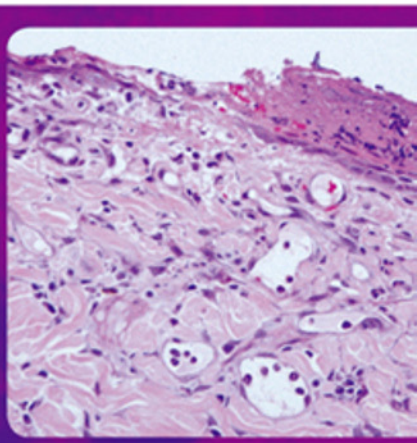
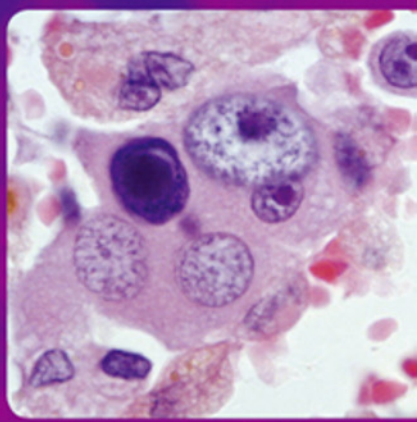
General Pathology
for Veterinary Nurses

Harriet Brooks





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General Pathology for Veterinary Nurses

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A John Wiley & Sons Ltd., Publication

This edition first published 2010

Blackwell Publishing was acquired by John Wiley & Sons in February 2007. Blackwell's publishing programme has been merged with Wiley's global Scientific, Technical, and Medical business to form Wiley-Blackwell.

Registered office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

Editorial offices
9600 Garsington Road, Oxford, OX4 2DQ, United Kingdom
2121 State Avenue, Ames, Iowa 50014-8300, USA

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Library of Congress Cataloging-in-Publication Data

Brooks, Harriet W.
General pathology for veterinary nurses / Harriet W. Brooks.
p. ; cm.
Includes index.
ISBN 978-1-4051-5590-8 (pbk. : alk. paper)
1. Veterinary pathology. 2. Veterinary nursing. I. Title.
[DNLM: 1. Animal Diseases–physiopathology–Nurses' Instruction.
2. Pathology, Veterinary–Nurses' Instruction. SF 774.5 B873g 2010]
SF774.5.B76 2010
636.089′607–dc22
2009027991

A catalogue record for this book is available from the British Library.

Set in 10/12.5pt Avenir by Aptara® Inc., New Delhi, India
Printed in Malaysia

1 2010

Contents

About This Book

Don't skip this part! This section will explain how to get the most from this book.

Aims of this section

- To introduce general pathology
- To explain the format of the book
- To give some general information

Welcome to general pathology!

What do we mean by general pathology? Before answering that, let us talk about pathology in its broadest sense.

What is pathology to you?

You may think of pathologists as people in paper suits, who get involved with murder investigations on the television, very remote from your everyday life. If you are already studying for your nursing qualification, you may view pathology as a dreary subject to be passed on the way to the more exciting subjects of surgical or medical nursing. You may have completed your studies and feel you 'got by' without needing to know too much pathology anyway.

Well, I hope that, through this book, I can help you to view pathology as not so boring after all, and relevant to every one of us involved in veterinary medicine.

Pathology underpins all you do as a veterinary nurse; it is central to veterinary science. Apart from some elective surgical procedures, all

that exciting medicine and surgery hinge on pathological processes occurring within the body. Understanding these pathological processes will help you to understand the clinical presentations of your patients, to follow the rationale of the treatments used in the clinics, and to explain the conditions and procedures to anxious owners. A good understanding of pathology will turn a competent veterinary nurse into an outstanding one.

So, what is pathology?

This question will be answered more fully in the first two chapters, but briefly, pathology is the study of the effects of disease on the body. It is a broad subject, encompassing a number of sub-divisions such as *general* pathology, *systematic* (or *special*) pathology and *clinical* pathology.

