Manual of

Skin Diseases of the Dog and Cat

Manual of

Skin Diseases of the Dog and Cat

Second Edition

Sue Paterson MA VetMB DVD DipECVD MRCVS

RCVS and European Specialist in Veterinary Dermatology
Head of Dermatology and Director Rutland House Referral Hospital
St Helens, Merseyside

Blackwell Publishing

This edition first published 2008

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 office
9600 Garsington Road, Oxford, OX4 2DQ, United Kingdom

For details of our global editorial offices, for customer services and for information about how to apply for permission to reuse the copyright material in this book please see our website at www.wiley.com/wiley-blackwell.

First published 1998 and 2000 as *Skin Diseases of the Dog* and *Skin Diseases of the Cat* by Blackwell Science Ltd
Second edition published by Blackwell Publishing 2008

Library of Congress Cataloging-in-Publication Data

Paterson, Sue.
Manual of skin diseases of the dog and cat / Sue Paterson. – 2nd ed.
p. ; cm.
Originally published as two separate works: Skin diseases of the dog / Sue Paterson. 1998, and Skin diseases of the cat / Sue Paterson. 2000.
Includes bibliographical references and index.
ISBN-13: 978-1-4051-6753-6 (pbk. : alk. paper)
ISBN-10: 1-4051-6753-X (pbk. : alk. paper) 1. Dogs–Diseases–Handbooks, manuals, etc. 2. Cats–Diseases–Handbooks, manuals, etc. 3. Veterinary dermatology–Handbooks, manuals, etc. I. Paterson, Sue. Skin Diseases of the Dog. II. Paterson, Sue. Skin Diseases of the Cat. III. Title.
[DNLM: 1. Dog Diseases–Handbooks. 2. Cat Diseases–Handbooks. 3. Skin Diseases–veterinary–Handbooks. SF 992.S55 P297m 2008]

SF992.S55P37 2008
636.7′08965–dc22
2007039707

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

Set in 10/12pt Sabon by Aptara Inc., New Delhi, India
Printed in Singapore by C.O.S. Printers Pte Ltd

1 2008

Contents

Dedication

To Richard, Sam and Matt

Acknowledgements

To all the staff especially the dermatology crew (Steve, Laura, Bernie, Emma and Lydia) at Rutland House as well as "the boys" for putting up with my madness, my friend and co-conspirator Janie and of course to all our loyal referring veterinarians without whom I would not have a day job.

Thanks,
Sue

Abbreviations

Dose schedule and measurement units:

sid	once daily
bid	twice daily
tid	three times daily
qid	four times daily
eod	every other day
po	by mouth
sq	by subcutaneous injection
sc	subcutaneously
iv	by intravenous injection
im	by intramuscular injection
mm	millimetres
cm	centimetres
kg	kilograms
mg	milligrams
ml	millilitres

General:

BMZ	basement membrane zone
IRS	inner root sheath
ORS	outer root sheath
DTM	dermatophyte test medium
SDA	Sabouraud's dextrose agar
MRSA	methicillin resistant *Staphylococcus aureus*
EMG	electromyogram
MRI	magnetic resonance imaging
HA	hospital acquired
CA	community acquired
BCG	bacille Calmette–Guerin
DTM	dermatophyte test medium
ELISA	enzyme-linked immunosorbent assay
CDV	canine distemper
FeLV	feline leukaemia virus
FIV	feline immunodeficiency virus
FIP	feline infectious peritonitis
FRV	feline rhinotracheitis virus
FCV	feline calici virus
FSV	feline sarcoma virus
ADV	Aujeszky's disease virus
FHV1	feline herpes virus 1
TSH	thyroid-stimulating hormone
ALT	alanine transaminase/ alanine aminotransferase/ alanine transferase
SAP	serum alkaline phosphatase
ALP	alkaline phosphatase
SAT	serum aspartate transaminase
AST	aspartate transaminase
TT4	total thyroxine
FT4	free thyroxine
TT3	total triiodothyronine
FT3	free triiodothyronine

SAP	serum alkaline phosphatase
LDH	lactate dehydrogenase
ACTH	adrenocorticotrophic hormone
CRF	corticotropin-releasing factor
IGF-1	insulin-like growth factor – 1
NME	necrolytic migratory erythema
SLE	systemic lupus erythematosus
ANA	antinuclear antibody test
LE	lupus erythematosus
CAD	cold agglutinin disease
TEN	toxic epidermal necrolysis
EM	erythema multiforme
CM	Chiari-like malformation
SM	syringomyelia
EB	epidermolysis bullosa
WKS	Waardenburg–Klein syndrome
VKH	Vogt–Koyanagi–Harada-like syndrome
FOPS	feline orofacial pain syndrome
TVT	transmissible venereal tumour
SCC	squamous cell carcinoma

Please note that some of the drugs mentioned in this book are not licensed specifically for use in animals. It is the veterinary surgeons responsibility to ensure that where possible a licensed drug should be used and the veterinary cascade should be followed.

1 Introduction – structure and function

Dermatological diseases remain some of the most common and frustrating problems presented to veterinary surgeons in practice. All veterinary practitioners can expect up to 20% of their caseload to include skin cases, and as such they should have a thorough grounding in dermatology. The pet owning client now has the opportunity to seek specialist advice through a referral from their veterinary surgeon. Therefore, the generalist should not only exhibit competence in the management of common diseases, but should also have the ability to identify those requiring specialised care, whether they are unusual manifestations of everyday problems or rare dermatoses.

The skin is one of the most important organs in the canine and feline body. It is crucial for the provision of a wide range of functions. These include the following:

- Effective barrier to prevent loss of water, electrolytes and macromolecules
- Mechanical protection from chemical, physical and microbial damage
- Elasticity to allow movement
- Production of adnexa, e.g. hair and claws
- Nerve sensors to allow the perception of heat, cold, pressure, pain and itch
- Temperature regulation
- Storage of vitamins, electrolytes, water, fat, carbohydrates and protein
- Immune regulation to prevent development of infection and neoplasia
- Antibacterial and antifungal activity
- Vitamin D production
- Pigment production to protect against solar damage
- Communication as to the health of the individual and sexual identity
- Secretion via epitrichial, atrichial and sebaceous glands
- Excretion

Structure of the skin

Epidermis

This is the most superficial layer of the skin and is composed of multiple layers of cells. There are four distinct cell types:

- Keratinocytes ~ 85%
- Langerhans cells ~ 3–8%
- Melanocytes ~ 5%
- Merkel cells ~ 2%

Keratinocytes

These cells form the bulk of the epidermis. They are constantly reproducing and pushing upwards from the stratum basale to replace those cells above them. As they move into the outermost layers of the epidermis they are shed as dead horny cells. They have a variety of functions in both providing structural support for the skin and playing a role in epidermal immunity as

- they produce structural keratins,
- are phagocytic and capable of processing antigens,
- produce cytokines (IL-1, IL-3, prostaglandins, leukotrienes, interferon) to stimulate or inhibit the immune response.

Langerhans cells

These are mononuclear dendritic cells that form an important part of the immune surveillance of the skin. They can be found basally or suprabasilar. Their principal functions are

- antigen processing and presentation to helper T lymphocytes,
- induction of cytotoxic T lymphocytes directed to modified alloantigens,
- production of cytokines including IL-1, and
- phagocytic activity.

Melanocytes

These are dendritic cells found within the basal layer of the epidermis, outer root sheath, hair matrix of the hair follicle and ducts of sebaceous and sweat glands. In the epidermis, each melanocyte communicates via its dendritic projections with 10–20 keratinocytes to form the 'epidermal melanin unit'. Each melanocyte produces eumelanin or pheomelanin within melanosomes through series of steps from tyrosine. Melanosomes containing pigment migrate to the end of dendrites and transfer melanin to adjacent epidermal cells. They have a variety of important functions:

- production of protective colouration and for sexual attraction,
- barrier against ionising radiation,
- scavengers for cytotoxic radicals,
- contribution to inflammatory response via production of cytokines.

Merkel cells

These are dendritic epidermal cells confined to the basal cell layer of the epidermis or just below.

They are predominantly found in tylotrich pads and hair follicle epithelium. Their principal functions are

- specialised slow-adapting mechanoreceptors,
- influencing cutaneous blood flow and sweat production,
- coordinating keratinocytes proliferation,
- controlling of hair cycle by maintaining and stimulating hair follicle stem cell population.

Epidermal structure

The epidermis in the dog and cat is a very thin structure; it is only 2–3 nucleated cells thick not including the horny cell layer. In haired skin it is 0.1–0.5 mm thick and in the footpads and planum nasale up to 1.5 mm. It can be divided into different layers working from the inner to the outer layers; these are as follows:

- Stratum basale – basal cell layer
- Stratum spinosum – spinous/prickle cell layer
- Stratum granulosum – granular cell layer
- Stratum lucidum – clear cell layer
- Stratum corneum – horny cell layer

Stratum basale

This is made up of a single layer of columnar cells, tightly adherent to the basement membrane. It is mostly made up of keratinocytes. Hemidesmosomes are located along the inner aspect of the basal keratinocytes. These structures act to anchor the epidermis to the basement membrane zone. The basal cell layer is the initial site of keratin production.

