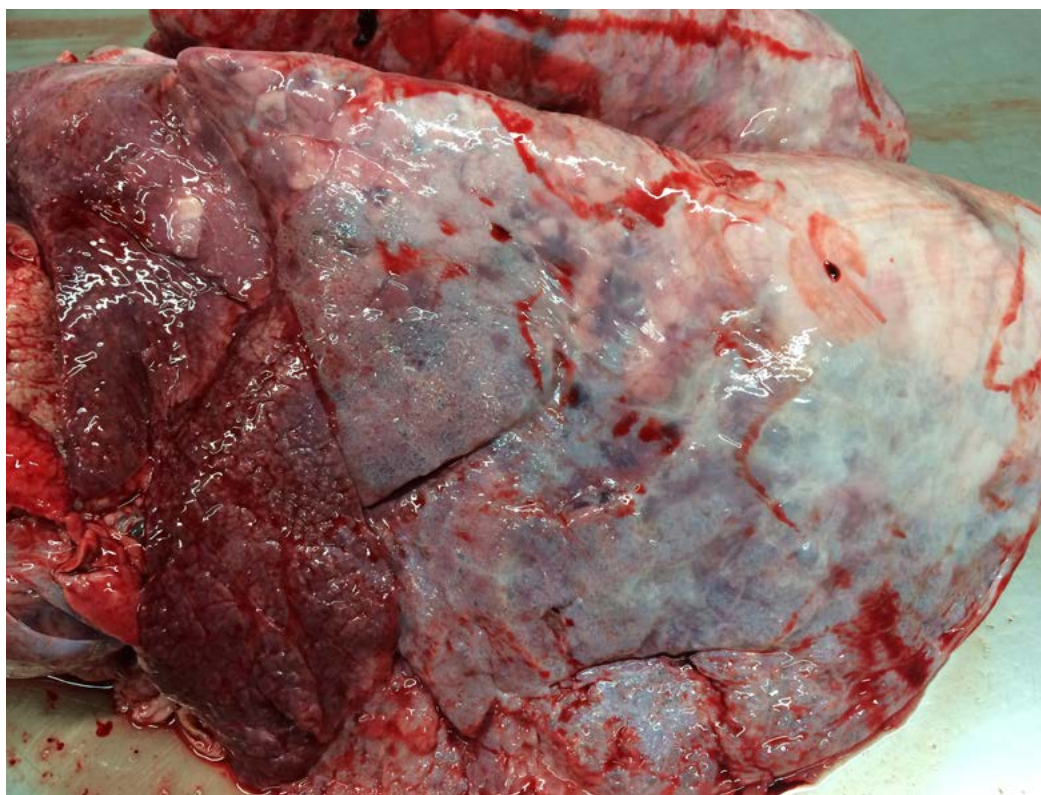


Figure 56. Craniocentral bronchopneumonia in a calf (cause in this case: respiratory syncytial virus)

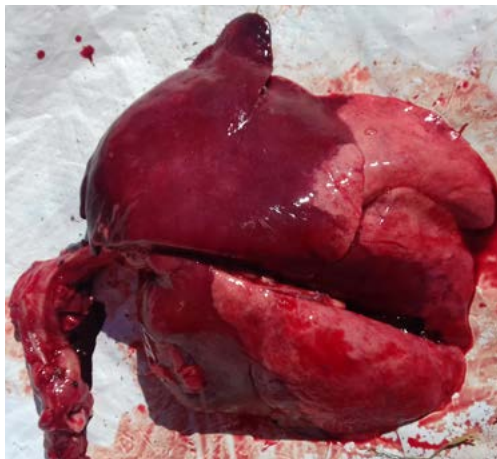


Figure 57. Pasteurella pneumonia in a lamb

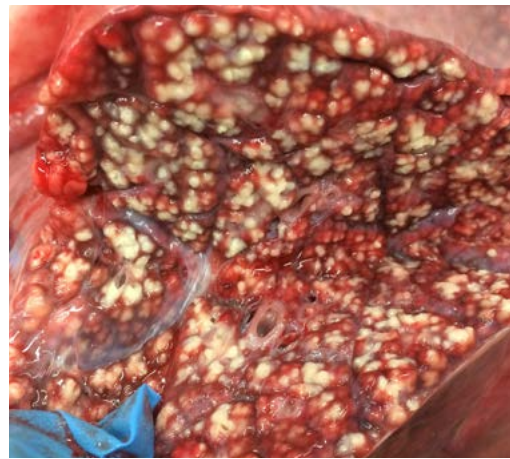


Figure 58. *Mycoplasma bovis* pneumonia in a calf. A cut section of solid organs can sometimes provide more information than the external surfaces