This book concentrates on general pathology, which is the study of the basic pathological processes that are not specific to particular organs or tissues. For instance, processes such as cell degeneration, inflammation and tumour formation are pretty much the same in all parts of the body, and so are considered under the heading of general pathology.

Other textbooks and references will cover *systematic* pathology, discussing specific organ systems. If you refer to these texts you will be able to apply the knowledge of general pathology that you gain from this book.

Clinical (or *chemical*) *pathology* is the pathology used in the laboratory, whether the practice laboratory or a diagnostic laboratory – many general nursing texts cover basic clinical pathology, e.g. urinalysis or blood biochemistry, so I have not covered these aspects in this book.

The format of this book and how to use it

Each chapter starts with two boxes, one giving an outline of the chapter and the other explaining the aims of the chapter. Read the aims box carefully. Understanding the aims of each chapter will help to guide your reading of the topic.

There are sub-headings dividing up each chapter into main topics and at the end of each chapter is another text box summarising the main points covered in the chapter.

More boxes!

Dotted through the text there are diagrams and tables and a few photographs, all included as numbered boxes. These numbered boxes

aim to summarise information or revise it, so that many important topics will be encountered three times – in the text, in the diagram and as a caption to the diagram. The diagrams and tables can also be used as a revision aid if you are unlucky enough to be facing examinations. A glossary of terms used in the book, or that you may come across in your reading, is included towards the back of the book.

You might find that some areas do not have summary boxes when you feel you could do with them or a useful term is omitted from the glossary; in this case, draw up your own boxes to help your study and add missing words to the glossary – do not just accept what I have given you! Remember this book is just a starting point for you – use it to gain the basics and the confidence to start to read around the subject. Who knows where you could end up?

Questions, questions!

Each chapter finishes with up to six test yourself questions. The questions vary slightly in their format and some require short snappy answers, whilst others could almost require short essay answers. These are to help you make sure you have understood what you have read; use them in whatever way helps you most. You may like to actually sit and write your answers from memory, you may like to jot notes or key words or you may find just reading through the questions helps you. At the end of the book are some suggested answers; however, you choose to use the questions, try not to cheat! It will help you most if you have a go at answering the questions yourself before you read my suggestions.

The book is designed to be a workbook. If this is your own book, do not be afraid to personalise it – jot notes or reminders in the margin, cross reference to published articles or to other parts of the book, or to cases you have seen in the clinics. Annotate the diagrams; draw moustaches on the cartoons. Make this book totally yours. (Note – do not do this if it is a library copy, if you are reading this in a bookshop or if it belongs to someone else.)

Your roles

You will need to be an active reader to get the most from this book! Many sections within this book build on one another. Some prior knowledge of histology, anatomy and physiology is expected, so you may need to refer to other texts or study notes to supplement some areas if you are uncertain what is being discussed.

Get in touch – the author would like to hear from you if you have comments or complaints, or suggestions for future editions.

Most of all, I hope you will enjoy reading and using this book and that it might change your mind about pathology (unless, of course you liked it all along!).

This book is dedicated to my parents, with fondest love

Acknowledgements

I am indebted first and foremost to Wiley-Blackwell for inviting me to write this book, and thanks to many people there, but especially Katy Loftus, for encouragement, advice and extreme patience during its protracted production.

Many thanks also to all of my family, especially my mother and husband, for their support, love and a good deal of humour; I might have given up many times had you not all kept me going. Thanks also to Joe, my husband, for comments on Chapter 5, and for the use of his photograph in that chapter, and to Helen Wakeham for allowing us to photograph her sow and piglets.

My beloved canine companions – Daisy, Dilly and Edie – deserve a mention for keeping my spirits high and for taking me out for many a good walk to clear my mind.

This book is based on my pathology teaching material for trainee nurses at the Royal Veterinary College. So finally, but certainly not least, I acknowledge all past and future trainee veterinary nurses who have inspired me to write the book; I truly hope it helps to underpin your chosen careers, and I wish you every happiness and success in the future.