Stratum spinosum

This layer is generally 1–2 cells thick except in footpads, nasal planum and at mucocutaneous junctions where there may be up to 20 cell layers. Cells within it are polyhedral to flattened cuboidal

in shape. The 'prickles' or desmosomes are intercellular bridges that mediate adhesion between keratinocytes. Keratinocytes within this layer synthesise lamellar granules, which are important in the barrier function of the skin. Keratin production also accelerates in the stratum spinosum and is formed into bundles.

Stratum granulosum

The granular cell layer is not always present in haired skin, where it occurs it is made up of a layer of 1–2 flattened cells. In non-haired skin it may be up to 4–8 cells thick. The cells contain keratohyaline granules, which are rich in profilaggrin. Within this layer profilaggrin is converted to filaggrin, which acts to bind keratin filaments as the cornified envelope starts to form. Lamellar granules migrate to the periphery of the cells and discharge their contents, rich in phospholipids and ceramides, into intercellular space to form lipid-rich lamellae between cells. Degeneration of cell organelles and the nucleus starts in this level.

Stratum lucidum

This is a compact layer of dead keratinocytes only found in footpads and nasal planum.

Stratum corneum

This is the outermost layer of the epidermis and consists of multiple layers of flattened cornified cells. These are constantly shed to balance the proliferation of basal cells. On the canine trunk it is about 47 cells thick. The transit time from the stratum basale to stratum corneum is approximately 22 days. The cells have an internal scaffold of keratin/filaggrin and an external lipid-rich cornified cell envelope.

Basement membrane zone (BMZ)

This is the area that separates the epidermis from the dermis. The functions of this area are as follows:

- Acting to anchor the epidermis to the dermis.
- Maintaining a functional and proliferative epidermis.
- Maintaining tissue architecture and acting as a physical barrier.
- Aiding wound healing.
- Regulating nutrition between the epithelium and the underlying connective tissue.

The BMZ can be divided into four components; moving from the epidermis to the dermis it can be divided into

- basal cell plasma membrane – contains the anchoring hemidesmosomes of basal cells,
- lamina lucida,
- lamina densa,
- sublamina dense – contains anchoring fibrils and dermal microfibril bundles.

Dermis

The dermis is part of the body's connective tissue system; it accounts for most of the tensile strength and elasticity of the skin. It is made from a combination of insoluble fibres (collagen and elastin) and soluble polymers (proteoglycans and hyaluronan).

Fibrous components resist tensile forces. The soluble polymers help dissipate compressive forces. The dermis is composed of four main components:

- fibres
- ground substance
- cells
- epidermal appendages, arrector pili muscles, blood and lymph vessels

Fibres

The dermal fibres are produced by fibroblasts and are collagenous, reticular or elastic.

Collagenous fibres (collagen)

These account for about 90% of all dermal fibres and 80% of the extracellular matrix. They form thick bands of multiple protein fibrils. They provide tensile strength and some elasticity.

Collagen types are as follows:

- Predominant collagen types in the dermis are fibrillar and collagen I (87%), III (10%), V (3%).
- Collagen VI present as microfibrils.
- Collagen IV (lamina densa) and collagen V (lamina lucida) found in BMZ.
- Collagen VII found in anchoring fibrils of BMZ.

Reticular fibres (reticulin)
These fibres form a network of fine branching structures.

Elastin fibres
These fibres account for about 4% of the extracellular matrix. They are single fine branching structures bordering collagen bundles. They give the skin much of its elasticity.

Ground substance

The ground substance is produced by fibroblasts. It is composed of glycosaminoglycans linked to proteoglycans. It fills the space around all the other structures to provide dermal support. It contributes to water storage, lubrication, growth and development.

Cells

The normal dermis is sparsely populated with cells. Fibroblasts and dermal dendrocytes are found throughout the dermis. Melanocytes are found around superficial blood vessels and around hair bulbs. Mast cells can also be found around superficial dermal blood vessels and appendages. Other cells that can be seen in very small numbers in normal skin are neutrophils, eosinophils, lymphocytes, histiocytes and plasma cells.

Epidermal appendages

Arrector pili muscles
These are smooth muscles that originate in superficial dermis and insert at the bulge region of primary hair follicle. They are present in all haired skin especially prominent in neck and rump. Contraction of muscle raises the hair (piloerection). They are under cholinergic nerve control. Piloerection is associated with 'flight or fight'. It is also important as a mechanism for thermoregulation and emptying sebaceous glands.

Blood vessels
Three intercommunicating plexuses of arteries and veins are found within the dermis:

- deep plexus, which supplies the subcutis, lower portions of hair follicle and epitrichial sweat gland;
- middle plexus, which supplies the arrector pili muscle, middle portion of hair follicle and sebaceous gland;
- superficial plexus, which supplies upper portion of hair follicles and sends capillary loops up to the epidermis.

Arteriovenous anastomoses are the connections between arteries and veins found especially in the deep dermis that allows blood to bypass the capillary bed; they are most commonly seen in the extremities.

Lymph vessels
These arise from capillary networks in superficial dermis and surround adnexal structures. The vessels that arise from these networks drain into a subcutaneous lymphatic plexus. Lymphatics control the microcirculation of the skin. Their main functions are as follows:

- draining away debris and excess matter that results from daily wear and tear in the skin;
- serving as channels for the return of proteins and cells from tissues to blood stream;
- linking the skin and regional lymph nodes;
- carrying material that has penetrated the skin, e.g. solvents, topical drugs, vaccines inflammatory products.

Nerves
The nerve supply to the skin can be divided into a dermal network, hair follicle network and specialised end organs within the dermis. Sensory nerves can be either thermoreceptors (cold

or warm units) thought to be in the epidermis or mechanoreceptors (Pacinian corpuscle, Ruffini corpuscles), which are spread throughout the skin. Mechanoreceptors are also associated with hairs; either large guard hairs or tylotrich hairs (G and T hair units) or all hair, especially down hairs (D hair units). Motor nerves supply the arrector pili muscle and the epitrichial sweat gland.

Hair follicle

The hair follicle can be divided into three sections:

- Infundibulum, which extends from the entrance of sebaceous gland to epithelial surface.
- Isthmus, extending from the entrance of sebaceous gland to the attachment of arrector pili muscle.
- Inferior segment, extending from the attachment of arrector pili muscle to the dermal papilla.

The dog and cat both have compound hair follicle. A cluster consists of 2–5 large primary hairs surrounded by groups of smaller secondary (down) hairs. One of the primary hairs is the largest (central primary hair) and the others are smaller (lateral primary hairs). Each primary hair can have 5–20 secondary hairs accompanying it.

Each primary hair has an arrector pili muscle, sebaceous gland and sweat (epitrichial) gland. Each secondary hair usually has only a sebaceous gland. Primary hairs emerge independently through individual holes; the secondary hairs emerge through a common hole. Two specialised forms of tactile hairs are found in mammalian skin; these are the sinus hairs and tylotrich hairs:

- Sinus hairs (vibrissae, whiskers) are found on the muzzle, lips, eyelid, face and throat, also on the palmar aspect of the carpus of cats. Hairs are thick, stiff and tapered distally. They are thought to act as slow-adapting mechanoreceptors.
- Tylotrich hairs are scattered amongst normal body hairs. Follicles are larger than the surrounding ones and contain a single stout hair and an annular complex of neurovascular tissue at the level of the sebaceous gland. These hairs are thought to act as rapid acting mechanoreceptors.

Structure of the hair follicle

The hair follicle has five major components:

- dermal hair papilla
- hair matrix
- hair
- inner root sheath
- outer root sheath

Dermal hair papilla

Extension of dermal connective tissue covered by basement membrane.

Hair matrix

The hair matrix is made up of nucleated epithelial cells covering the dermal papilla that give rise to the hair and inner root sheath.

Hair

The hair is made up of three parts – medulla, cortex and cuticle:

- Medulla, which is the innermost region composed of longitudinal rows of cuboidal cells.
- Cortex, composed of cornified spindle-shaped cells, containing pigment to colour the hair.
- Cuticle, the outermost layer of flattened cornified anuclear cells, these form 'tiles' that interlock with the cuticle of the inner root sheath.

Secondary (down) hairs have a narrower medulla and more prominent cuticle than primary hairs. Lanugo hairs have no medulla.

Inner root sheath (IRS)

The function of the IRS is to mould the hair within it, which is accomplished by hardening in advance

of the hair. It is composed of three concentric layers all of which contain eosinophilic granules (trichohyalin granules). Working from the innermost layer outwards, these layers are as follows:

- IRS cuticle single layer of overlapping cells that point towards the hair bulb and interlock with cells of hair cuticle.
- Huxley's layer consisting of 1–3 nucleated cell layers.
- Henle's layer – a single layer of anuclear cells.

Outer root sheath (ORS)

The ORS is a downward extension of the epidermis. It is thickest towards the epidermis and thinnest towards the hair bulb. In the infundibulum normal keratinisation occurs in the same way as the epidermis with the formation of keratohyaline granules. In the isthmus trichilemmal keratinisation occurs. Below the level of the isthmus no keratinisation occurs as ORS is covered by IRS. The ORS is surrounded by two other structures, which are the basement membrane (glassy membrane), a downward extension of the epidermal basement membrane, and the fibrous root sheath, which is a layer of thick connective tissue.