Figure 59. Ovine Pulmonary Adenocarcinoma in the lung of a ewe – external view



Figure 60. Ovine Pulmonary Adenocarcinoma in the lung of a ewe – cut section. The cut section also includes multifocal abscessation

The Kidney

The kidney can be sectioned down the middle like a bread roll.

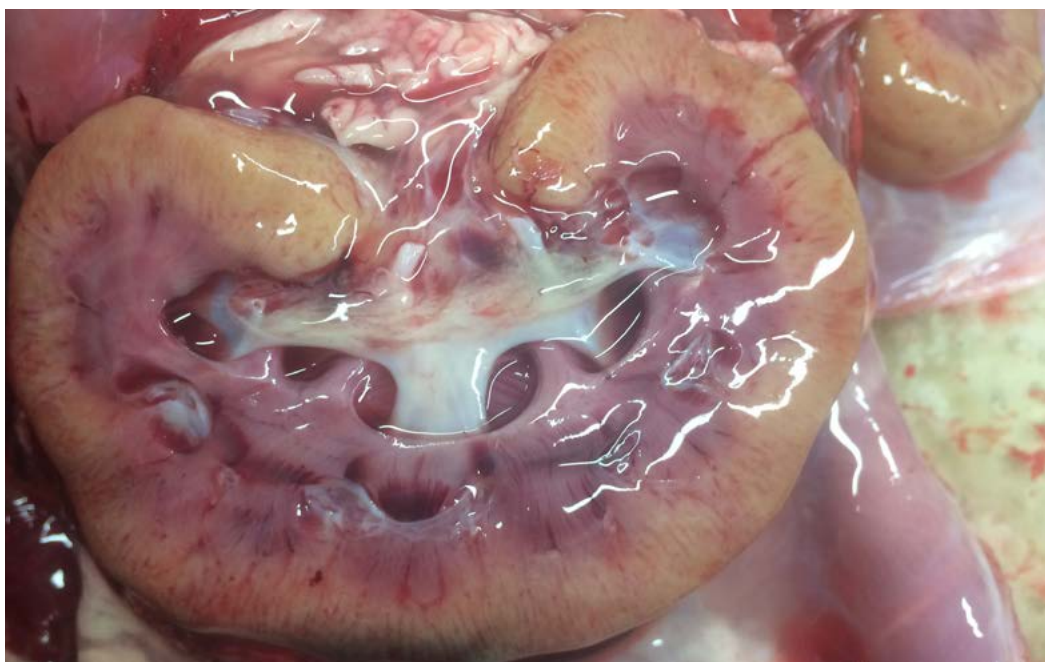


Figure 61. Hydronephrosis in a sheep

Organs with a lumen

The heart

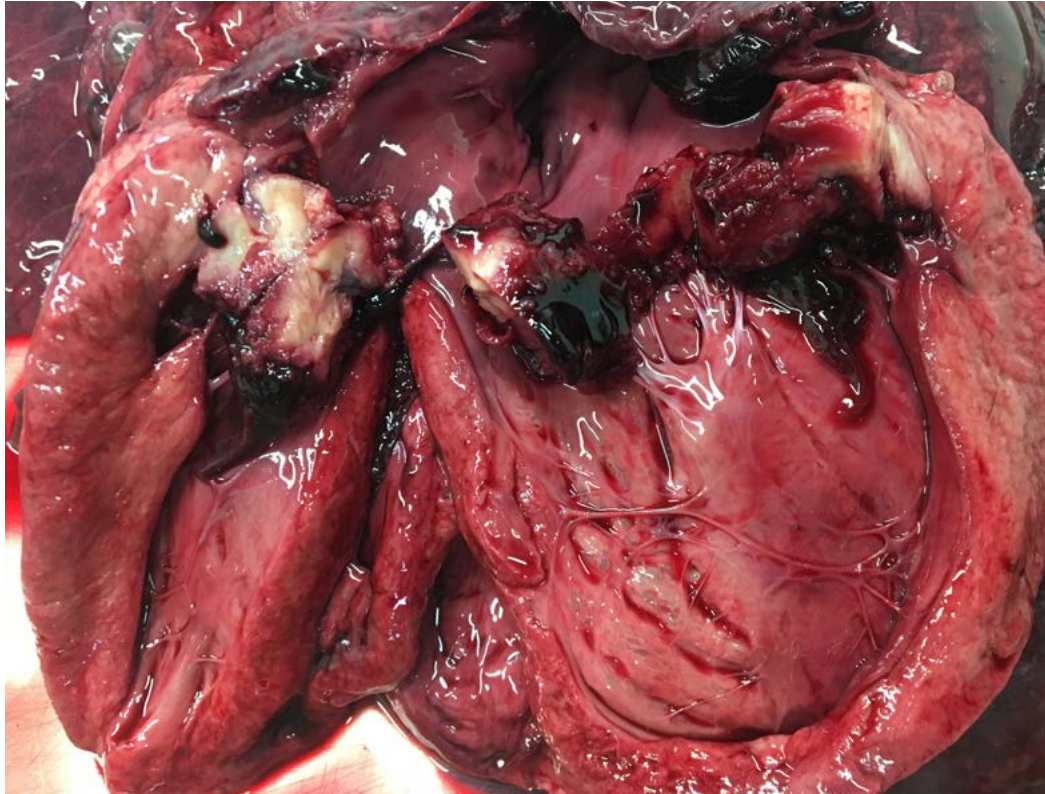


Figure 62. Endocarditis in a ewe. The ventricle has been incised and the heart opened for the picture

The gastrointestinal tract



Figure 63. The rumen of a calf with fungal plaques. The whole organ is in the photo and the individual lesions in this case are clearly visible