Harriet Brooks

Chapter 1

Introduction to Veterinary Pathology

What is pathology?

Who 'does' pathology?

- Anatomic pathology
- Clinical pathology
- Microbiology
- Parasitology
- Immunology
- Toxicology
- Veterinary forensic pathology
- Government agency laboratories
- Pharmaceutical laboratories

Pathology as an academic subject

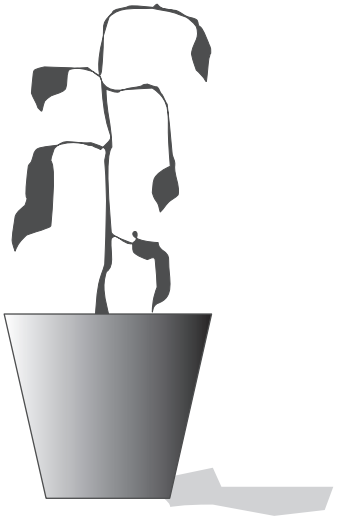
Aims of Chapter 1

- To define pathology as part of (veterinary) medicine
- To define general pathology as part of pathology
- To briefly discuss how pathology is used everyday, and who uses it and where it is used

What is pathology?

The word pathology comes from two Greek words, *Pathos* – which literally means '*experience*' or '*something which one suffers*', but which in this context is used in terms of suffering *from a disease*, and *-logy* meaning '*word*', '*speech*' or '*reason*'. The suffix *-logy* is used in compound words (when it is added to another word such as in biology, physiology and entomology), and then it infers '*study of*' or '*science of*'.

So, *pathology is the branch of medical science that involves study of the causes of diseases, how they develop and their effects on the body*. It encompasses any deviation from a healthy or normal condition in any living creature. There is even a branch of horticulture that involves study of pathology in plants.



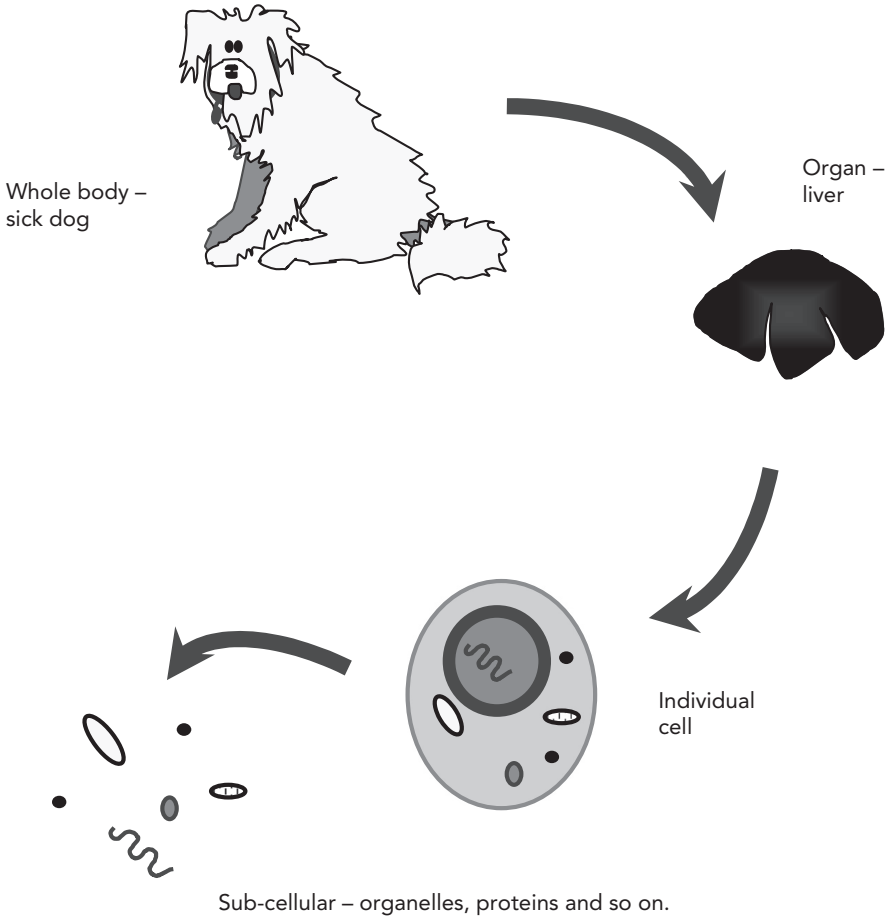
In pathology, the effects of diseases can be studied at various levels: the *whole body*, the *organs* or *tissues*, *cells* and even *within cells* (at sub-cellular level) (see Box 1.1).