Arrector pili muscle

See Section 'Epidermal appendages'.

Sebaceous gland

The sebaceous glands are distributed throughout haired skin. They are not found in the footpads or nasal planum. They open through a duct into hair follicle canal in the infundibular region. They tend to be large and numerous in sparsely haired areas especially mucocutaneous junctions and interdigital spaces, dorsal neck, rump and chin (submental organ) and dorsal tail (tail gland, supracaudal organ, preen gland). Sebaceous glands have an abundant blood supply and are innervated: their oily sebum secretion thought to be under hormonal control; androgens causing hypertrophy and hyperplasia; oestrogens and glucocorticoids causing involution. Sebaceous gland secretion is thought to be predominantly triglycerides and wax esters this mixes with fatty acids derived from follicular bacteria to make the sebum excreted onto the skin surface. Functions of sebum include

- physical barrier by lubrication and hydration of skin and hairs,
- chemical barrier (sebum/sweat emulsion has antimicrobial activities),
- pheromonal properties.

Sweat gland

Two types are recognised: the epitrichial (apocrine) or atrichial (eccrine) sweat glands.

Epitrichial (apocrine)

These are distributed throughout haired skin but not found in footpad or nasal planum. These structures are located below sebaceous glands and open through duct into hair follicle canal in the infundibular region above sebaceous gland opening. They are large and numerous in sparsely haired areas as sebaceous glands. They have a rich blood supply but are not innervated. Their control is thought to be by diffusion of neurotransmitters from the circulation. The secretions from these glands are thought to help act as a chemical barrier as the secretion is especially rich in IgA. Epitrichial sweat is also thought to have pheromonal properties.

Atrichial (eccrine)

Atrichial sweat glands are only found in footpads and are not associated with hairs. They have a rich nerve supply; direct nerve control thought to occur.

The hair cycle

The hair cycle is made up of three main parts: anagen, catagen and telogen.

Anagen (growing phase)

A new hair bulb forms and germ cells at the base of follicle extend down to surround the dermal papilla deep in the dermis. A well-developed spindle-shaped dermal papilla covered by hair matrix ('ball and claw' appearance) can be identified to form the hair bulb. Hair matrix cells are often heavily melanised and show mitotic activity. A hair plucked in anagen shows a large expanded root that is moist and glistening, often pigmented and square at the end.

Catagen (intermediate phase)

During this phase hair growth stops and the dermal papilla moves away from matrix cells as hair moves up in dermis.

Telogen (resting phase)

During this phase the dermal papilla separates from the bulb of matrix cells ('club' hair appearance). The pigment is lost from bulb and there is no visible mitotic activity. Hairs plucked in telogen show a tapered club root with little or no pigment.

Subcutis (hypodermis)

This is the deepest and thickest layer of the skin; it is 90% triglyceride by weight. There is no subcutis in the lips, cheek, eyelid, external ear and anus. Fibrous bands that are continuous with the fibrous structures of the dermis penetrate and lobulate the subcutaneous fat into lobules of lipocytes. These form attachments of the skin to underlying fibrous skeletal components. Superficial portions of the subcutis project into the deeper layers of dermis to provide additional protection to some of the deeper structures. Functions of the subcutis include

- an energy reserve,
- important in thermogenesis and insulation,
- protective padding and support,
- maintaining surface contours,
- steroid reservoir, site of steroid metabolism and oestrogen production.

Table 1.1 Resident and transient bacteria of the canine skin.

Resident organisms – dog skin	Transient organisms – dog skin
Skin • *Micrococcus* spp. • Coagulase negative staphylococcus esp. *S. epidermidis, S. xylosus* • Alpha haemolytic streptococci • *Clostridium* spp. • *Propionibacterium acnes* • *Acinetobacter* spp. • Gram negative aerobes **Hairs** • *Micrococcus* spp. • Gram negative aerobes • *Bacillus* spp. • *Staphylococcus intermedius* (seeded from mucosa) **Hair follicles** • *Micrococcus* spp. • *Propionibacterium acne* • *Streptococci* • *Bacillus* spp. • *Staphylococcus intermedius* (seeded from mucosa) **Mucosal sites** • *Staphylococcus intermedius* (nares, oropharynx and anal ring)	**Skin** • *Escherichia coli* • *Proteus mirabilis* • *Corynebacterium* spp. • *Bacillus* spp. • *Pseudomonas* spp.

Cutaneous ecology

Both canine and feline skins have a normal microflora. Bacteria are located in the superficial epidermis and infundibulum of the hair follicles. The normal flora is a mixture of micro-organisms that live in symbiosis. These so-called 'normal inhabitants' can be classified as resident or transient (see Tables 1.1 and 1.2):

- Resident organisms can successfully multiply on normal skin.

Table 1.2 Resident and transient bacteria of the feline skin.

Resident organisms – cat skin	Transient organisms – cat skin
Micrococcus spp.	Beta haemolytic streptococci
Coagulase negative staphylococcus esp. *S. simulans*	*E. Coli* *P. mirabilis*
Alpha haemolytic streptococci	*Pseudomonas* spp.
Acinetobacter spp.	*Alcaligenes* spp.
Coagulase positive staphylococcus esp. *S. intermedius, S. aureus*	Bacillus spp. *Staphylococcus* spp. (coagulase positive)
	Staphylococcus spp. (coagulase negative except *S. simulans*)

- Transient organisms do not multiply on the normal skin of most animals. They can be cultured from normal skin but are of no significance unless they become involved in the pathological process as secondary invaders.

In some situations, bacteria from other body sites can be important as pathogens. In bite wounds in cats the pathogenic organisms are usually those derived from the mouth flora (Table 1.3).

Faecal contamination of skin and soft tissue, especially where wounds are licked, can lead to faecal anaerobes becoming pathogens (Table 1.4).

Table 1.3 Normal flora of the feline mouth.

Normal mouth flora of the cat
Pasteurella multocida
Beta haemolytic streptococci
Corynebacterium spp.
Actinomyces spp.
Bacteroides spp.
Fusobacterium spp.

Table 1.4 Faecal contaminants of the canine and feline skin.

Faecal contaminants of skin – dog and cat (anaerobes)
Actinomyces spp.
Clostridium spp.
Peptostreptococcus spp.
Bacteroides spp.
Fusobacterium spp.
Prevotella spp.

Selected references and further reading

Campbell, K.L. (ed) and Lichtensteiger, C.A. (2004) Structure and function of the skin. In: *Small Animal Dermatology Secrets*. pp. 1–9. Hanley and Belfus, Philadelphia

Haake, A.R. and Holbrook, K. (1999) The structure and development of the skin. In: Freedberg, I.M. et al. (eds). *Fitzpatrick's Dermatology in General Medicine*. 5th edn. pp. 70–113. McGraw-Hill, New York

Jenkinson, D.M. (1990) Sweat and sebaceous glands and their function in domestic animals. In: von Tscharner, C. and Halliwell, R.E.W. (eds). *Advances in Veterinary Dermatology I*. p. 229. Bailliere Tindall, Philadelphia

Kwochka, K.W. (1993) The structure and function of epidermal lipids. *Vet Dermatol*, **4**, 151

Mason, I.S. and Lloyd, D.H. (1993) Scanning electron microscopical studies of the living epidermis and stratum corneum in dogs. In: Ihrke, P.J. et al. (eds). *Advances in Veterinary Dermatology II*. p. 131. Pergamon, Oxford

Scott, D.W. (1990) The biology of hair growth and its disturbance. In: von Tscharner, C. and Halliwell, R.E.W. (eds). *Advances in Veterinary Dermatology I*. pp. 3–33. Bailliere Tindall, Philadelphia

Scott, D.W. et al. (2001) Structure and function of the skin. In: *Muller and Kirk's Small Animal Dermatology*. 6th edn. pp. 1–70. WB Saunders, Philadelphia

Suter, M.M. et al. (1997) Keratinocyte biology and pathology. *Vet Dermatol*, **8**, 67

2 Approach to the case

History taking

Time is always the most important limiting factor when taking a history from a client. Often, it is impossible to assess a patient during a normal consultation and it is tempting to prescribe a symptomatic treatment during a busy clinic. This is a justifiable practice providing the therapy that is supplied does not compromise the ability to investigate the problem more thoroughly at a later date. Antibiotics, antihistamines and topical therapy in the form of shampoos will rarely complicate a diagnosis. The response of a patient to such treatments can often help in directing further tests. Symptomatic steroid therapy is rarely indicated and often makes further investigations impossible in the short term.

History taking needs to be logical and different clinicians approach their questioning in a different manner. Often, the emphasis will be changed depending on the initial owner complaint.

History forms are used extensively by some clinicians, but the author does not use a preprinted sheet as she feels that this tends not to encourage relevant questioning that can be varied for each case. The history itself can be divided into six sections.