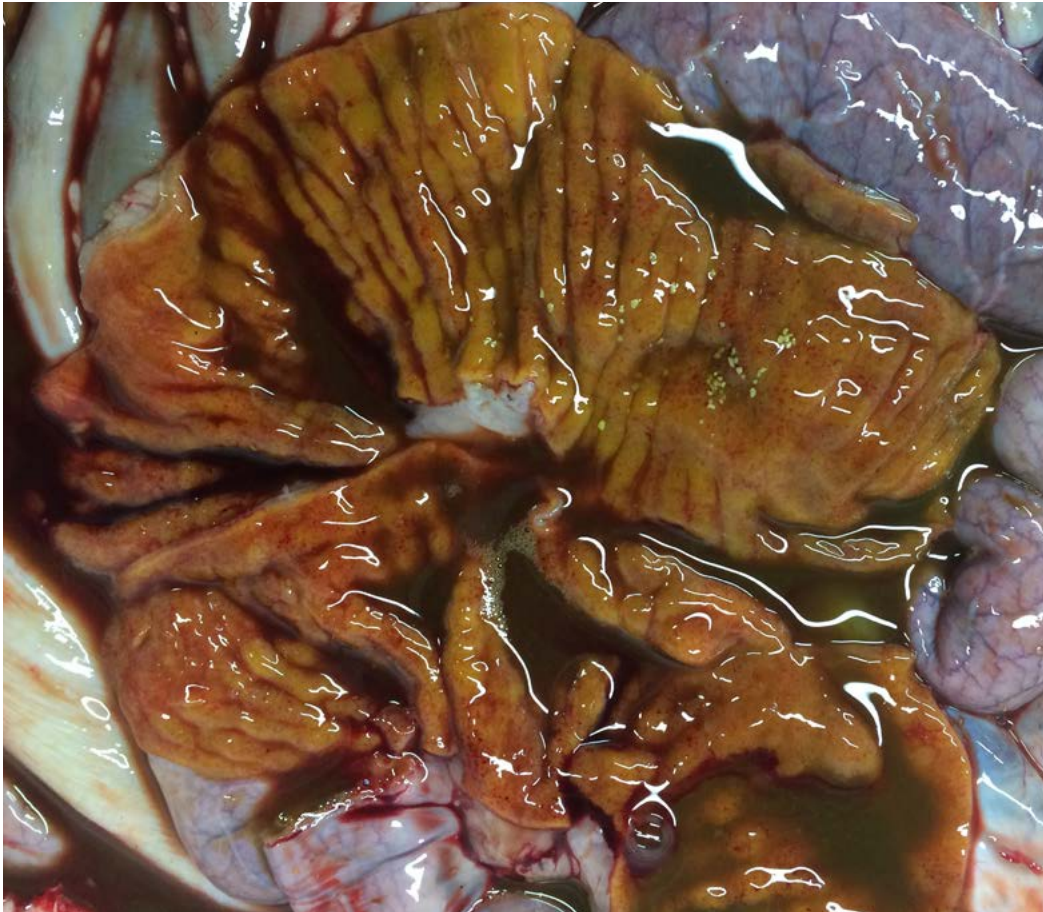


Figure 64. Johne's in a sheep. The thickened intestine is in the middle of the photo and clear to assess



Figure 65. Coccidiosis in a lamb. External view showing the reddened intestines

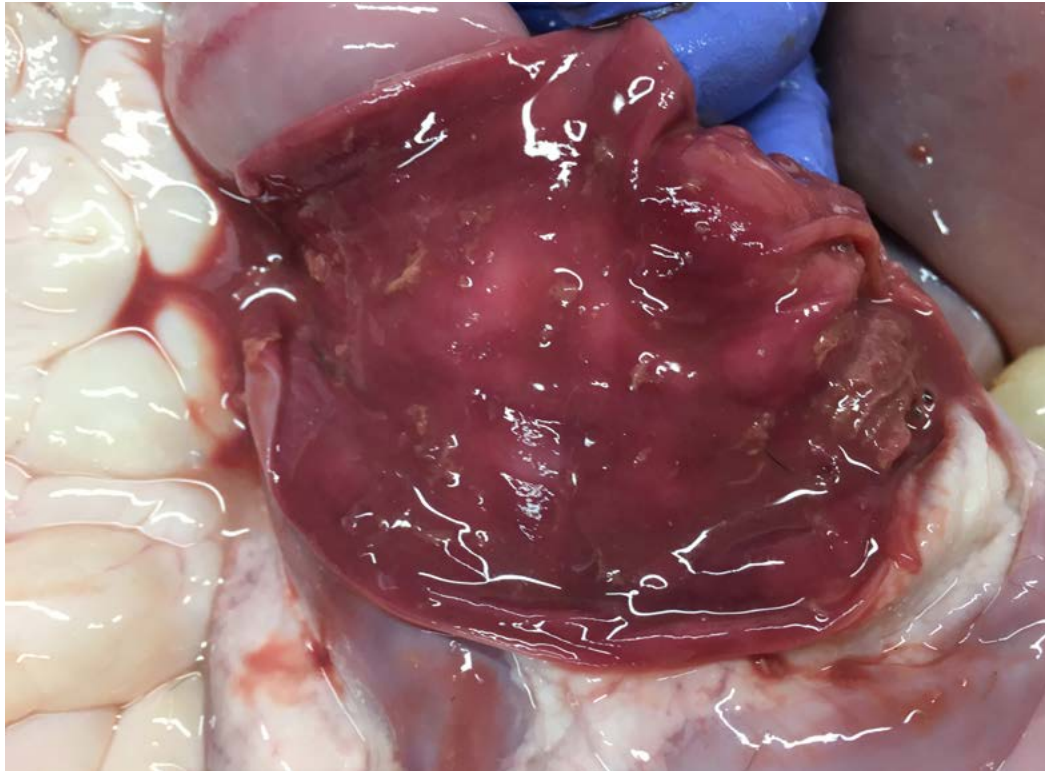


Figure 66. Coccidiosis in a lamb. View of the lumen showing the red contents



Figure 67. A mass of fat necrosis around the small intestine of a dairy cow. This transverse section allows assessment of the lesion on the lumen

Other structures



Figure 68. An opened joint of a lamb with joint ill

The whole carcass



Figure 69. Schistosomus reflexus in a lamb. In some cases, an overview provides more information than a close-up

Body cavities



Figure 70. Fibrinosuppurative pleurisy and hydrothorax in a lamb with *Mannheimia haemolytica*. This photo was taken before the lungs were removed from the chest and shows the full extent of the pleurisy, as well as the fluid in the thoracic cavity



Figure 71. Severe fibrinosuppurative peritonitis in a beef cow. A photo before the abdominal contents were removed provided the best information in this case

Making a diagnosis

Gross pathology findings should be taken into consideration with the results of any further testing conducted, as well as the history and clinical signs of the animal.