Box 1.1 What is pathology?

Pathology is the branch of medical science involving study of the *causes* of diseases, how they *develop* and their *effects* on the body.

Pathology includes consideration of any deviation from a healthy or normal condition, in any living creature (including plants).

In pathology, the effects of diseases are studied at various levels: the *whole body*, the *organs* or *tissues*, the *cells* and even *within cells* (at sub-cellular level).



Who 'does' pathology?

You might answer that question by saying pathologists do, and that is certainly correct. We will discuss pathologists in a moment, but the 'pathologically trained' professionals are not the only ones actively engaged in pathology. If you are working in general practice, you are too.

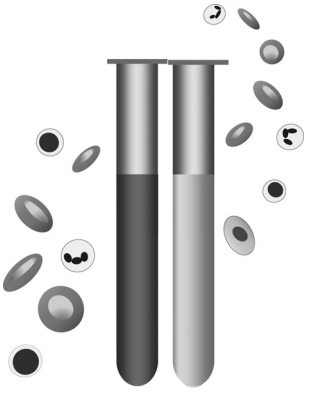
As we said at the beginning of this chapter, pathology involves not just study of what causes diseases, but also how diseases develop and their effects on the body. Every time you record the temperature, pulse and respiration of a patient, use a dipstick to test an animal's urine, run an automated blood analyser, change the dressing on an infected wound, or advise an owner about flea control to help their cat's red itchy skin, or diet to control diarrhoea in a sensitive golden retriever, you are assessing the deviation from a healthy or normal condition in the animal; you are assessing pathological changes. So, you and the vets, physiotherapists and others with whom you work use their knowledge of pathology. But there will be times when you require help from a pathology diagnostic laboratory to make the diagnosis; perhaps you need tests beyond the scope of your practice laboratory.

Pathology laboratories may be independent businesses, or they may be based at a university veterinary school, or they may be government agencies. The pathologists who work at these laboratories are often classified according to the type of diagnostic work they do, though a few will be all-rounders and will do everything!