Owner complaint

It is important to assess how reliable your owner is. Owners can mislead a clinician by failing to give an accurate history. Other members of the family present in a consultation can often provide useful information, especially children. At this stage, decide whether you are dealing with a pruritic disease, seborrhoeic problem, pustular disease, etc. This can help with the emphasis of your questioning.

General details

The age, sex, breed, colour and weight of the animal can give important clues to the nature of the disease. For example, demodex is more usually found in young dogs; certain breeds are predisposed to particular diseases.

General health

- Level of activity, e.g. lethargy, poor exercise tolerance in canine hypothyroidism or hyperactivity in feline hyperthyroidism.

- Sexual behaviour, e.g. abnormal attention to other dogs in cases of Sertoli cell tumours.
- Appetite/thirst is often increased in hyperadrenocorticism and in steroid administration.
- Feeding, especially the types of food, changes of diet, titbits, supplements; are cats being fed elsewhere?
- Gastrointestinal signs; e.g., signs of colitis can be associated with dietary intolerances.
- Urogenital signs, e.g. cystitis associated with hyperadrenocorticism.
- Cardio-thoracic signs of a bradycardia are often seen in canine hypothyroidism; previous history of respiratory disease in a kitten may be an indicator of a naso-pharyngeal polyp.
- Central nervous system signs, e.g. fits may occur in hyperadrenocorticism, or otitis interna may be associated with long-standing allergic otitis.
- Locomotor system signs, e.g. polyarthritis associated with systemic lupus erythematosus; lameness can also be seen with onychodystrophy in dogs and nail bed problems, e.g. pemphigus foliaceus, in cats.
- Eye disease, e.g. conjunctivitis, may be seen with allergy in both dogs and cats; keratoconjunctivitis sicca may accompany canine hypothyroidism.
- Ear disease may be seen as an extension of an allergic or endocrine disorder.
- Weight loss – associated with neoplasia, diabetes, chronic systemic disorders.

Environmental history

- Other in contact animals, either pets or wild animals, e.g. foxes and hedgehogs in cases of dogs or small rodents for hunting cats, which can be a source of cat pox (Figure 2.1).
- Human contacts – owner contagion especially ringworm, scabies, cheyletiella (Figure 2.2), flea bites.
- Animal's environment; e.g., does the dog live indoors or outdoors? What types of bedding are used? Does the pet sleep on the owner's bed?
- Holidays/kennelling; especially if the pet improved in a kennelled environment.

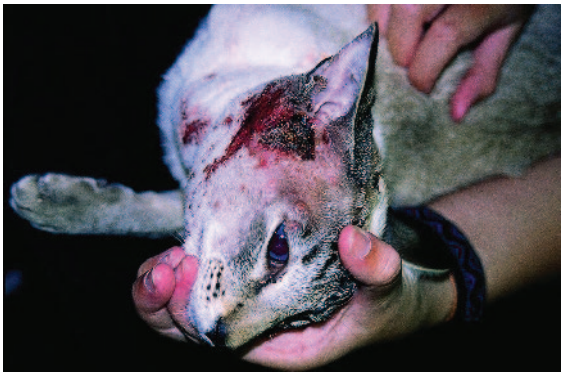

Figure 2.1 Lesions of cat pox in a Siamese cat.

Dermatological history

- When did the symptoms first appear?
- What part of the body was first affected?
- Progression of the disease; has there been evidence of any seasonality?
- Is pruritus present?

Previous therapy

- What previous therapy has been given?
- How has the pet responded to previous treatment?

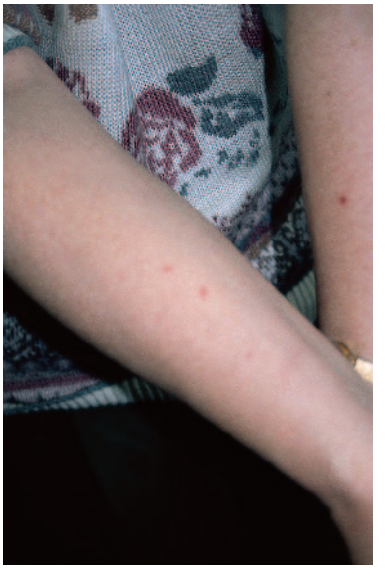

Figure 2.2 Papular lesions of *Cheyletiella* on the arms of an owner.

- Flea treatment; especially which products are used, how often and when it was last used?
- Topical treatment; when was the dog last shampooed, have any cream or lotions been applied?

Examination of the animal

Once a history has been taken the animal can be examined. A general physical inspection should be undertaken in every case. A more detailed examination of some organ systems can be undertaken where indicated. Ophthalmological, neuromuscular examination including cranial nerve reflexes may be indicated in some systemic diseases.

Physical examination

It is important to have adequate space, good owner and pet cooperation (sedation of the pet may be necessary) and good lighting.

Before even touching the dog or cat it is important to assess the animal's general appearance (Figure 2.3), demeanour, body condition. After that the examination should be logical to include the following:

- Temperature, pulse and respiratory rate.
- Mouth – especially the gums and palate (Figure 2.4) looking for abnormalities of colour, petechiation (Figure 2.5), lesions such as ulcers and erosions.
- Ears/eyes – are often affected as an extension of the skin disease.
- Palpation of peripheral lymph nodes – lymphadenopathy can be seen with neoplastic disease or infections.
- Auscultation of the chest – bradycardia (hypothyroidism), tachycardia (hyperthyroidism).
- Abdominal palpation – abdominal masses, hepatomegaly in endocrine disease.
- Musculature – masticatory muscles can be atrophic with dermatomyositis, facial asymmetry with cranial nerve damage in otitis media, pot bellied appearance in hyperadrenocorticism.

Figure 2.3 Does the dog scratch during the consultation?

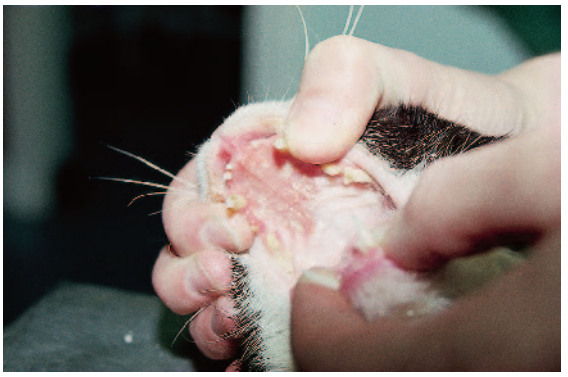

Figure 2.4 Eosinophilic granuloma on the soft palate.

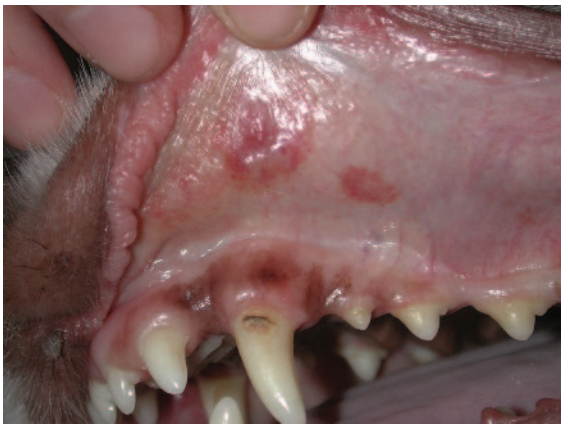

Figure 2.5 Petechiation on the gums of a dog.

- Genitalia: male – scrotal masses, gynaecomastia with sex hormone imbalances; female – vulval enlargement seen with sex hormone imbalances.

Dermatological examination

This should include the whole of the skin and all of the mucous membranes:

- Has the animal given you any dermatological clues whilst it has been in the room? Is dog scratching during the consultation? Is the cat over grooming?

General assessment of the coat

- Presence of scales suggestive of increased epidermal turn over or crust often associated with superficial infection with bacteria or dermatophytes.
- Hair colour/texture – is the coat faded, have primary hairs been lost?

Skin

It is important to check the inaccessible areas of the skin, always turn the animal over to check the ventral abdominal skin (Figure 2.6) as well as inside the mouth and ears; the perianal skin; interdigital spaces and footpads. Assessment of the skin should include the following.

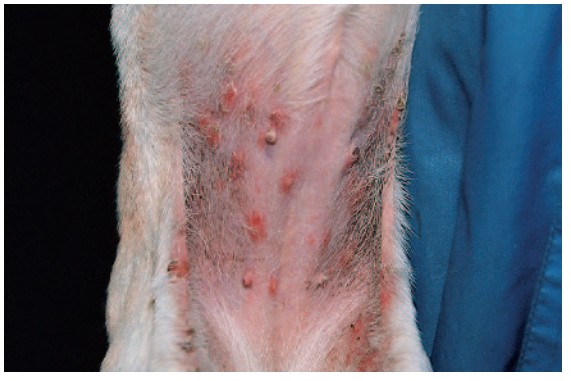

Figure 2.6 Ventral abdominal skin showing primary pustular and papular lesions.

Glabrous (non-haired) skin

- Skin quality – atrophic/inelastic with hyperadrenocorticism, skin fragility syndrome.
- Skin temperature – often cool in hypothyroidism.
- Colour – pallor, erythema, hyperpigmentation, jaundice.
- Primary and secondary lesions – pustules, papules, comedones, etc.