It is not possible to include descriptions and photos of all pathology seen in cattle and sheep in this publication. For a comprehensive coverage of the pathology, refer to:

1. Pathologic Basis of Veterinary disease, sixth edition (textbook). James F. Zachary, Elsevier, 2017.
2. Pathology of Domestic Animals, sixth edition (textbook). Jubb, Kennedy and Palmer, 2017.
3. Bovine Pathology A text and colour atlas (textbook). Claus D. Buergelt, Edward G. Clark and Fabios Del Piero, CAB International, 2017.
4. **CL Davis Thompson Foundation NOAH's Arkive** (2018) (Use the search function to look for gross photos of cattle and sheep).
5. **CL Davis Thompson Foundation YouTube** (2019) (this has summary videos of gross lesions in cattle and sheep).
6. **Farm Post Mortems Ltd photo archive.**
7. Van Donkersgoed, J. And Ravi, M.B. (2018) **Feedlot lamb pathology atlas**, Kirkland, QC, Intervet Canada Corp., subsidiary of Merck & Co., Inc.

Post-mortem report

A short PM report will provide the farmer with a record of the post-mortem and demonstrate what you did and didn't find. It can also be kept on the farm records for future information, to be used in future herd or flock planning.

The report should include:

- Case details
- A summary of the history and clinical findings
- A comment on the condition of the carcass (e.g. the carcass was in a state of good/moderate/poor post-mortem preservation)
- Post-mortem findings
- Results of any further tests
- An interim (if awaiting further diagnostic tests) or final diagnosis
- Photos of the post-mortem
- A comment on what this means for the farm and what, if any, action should be taken

An **example post-mortem report** and a **report template** can be found at ahdb.org.uk

Can farmers perform post-mortems?

Some practitioners work closely with their clients to collect information about diseases on-farm by the farmers conducting PMEs themselves. This is most often done in sheep and, most commonly, neonatal lambs.

This is something that requires a close working relationship between the client and the vet to make sure that farmers are adequately trained to undertake the post-mortem and that the vet is always consulted to discuss the findings and onward actions. Good-quality photographs taken by farmers and shared electronically are essential for correct interpretation of findings in these cases.

There are a number of challenges and benefits to this and we therefore recommend reading the following publication:

Gasgoine, E., Bazely, K. and Lovatt, F. (2017) Can farmers reliably perform neonatal lamb post-mortems and what are the perceived obstacles to influencing lamb mortality? *Small Ruminant Research*, **151**, 36–44.

The following AHDB BRP resources are also available for farmers conducting PME in lambs:

Reducing lamb losses for better returns: ahdb.org.uk/knowledge-library/reducing-lamb-losses-for-better-returns

Post-mortem worksheet: ahdb.org.uk/knowledge-library/lamb-post-mortem

Recommended reading

Buxton, D. and Henderson, D. (1999) Infectious abortion in sheep. *In Practice* **21**, 360–368.

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Glossary

ACVP – American College of Veterinary Pathologists

AFBI – Agri-Food and Biosciences Institute

APHA – Animal and Plant Health Agency

Cert AVP – Certificate in Advanced Veterinary Practice

Defra – Department for Environment, Food & Rural Affairs

DBR – Diploma in Bovine Reproduction

ECVP – European College of Veterinary Pathologists

FRCPath – Fellow of the Royal College of Pathologists

PM – Post-mortem

PGE – Parasitic gastroenteritis

PME – Post-mortem examination

PPE – Personal Protective Equipment

SRUC – Scotland's Rural College

TWC – Total Worm Count

VIO – Veterinary Investigation Officer

WEC – Worm egg count



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