Anatomic pathology

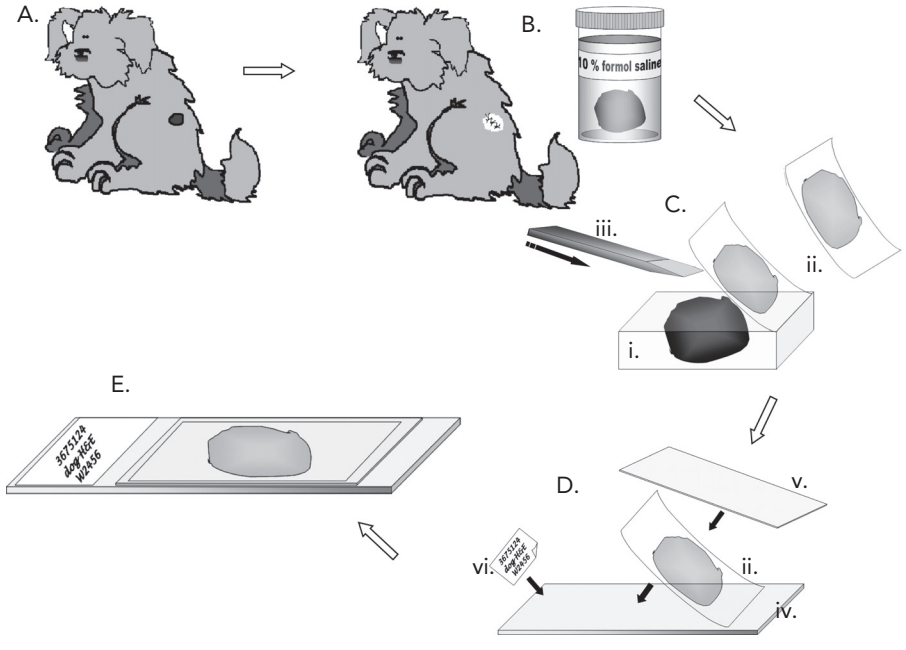
Anatomic pathologists study disease by looking at tissue and organs. This may be by performing post-mortem examinations (also called *necropsies*) and writing a post-mortem report, or by looking at tissues from live animals (called *biopsies*). Anatomic pathologists will look at the tissues or organs by eye (gross examination) to identify abnormalities, but also use histologic sections, mounted on glass slides to look at the tissue under the microscope (see Box 1.2).

Clinical pathology



Clinical pathologists assess disease in an animal by studying body fluids (such as blood, urine, joint fluid, abdominal tap fluid, cerebrospinal fluid and so on). They may look at the chemical composition (*clinical biochemistry*) or the types of cells in the fluid or in an FNA, using a microscope to study a stained smear of the sample on a glass microscope slide (this is called *cytology*). Clinical pathologists might spot bacteria or other infectious organisms in a cytology preparation.

Box 1.2 How histology sections are produced (see diagram below)



A. A dog is presented at the vet's surgery with a skin tumour.

B. Taking a biopsy, the vet decides to remove the tumour, perhaps after performing a fine-needle aspirate (FNA) and checking what the mass is. The vet and owner decide that they would like to send the mass to a pathologist to confirm the diagnosis. The mass is placed in a fixative solution which will preserve the tissue by fixing (denaturing) the proteins. Usually, a 10% solution of formalin is used (10% formol saline). In this example, the vet has removed (excised) the whole mass, this is called an *excision biopsy*. Sometimes only a part of a tissue is removed (incisional biopsy) and sent for histopathology. The biopsy is sent to the laboratory in a leakproof, wide-mouthed container.

C. In the laboratory, the tissue is *processed* by embedding it in a paraffin wax block (i). When this is done, very thin, almost transparent, slices of the tissue can be taken (ii), using an extremely sharp cutting instrument, called a *microtome* (iii). These slices are so thin that 1 cm of tissue could be sliced 5000 times.

D. A thin slice of the tissue is placed flat (*mounted*) on a glass microscope slide (iv), and dyed using histological stains. The standard staining method uses the stains haematoxylin and eosin (often shortened to 'H and E') which stains the sections pink and blue. The stains allow the pathologist to examine the tissues more easily than would an unstained section. The tissue section is protected by

Box 1.2 (*Continued*) How histology sections are produced

a very thin glass *cover slip* (v) which is glued on top. Finally, the slide is labelled with a reference number and other laboratory details (vi).

E. The pathologist examines the tissue section under the microscope and writes a report, which may suggest a diagnosis and prognosis. In the case of our dog's tumour, the pathologist may also be able to tell whether the vet has managed to remove it all or whether further surgery at the site is advisable (the pathologist can tell this by looking at the edges of the tumour and observing whether there is a rim of normal tissue around the edge – the *excision margins*).

Haematology is specifically the study of cell types in blood, and this can indicate an increase in white blood cells (*leucocytes*) in an animal fighting an infection or a decrease in red blood cells (*erythrocytes*) in an animal with anaemia.