Haired skin

- Will the hair epilate easily?
- Are there areas of stubble suggesting the hair has been chewed out?
- Do the hairs look unusual – are there follicular casts?
- Is there evidence of pigment abnormalities on the hairs?

After taking a careful history and completing a physical and dermatological examination, the clinician should be in a position to compile a list of differential diagnoses. This helps in deciding which further diagnostic tests are required. It is often not necessary to perform every test on each animal. This can also act as a guide to the owners at an early stage as to the possible causes of the disease, the prognosis, and what diagnostic investigations are to be undertaken. It is important at this stage to discuss a treatment plan with the owner including the potential costs.

Selected references and further reading

Bloom, P. (2004) Diagnostic techniques in dermatology. In: Campbell, K.L. (ed) *Small Animal Dermatology Secrets*. pp. 21–33. Hanley and Belfus, Philadelphia

Medleau, L. and Hnilica, K. (2006) Diagnostic techniques. In: *Small Animal Dermatology A Color Atlas and Therapeutic Guide*. 2nd edn. pp. 12–24. WB Saunders, Philadelphia

Scott, D.W. et al. (2001) Diagnostic methods. In: *Muller and Kirk's Small Animal Dermatology*. 6th edn. WB Saunders, Philadelphia

3 Diagnostic tests

Initial diagnostic tests

There can be no excuse not to perform a basic diagnostic panel on all cases. Many laboratories now offer a skin panel as part of their service. However, despite careful packaging of samples prior to posting they rarely arrive at the laboratory in the state they left the practice. A good quality microscope is essential, but other than this expense initial diagnostic tests require a minimal amount of outlay for equipment.

Minimum database for skin disease for both the cat and dog:

- Wet paper test
- Coat brushings
- Diascopy
- Acetate tape impression smears of coat and skin
- Skin scrapings – superficial and deep
- Hair plucking/trichography
- Cutaneous cytology – impression smears, fine needle aspirate

In addition, in the cat (all cases) and inflammatory skin disease dog:

- Fungal culture

Minimum database for otitis in cat or dog:

Ear flap

- Acetate tape impression smears skin
- Skin scrapings – superficial and deep
- Hair plucking/trichography
- Impression smears/exudate from lesions

External ear canal

- Ear discharge – unstained and stained

Wet paper test

The coat is brushed onto a piece of wet paper. Flea faeces will show up as red streaks (Figure 3.1). This should be undertaken in all cases of pruritic skin disease, especially where there is dorsal involvement. It is important to check if the pet has been shampooed recently. False positive tests are common in cats due to the fact that faeces are groomed out of the coat.

Coat brushings

The coat is brushed onto dry paper (Figure 3.2) and can be examined with a hand lens to look for

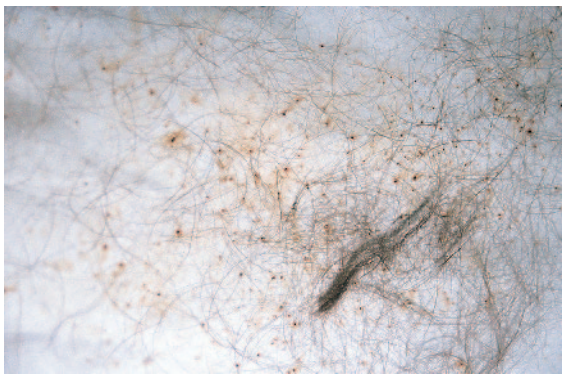

Figure 3.1 Wet paper test; flea faeces appear as red streaks on wet paper.

surface parasites, e.g. cheyletiella, lice. Alternatively, the material on the paper can be mounted in either potassium hydroxide of liquid paraffin and examined under the microscope.

Diascopy

This is a useful and simple technique to assess the difference between vasodilation and haemorrhage. A glass slide is placed over an erythematous lesion and gentle pressure is applied:

- Erythematous lesions blanche when pressure is applied as they are caused by dilated blood vessels.
- Haemorrhagic lesions do not blanche when pressure is applied as they are caused by red blood cell leakage out of vessels.

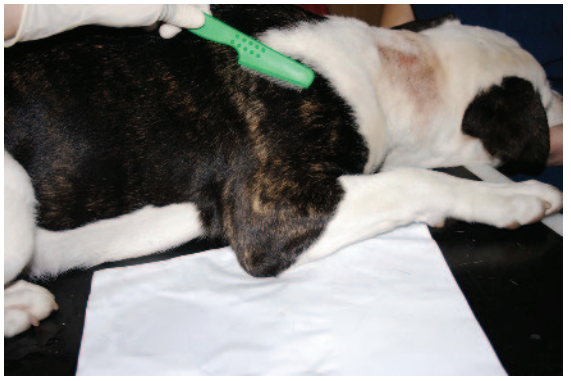

Figure 3.2 Coat brushing technique.

Figure 3.3 Tape stripping hair from the dorsum.

Acetate tape impression smears

This technique can be performed on the skin or hair.

Hair

The tape is pressed repeatedly onto the coat to pick up eggs from the hairs (Figure 3.3), e.g. cheyletiella, lice as well as parasites on the surface of the skin, e.g. lice, trombicula. This is a useful technique to trap some of the fast moving parasites, which can often be seen with the naked eye. It can also be used to identify flea faeces. Selection of site is important in the cat where samples should be taken from areas where the cat is unable to lick, e.g. the back of the neck.

Skin

The tape is pressed firmly onto an alopecic area of skin, which may be clipped if necessary. Site selection is important. Thickened lichenified skin is most likely to reveal evidence of yeast infection. The author will usually rub the tape gently with a thumbnail to ensure good contact of the tape with the skin. A modified Wright's stain such as Diff-Quik can then be applied to the tape, which is then carefully inverted with the adhesive slide downwards onto a microscope slide for examination. As the tape acts as a cover slip, the sample can be examined under high power (100× oil immersion) if necessary. This method can be used to identify surface bacteria; yeast, especially

Table 3.1 Mounting material for skin scrapes – advantages and disadvantages.

Liquid paraffin	Potassium hydroxide
Non-irritant to skin	Potential skin irritant
Will not clear the sample	Will clear the sample by digesting keratin
Does not kill the mites, which can thus be identified by movement across the slide	Mites killed
Mites will curl up if the sample is not examined soon after it is taken, making mite identification difficult	Mites well preserved and observation of body parts easier, esp. cheyletiella

Malassezia; parasites, especially surface living demodex *Demodex corniei* (dog) *Demodex gatoi* (cat).

Skin scrapings

Skin scrapes are essential as part of any basic dermatological investigation. Scrapes may be taken into either liquid paraffin or 10% potassium hydroxide. When liquid paraffin is used a few drops can be gently added to the sample before a cover slip is added. When potassium hydroxide is used the sample is best left to stand for 10–15 minutes and may be gently warmed before examining as this allows the potassium hydroxide to digest keratin to clear the field. There are advantages and disadvantages of both mounting materials (see Table 3.1).

Superficial skin scraping

A scalpel blade should be blunted by gently rubbing on the microscope slide prior to use. It is moistened with either 10% potassium hydroxide or liquid paraffin to provide better collection of material and scraped through the coat and superficial layers of the skin. There are advantages and disadvantages of using each mounting material; these are listed in Table 3.1. Hair may be gently clipped away if the coat is very thick. The scalpel blade is normally held perpendicular to the skin and the scraping should be in the direction of the hair coat. Material should be spread thinly onto the slides. Multiple samples should be taken from non-excoriated areas. When potassium hydroxide is used, the slides may be gently warmed to break up keratin and/or left to stand for 10–15 minutes prior to examination.

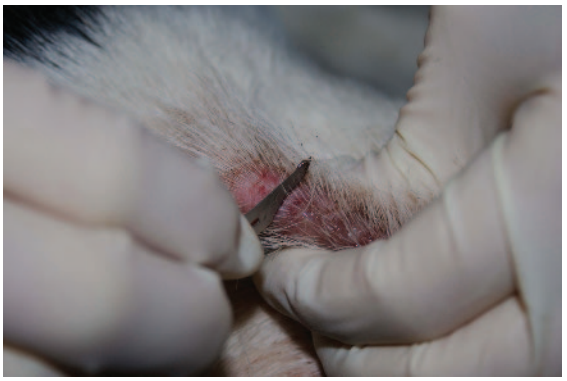

Figure 3.4 Skin scraping technique.

Deep skin scraping

The technique is identical to that for superficial scrapings except that scrapings should be taken to a depth where the skin is erythematous and mild capillary ooze is seen (Figures 3.4 and

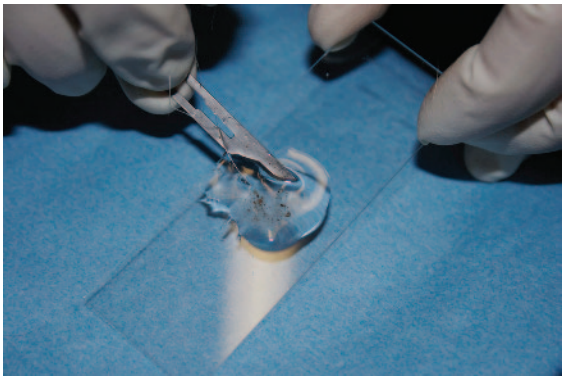

Figure 3.5 The skin scrape may be mounted in liquid paraffin or potassium hydroxide.

Table 3.2 Ectoparasites and most appropriate tests to identify them.

Parasite	Methods that are most useful to identify	Comments
Cheyletiella spp.	Superficial skin scrapes, tape strips, coat brushing	False negative in animals grooming excessively
Demodex canis	Deep skin scrapes, hair plucks, skin biopsy	Skin scrapes false negatives on thickened lesions and from shar-peis; biopsy and hair pluck better; choose areas of comedones for scraping
Demodex corniei	Superficial skin scrapes, tape strips	
Demodex cati	Deep skin scrapes, hair plucks, skin biopsy	Choose areas of comedones for scraping
Demodex gatoi	Superficial skin scrapes, tape strips	Lateral shoulder may be predilection site
Felicola subrostratus	Superficial skin scrapes, tape strips, coat brushing	
Fleas	Wet paper test, tape strips, coat brushing	False negative in animals grooming excessively
Linognathus setosus	Superficial skin scrapes, tape strips	
Lynxacarus radosky	Superficial skin scrape, tape strip, coat brushing	
Neotrombicula autumnalis	Superficial skin scrape, tape strip	
Notoedres cati	Superficial skin scrape, tape strip	
Otodectes cynotis	Superficial skin scrape, tape strip (skin) wax examination	
Sarcoptes scabiei	Deep skin scrape	False negatives common, predilection sites ear tips and lateral elbows; serology and empirical therapy also useful
Trichodectes canis	Superficial skin scrape, tape strip, coat brushing	

3.5). The skin may be pinched to express the mites from the follicles. Different depths of scraping are needed to identify different ectoparasites (Table 3.2).

Hair plucking/trichography

Hair plucks are a useful way to assess a variety of different factors including the presence of fungal infection, trauma, shaft defects and hair growth phase (Figure 3.6).

Hair tip

Examination of the tip is particularly useful in cats where damage to the hair tips suggests

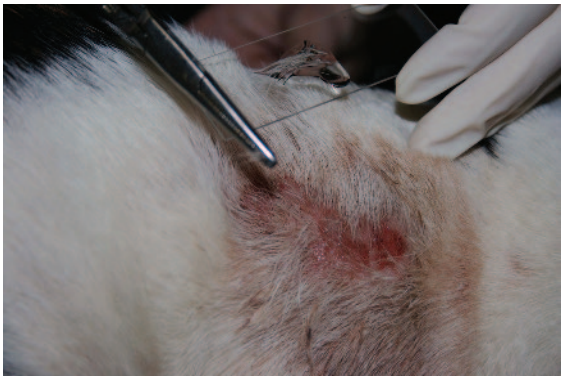

Figure 3.6 Hair plucking for trichography.

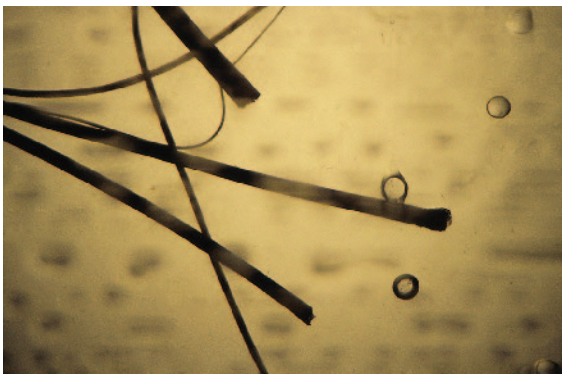

Figure 3.7 Traumatised hair suggesting excessive grooming.

self-inflicted trauma (Figure 3.7). In hair loss through endocrine disease, the tip remains finely tapered (Figure 3.8).

Hair shaft

Dermatophyte ectothrix spores can be identified on the shafts of the hairs. Spores appear as small spherical structures in rows along the shaft. Pigment changes such as clumping of pigment along the shaft are typical of colour mutant alopecia follicular dysplasia. Follicular casts can be seen in sebaceous adenitis, follicular dystrophy, demodicosis and hyperadrenocorticism (Figure 3.9). Ectoparasite eggs such as cheyletiella and lice can be seen attached to hair shafts (Figure 3.10). Other shaft abnormalities such as trichorrhexis nodosa have been recorded but are rare (Figure 3.11).

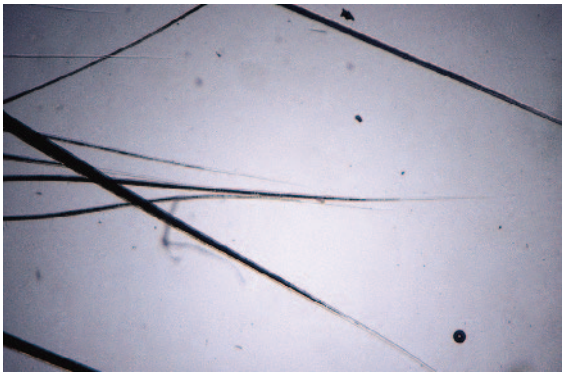

Figure 3.8 Non-traumatised hair tip in hair loss through endocrine disease.

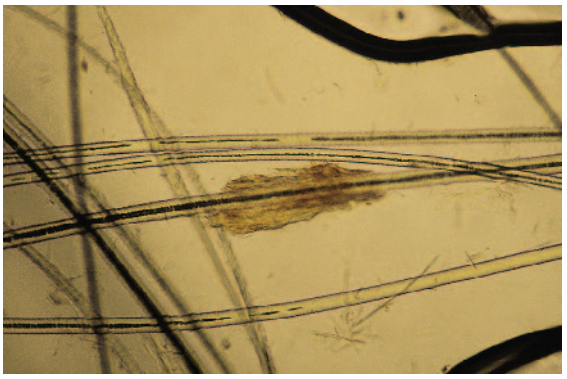

Figure 3.9 Follicular casts on hair shafts.

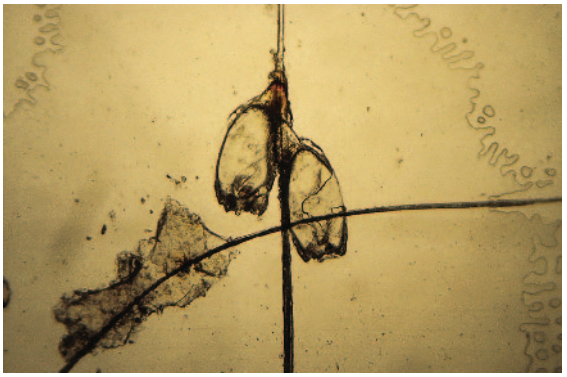

Figure 3.10 Lice eggs cemented to hair shafts.

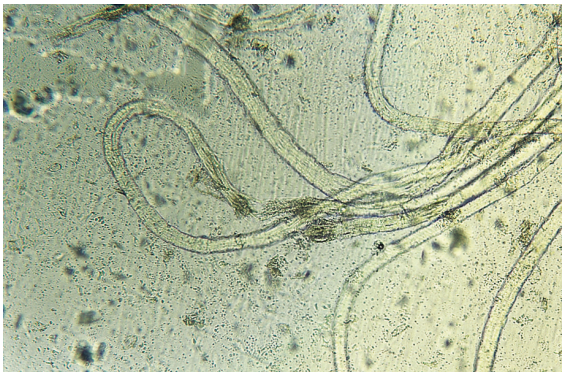

Figure 3.11 Trichorrhexis nodosa showing 'paint brush-like' splitting of hair shafts.

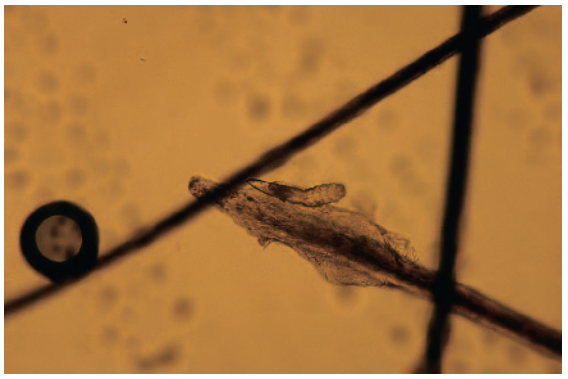

Figure 3.12 Follicular demodex on bulb of hair plucked from an area of comedone formation.

Hair bulbs

Examination of the bulbs allows assessment of the stage of the growth cycle of each hair. Parasites such as demodex can also be seen at the level of the hair bulb (Figure 3.12):

- Telogen hairs have elongated unpigmented spear-shaped roots (Figure 3.13). These are hairs in the resting phase and are most commonly seen in endocrine disease. Most hairs in normal dogs will be in this stage.
- Anagen hairs have bent club shaped roots that are heavily pigmented (Figure 3.13). These are growing hairs and should be identified in samples from normal dogs. In dogs with prolonged growth phase, e.g. poodles, most hairs will be in this stage.