An anatomic or clinical pathologist may suspect that infectious organisms are involved in the disease and may suggest a fresh (unfixed) sample should be sent for *microbiology* (see below) if the practice has not already done this.

Microbiology

Microbiologists study *infectious organisms* that may be associated with diseases, more specifically, bacteriologists study bacteria, virologists study viruses, and mycologists study fungi and yeasts. Clinical samples, such as urine, pus, mucus or even tissue may be sent to microbiology laboratories where they have the equipment, skills and expertise to grow (*culture*) and identify infectious organisms. In the case of bacterial infection, they may also be able to assess which antibiotics the organism is likely to be killed by (the *sensitivity* of the organism) which gives the vet an indication of what treatment to use.

Parasitology

Although the very small creatures studied by microbiologists could be described as being parasitic, parasitologists tend to be associated with the study of slightly larger organisms which live on or in other animals. So, parasitology encompasses the study of, for instance, parasitic worms in the gut, fleas living on the skin or demodex mites living in hair follicles.

Immunology

Sometimes an infectious organism is suspected of causing disease in an animal, but that organism itself cannot be cultured in the microbiology laboratory or seen in samples under the microscope. In this case, the immunology laboratory may be able to tell whether the animal has been infected by the suspected organism by looking for *antibodies*. Antibodies are produced by the body's immune system to help fight disease (this is part of what is known as an *immune response*); specific antibodies are produced for specific infectious agents, so finding certain antibodies will indicate that an animal has come into contact with a certain infectious agent (or has responded to a vaccine).

Infectious organisms have proteins on their surfaces, called *antigens*. These antigens are a sort of 'fingerprint' which the immune system can usually recognise as being 'foreign' and this stimulates the immune response. Sometimes specific antigens can be detected in samples by immunological tests.

Such immunological tests may be done on blood *serum* (this is called *serology*). Some immunological tests can also be carried out on tissues mounted on microscope slides, and this is then known as *immunostaining*. All types of cells of the body have their own 'fingerprint', though in a healthy individual the immune system recognises these and doesn't start to react against them. Sometimes we can use this property of cells to confirm the diagnosis, for instance, if a pathologist is having trouble identifying a particular skin tumour under the microscope immunostains for specific cell types can be applied to the tissue and can help to reveal the identity of the tumour.

Toxicology

In some cases, toxicologists may be asked to analyse samples for toxins or poisons, for instance, you or the pathologist might send stomach contents, urine or even fresh tissue from a necropsy in the case of an animal suspected of being poisoned. The laboratory may need some guidance as to which toxic substance is suspected, such as a reliable history of known or likely contact of an animal with that particular substance. Note also that very often the toxins or poisons break down or are metabolised after having their damaging effects, and may not be detected in biological samples. In these cases, the animal presents with clinical signs that require diagnosis and treatment, such as a severely

anaemic animal that has eaten anticoagulant rodent poison. The priority is to treat the anaemia, and toxicology may not be helpful, though it could be argued that confirming the cause of the animal's signs may help to prevent poisoning in other animals.

Veterinary forensic pathology

There are a small number of veterinary pathologists who deal with forensic cases; that is, cases where there may be suggestions of cruelty or malicious harm to men or animals, or police involvement due to suspected illegal activity of one sort or another. This subject is beyond the scope of this book, and it is usually best for general practices to seek advice if they get drawn into such a case unless they are experienced in dealing with them. As a rule of thumb all those involved with the case, including veterinary nurses, may be asked to give evidence at a later stage, and should always keep notes, photographs, logged telephone calls or case records securely and safely stored, in case they need to submit them to the authorities as part of the investigation. Any biological material, including bodies of deceased animals, should be logged and labelled, and stored securely until removal by an authorised person.

Government agency laboratories

Some pathologists are employed as veterinary investigation officers, and work for government agency laboratories. These laboratories principally investigate diseases in farm or production animals. As well as investigating disease in individual or small groups of animals, these pathologists are important in helping to maintain herd or flock health on farms and nationally. This helps to prevent widespread infectious diseases and to protect our food quality (and safety) and human health.

Pharmaceutical laboratories

Veterinary pathologists work at pharmaceutical laboratories too. Here they will help to investigate diseases and to develop drugs to treat men and animals. They will also take an interest in apparent unexpected drug reactions.

Pathology as an academic subject

This chapter has so far discussed some of the ways pathology is carried out in practice and who undertakes it. Pathology is a broad academic subject, and when we study it, we often divide it into *general* pathology and *systematic* (or *special*) pathology. What does this mean?

- *General* pathology is the study of *processes in disease*, without necessarily limiting discussion to one particular tissue or organ. For instance, inflammation and neoplasia are general pathological processes.
- Whereas *systematic* (special) pathology is the study of the *effects of disease* with *special reference to a specific tissue* or *a body system*. For instance, dermatitis (inflammation in the skin) and osteosarcoma (neoplasia of bone) are examples of systematic or special pathological changes.

From now on this book focuses on general pathology, but we will use examples of specific organs or body systems to help you understand the processes we are discussing, and perhaps to relate the topic to diseases you may have encountered in general veterinary practice.

Summary of key points in Chapter 1

- Pathology is the study of the causes of diseases, of how they develop and their effects on the body. It encompasses any deviation from a healthy or normal condition in any living creature.
- Veterinary pathology is carried out by a number of different people, from nurses and vets in general practice to trained pathologists in academia or industry.
- General pathology is the study of *processes* in disease, without limiting discussion to a particular tissue or organ. Inflammation and neoplasia are examples of general pathological processes.
- Systematic (special) pathology is the study of general pathology processes but with special reference to specific tissues or body systems, for instance, dermatitis (inflammation in the skin) and osteosarcoma (neoplasia of bone) are examples of systematic or special pathological changes.

Test yourself questions on Chapter 1

1. What is meant by the term 'pathology'?
2. Briefly discuss the work of
   a. anatomic pathologists and
   b. clinical pathologists.
3. a. What organisms are studied by microbiologists? (*list as many types as you can*)
   b. Still thinking about microbiology, what is meant by 'sensitivity' and why is it helpful and/or important?
4. Briefly suggest some sensible actions to take if you are involved in a case which involves the police or other authorities.
5. Why are veterinary pathologists important for the health of human beings?
6. What is meant by 'general' pathology and how does it differ from 'systematic' or 'special' pathology?

Chapter 2

Aetiology

Introduction to aetiology

Aetiology – the study of the causes of disease

What are aetiological agents?
Classification of aetiological agents
Classification of diseases
What determines whether disease occurs?

Aims of Chapter 2

- To define the term aetiology and discuss the main types of aetiological agents
- To discuss other factors which may act with aetiological agents in the development of disease
- To consider the main ways in which aetiological agents cause disease

Introduction to aetiology

Let us start with a few terms you may come across in your reading. Aetiology is pronounced *eet-ee-ology*. In American textbooks you may see it spelt without the first 'a' – *etiology*, but it is still pronounced as above.

You would have spotted that aetiology is another compound word (like the word pathology, discussed in Chapter 1) in which '*-logy*' denotes '*study of*' or '*science of*'. The first part comes from the Greek word '*aitia*' meaning 'cause'. So, aetiology means *the study or science of the causes of disease*.

The word *pathogenesis* is associated with aetiology. Pathogenesis involves '*pathos*' again, as introduced in Chapter 1, but in this case it is linked with *genesis*, which comes from the Greek verb for '*to become*' or '*to produce, to bring forth*'. Thus, pathogenesis relates to *things which produce disease*, and tends to be used when discussing how factors *lead to disease*, or *the mechanisms of disease development*. It describes the chain of events from the initial stimulus to the manifestation of the disease or the lesion produced.