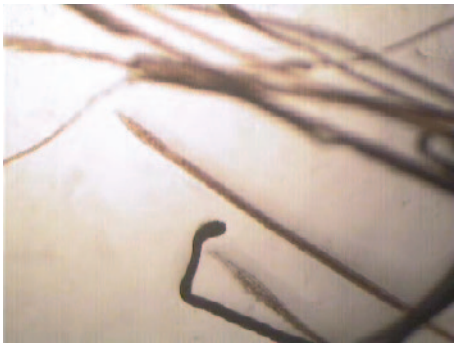

Figure 3.13 Anagen hair bulb in lower half of picture is dark and curled. Telogen hair bulb is long, thin and unpigmented.

Cutaneous cytology

Cytological examination is a useful technique that allows the clinician to look for the presence of infection (bacteria, yeast, fungi) and also assess infiltrating cell types (neoplastic, inflammatory cells, acanthocytes).

Three techniques may be employed:

- Direct impression smears
- Examination of pustule contents
- Fine needle aspirates

Direct impression smears

This technique is suitable for any exudative lesion, e.g. erosions, ulcers, papules and furuncles, or for obtaining samples from the undersides of crusts.

- None exudative lesions can be picked with a sterile 25 gauge needle to express fluid.
- The microscope slide is gently pressed onto the lesion to collect exudates (Figure 3.14).
- The sample may be air dried or carefully warmed to dry (the author uses a small hand-held hair dryer).
- The slide is stained using a modified Wright's stain (Diff-Quik) and gently rinsed and dried again.
- The sample should always be examined on low power (10× objective) initially to select areas for close inspection, subsequently on high power (40×) or under oil immersion (100×).

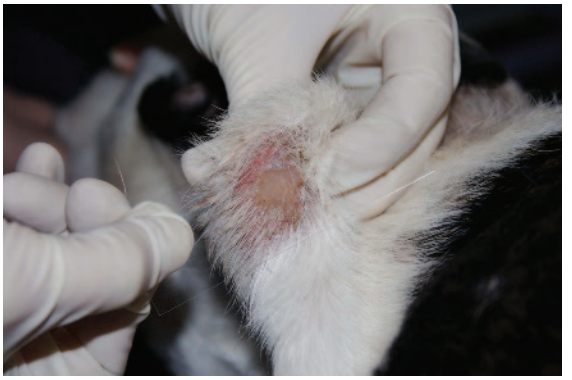

Figure 3.14 Impression smear of exudative lesion.

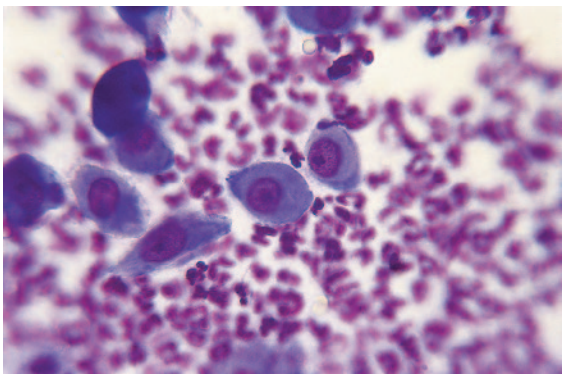

Figure 3.15 Acanthocytes from a sterile pustule in the case of pemphigus foliaceus.

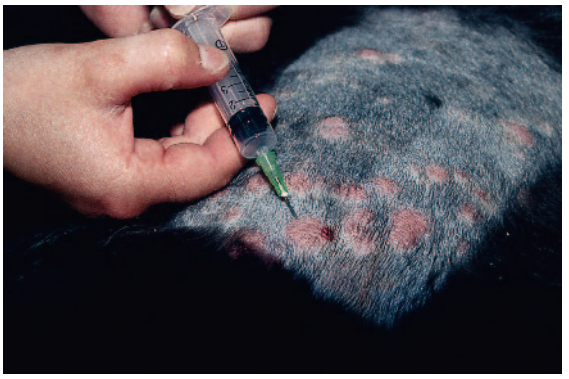

Figure 3.16 Fine needle aspirates from plaques on a dog's dorsum.

Examination of pustule contents

This method is useful for pustular lesions to identify if they have an infectious or sterile aetiology. The pustule should be picked with a sterile 25 gauge needle and the contents gently pressed onto the slide. It should be stained as above. Findings include the following:

- Bacteria plus degenerate neutrophils identified in bacterial infection.
- Acanthocytes (rounded nucleated keratinocytes), non-degenerate white blood cells (usually neutrophils and eosinophils) seen in immunological diseases such as pemphigus (Figure 3.15).
- Demodex mites, bacteria and degenerate neutrophils can be seen in follicular demodex.

Fine needle aspirates

Aspirates are most suitable for nodular lesions especially neoplastic and pyogranulomatous disease:

- A 21–23 gauge needle attached to a 2 or 5 ml syringe should be used (Figure 3.16).
- The lesion should be sterilised with spirit and immobilised between finger and thumb.
- The needle is inserted into the lesion whilst pressure is applied to the plunger to create negative pressure. The needle can be constantly repositioned within the lesion without removing it, to draw up as much material as possible.
- The pressure on the needle should be released before the needle is withdrawn. The sampling should be stopped if there is evidence of blood in the hub of the needle.
- The needle is then removed and the plunger withdrawn to fill the syringe with air.
- The needle is then replaced and the contents of the needle expressed onto a clean microscope slide.
- The material may be gently smeared if necessary and stained as above. The slide should be scanned initially on a low power (4× or 10×) to identify areas of interest before using high power (40×) or oil immersion (100×).

Fungal culture

Dermatophyte culture should be undertaken in any inflammatory canine skin disease and any feline skin problem. A sterile toothbrush, hairbrush or carpet square coat brushing can be used (Figure 3.17).

Sampling lesions

- Samples of hair and scale can be collected by brushing the lesion and an area of at least 3 cm^2 around its periphery. Alternatively, sterile forceps can be used to pick off scale, crust and hair.
- Wood's lamp examination of hairs may help select suitable hairs for sampling.

Figure 3.17 Tooth brushing from coat for dermatophyte culture.

- Nail clippings can also be cultured in cases of onychomycosis by clipping the nail and then grinding it up or shaving it and sprinkling onto the culture medium.

Sampling non-lesional skin/asymptomatic carriers

- A toothbrush is best employed to comb through the whole coat.

Choice of culture medium

- Samples can be bedded on dermatophyte test medium (DTM) or else Sabouraud's dextrose agar (SDA). Care should be taken to rest the samples on the surface and not embed them in the medium.
- DTM has the advantage of producing a colour change as dermatophytes grow, but macroconidia production is generally better on SDA.
- The plates should be checked daily for growth. Dermatophyte colonies appear as white fluffy or buff-coloured colonies. Pigmented colonies are almost always contaminants.
- Dermatophytes lead to a colour change on the medium from yellow to red. Colonies sporulate poorly on DTM but colonies can be collected in many cases by the use of acetate tape touched onto the surface to collect macroconidia, which can subsequently be stained and mounted.

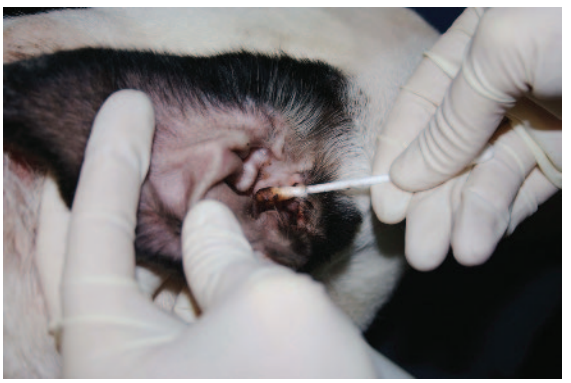

Figure 3.18 Collection of ear wax using a cotton swab.

Examination of ear wax

Both plain unstained samples and stained samples should be examined from the external ear canal (Figure 3.18). This procedure can be used to make initial decisions for treatment, possibly pending cultures, and can also be used to monitor the progress of the disease.

Initial sampling

- Plain sample is prepared by rolling wax collected on a cotton wool swab from the external ear canal onto a microscope slide (Figure 3.19). The sample should then be examined unstained. Initially, this should be done on low power (4×, 10×) rarely is a higher power needed. *Demodex* spp. and *Otodectes cynotis* can be identified by this technique.

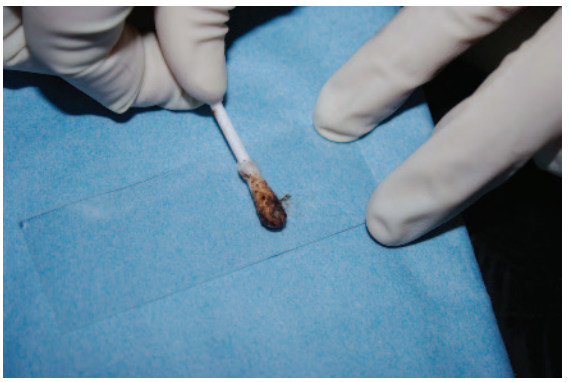

Figure 3.19 The cotton swab is rolled along the slide and air dried.