There are some other terms we use which relate to pathogenesis. A factor which is capable of producing disease may be referred to as *pathogenic*, and an infectious agent (bacteria, virus and fungus) capable of causing disease may often be referred to in non-specific terms as a *pathogen*. The term *aetiological agent* is also used for a factor capable of causing disease.

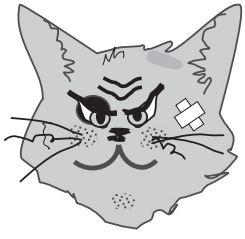
Do not worry too much about these terms at this stage; you will become more familiar with their usage as you read through this book and other texts.

So, now we have got some definitions out of the way; let us start to discuss aetiology.

Aetiology – the study of the causes of disease

Diseases occur when a harmful trigger (of whatever type) causes loss of normal health or disrupts a tissue or organ. Many diseases tend to have distinct and recognisable cause(s) (aetiology), development processes (pathogenesis), lesions and clinical signs.

Let us consider a familiar example to illustrate this. Two cats have a fight, and a few days later one of them develops an abscess in the skin on its back. Now think about the features of diseases in turn and apply them to our cat:



Cause(s): bacteria from one cat's mouth are introduced into another cat's skin via the teeth.

Development process: the bacteria multiply and start up the process of inflammation in the skin of the bitten cat. Inflammatory cells and bacteria die and accumulate as a pool of pus[1], with a rim of active inflammation around it (an abscess).

Lesion: surface skin wound and scab; abscess in the skin; heat (due to inflammation).

Clinical signs: pain, heat, swelling, pus, depression, loss of appetite, grumpiness etc.

In other cases it may be harder to clearly define diseases in this way. Many diseases involve more than one cause (aetiological agent), or they may be made more complex by other factors such as secondary infections. Development processes may be altered by other concurrent diseases. Finally, especially in veterinary patients, the lesions and clinical signs are often complicated by self-trauma – the animal licking, biting or scratching a diseased area, for instance.

We now go on to discuss some of the aetiological agents and some of the complicating factors that can affect disease development.

[1] Pus = thick fluid sometimes formed as a result of inflammation, consisting of white blood cells (especially neutrophils, see Chapter 4), dead cells and often also containing living and dead bacteria. By the way, note the correct spelling. Examiners HATE to see it referred to as 'puss'!

What are aetiological agents?

We said above that aetiological agents are factors capable of causing disease or tissue damage. Our knowledge of aetiological agents has altered as our scientific understanding has increased. In historical times, evil spirits, bad humors and foul smells were all considered to cause disease. Old rags were thought to cause bubonic plague (the Black Death) during medieval times – it was actually fleas on rats living in the rags which carried the plague bacterium.

The first microscopes were developed in the second half of the 1600s, allowing closer study of tissues and even description of bacteria, though the role of bacteria in disease was not recognised for another 200 years or so. Rudimentary, though successful, attempts at vaccination for diseases we now know to be caused by viruses, such as smallpox, were carried out from the 1770s.

Yeasts and fungi were first recognised for their roles in fermentation, and later some types of these organisms were found to be involved in disease especially in patients with weakened immune systems. The roles of nutrition and hygiene started to be taken seriously in the late 1800s and continued to gather momentum since then. By 1855, it was realised that a cholera outbreak in London was linked to a particular supply of drinking water in Lambeth, and since then our understanding of the infectious and environmental factors involved in disease development and tissue injury has grown enormously.

Sadly, the great wars have added to our understanding of physical trauma (but also have clearly illustrated the importance of emergency nursing for longer-term prognosis). More recently, molecular biology has increased our knowledge of the DNA in our genes; this has helped us to recognise the genetic basis of some diseases.

Throughout this book, we shall tend to consider aetiological agents in general terms, though we shall use a few specific examples to illustrate pathological processes. Other textbooks will be the sources of more specific information on causes of particular diseases (see Further Reading, page 238).

Classification of aetiological agents

To help our understanding we can usefully classify aetiological agents in various ways. You may see other classifications in other textbooks,