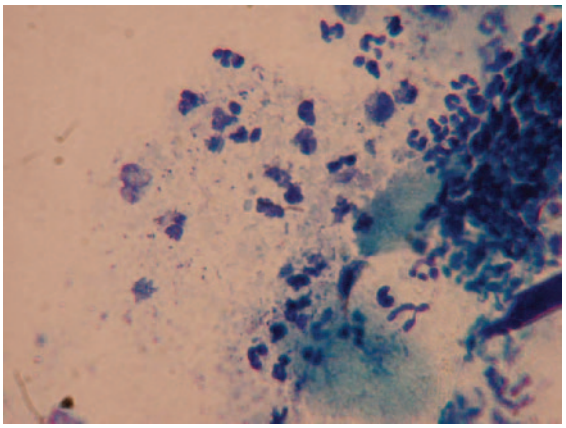

Figure 3.20 Degenerate neutrophils and bacteria on a stained sample of ear wax.

- Wax may also be collected and prepared in the same way but air dried or gently warmed and then stained with Diff-Quik. Examination should be performed with both low and high power objectives. This technique will identify different cell types and micro-organisms such as bacteria (rods and cocci, Figure 3.20) or yeast (Figure 3.21).

Follow-up samples

- These samples should be taken at different points during therapy.
- Assessment of the inflammatory infiltrate and micro-organisms helps to make judgements on the progression of the disease and response to therapy.

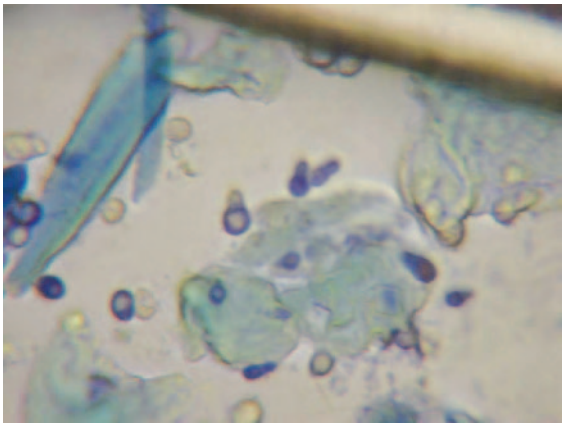

Figure 3.21 Malassezia yeast on a stained sample of ear wax.

Further diagnostic tests

Initial investigations will give information as to which further tests are deemed necessary. It is important to discuss these again with the owner at this stage.

Culture

Culture has become a more important tool in investigation, especially since methicillin resistant *Staphylococcus aureus* (MRSA) isolates have been identified in small animals. Bacterial culture is probably not indicated in all cases of bacterial pyoderma; however, it should be undertaken in certain circumstances (see Table 3.3).

The main groups of pathogens that can be cultured are as follows:

- Bacteria: sterile swabs or tissue culture can be submitted for aerobic or anaerobic culture.
- Fungi: hair, scale and crust can be submitted for growth on DTM or SDA.
- Yeast: contact plates are usually employed to look for Malassezia.

Superficial bacterial culture

Sterile swabs can be used to collect moist exudates from the skin or for absorbing pustule contents from pricked pustules. In ears, samples should be taken before any cleaning takes place. The more chronic the lesion the more important it is to look for anaerobic bacteria as well as aerobic pathogens. It is important to inform the laboratory if you are suspicious of an unusual or zoonotic organism, e.g. nocardia, mycobacterium or MRSA.

Deep bacterial culture

Samples from deep lesions are best taken as sterile biopsy samples. Samples once harvested should be placed in a transport swab container or else sterile saline and delivered to the laboratory as quickly as possible.

Table 3.3 Indications for bacteriology culture.

Indications for bacteriology culture	Comment
Cytology reveals cocci and there has been no response to (1) appropriate antibiotic at (2) correct dose for (3) appropriate length of time	High clinical suspicion of resistant staphylococcus possible MRSA
Cytology reveals evidence of cocci and rods or just rods	Difficult to predict antibiotic therapy; multiple antibiotics may be needed
Deep pyoderma	A long course of antibiotics is required so early appropriate antibiotic therapy is needed
Chronic disease – where glucocorticoids and multiple antibiotic treatments have been used	May be overgrowth of commensals or anaerobes with unpredictable sensitivity
German shepherd dog pyoderma	Often unpredictable sensitivity and multiple pathogens

Biopsy

Biopsy can provide an enormous amount of information if appropriate samples are taken. Ideally, samples should be from early lesions and where possible primary lesions should be biopsied. The major indications for biopsy include the following:

- Suspected neoplastic lesions (Figure 3.22).
- Ulcerative or vesicular lesions.
- Skin disease unresponsive to rational therapy.
- Unusual or serious skin disease, especially when the dog is systemically unwell.
- To make a diagnosis where expensive or potentially dangerous drugs are to be used.

Often a biopsy will not give a definitive diagnosis but will allow the clinician to place a disease within a general group. The main categories are as follows:

- Neoplasia
- Infection and deep parasites (folliculitis, cellulites, furunculosis, demodicosis)
- Immune mediated disease, e.g. autoimmune disease, vasculitis
- Endocrine disease, e.g. hyperadrenocorticism, follicular dysplasia
- Keratinisation disorders, e.g. sebaceous adenitis, primary seborrhoea
- Allergy and superficial parasites (fleas, sarcoptes, etc.)

Types of biopsy

- Punch biopsy: 6 mm or 8 mm biopsy sample.
- Excisional biopsy.
- Nail biopsy/amputation (see section on nail disease).

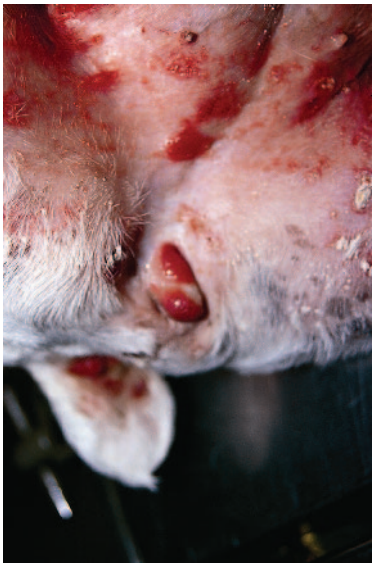

Figure 3.22 Erythroderma with scale, nodules and plaques in a dog with epitheliotrophic lymphoma. Such presenting signs warrant biopsy.

Table 3.4 Biopsy techniques.

Procedure	Comments
Select an appropriate area for biopsy	Choose primary lesions, e.g. pustules, vesicles Chronically damaged skin and secondary lesions, e.g. ulcers, lichenification and alopecia, rarely provide good diagnostic information
Select multiple areas to biopsy	Sample at least three areas and different representative lesions; footpad and nasal lesions are difficult to biopsy but provide useful information
Clip the area gently but do not prep the skin	Overpreparation of the skin can remove crust and scale, which is useful diagnostically; cleaning can affect tissue culture results
Inject a small bleb of local anaesthetic into the subcutaneous skin	Suitable agents include lidocaine, novocaine and articaine
Punch biopsy: use a disposable punch (6–8 mm); place over the lesion; apply gentle pressure and twist the punch	If a blunt punch is used it can distort the tissue by producing shearing forces and give unreliable results
Once the full thickness of skin has been penetrated the punch can be withdrawn	Care should be taken over delicate structures to ensure they are not damaged
Excisional biopsy: an elliptical excision is made around a lesion with a scalpel blade	This technique is useful for larger lesions also nose, footpads and ear flaps
Fine forceps should be used to grab the subcutaneous fat on the sample and any adherent fat can be snipped with fine forceps to release it	If the epidermis is grasped or heavy forceps are used, the sample can be damaged
Mount the sample on a piece of card	Allows the pathologist to orientate the sample for processing
Place in 10% formalin solution	Ensure that the sample is in at least 10× its own volume of formalin to ensure that it is adequately preserved
Ensure that the submission form contains a detailed clinical history and a list of differential diagnoses	Providing the pathologist with information allows them to provide you with more useful information
Submit to a pathologist with a level of expertise in dermatohistopathology	Subtle or rare diseases may not be recognised by a general pathologist
Once the sample has been removed the wound may be closed using sutures or staples	

For biopsy techniques, see Table 3.4.

Allergy testing

Allergy testing can be performed to identify offending allergens in both cases of food allergy and atopic dermatitis. In vitro tests (serology) are available for food allergy, and both in vitro (serology) and in vivo (intradermal skin testing) are available for atopic dermatitis.

Serology testing

These tests rely on the identification of antigen-specific antibody levels and are available for both environmental allergens and food allergens. The use of serology to identify food allergic individuals remains controversial with questions asked about the sensitivity and specificity of these tests. The author prefers to use a carefully selected food trial followed by dietary challenge to investigate food-allergic individuals. Serology testing for

Table 3.5 Advantages and disadvantages of serological versus intradermal allergy tests.

Serological tests	Intradermal tests
Can be performed by veterinary surgeon in practice	Needs to be performed by experienced operator
No outlay for diagnostic kit so individual animals can be tested, but test is relatively expensive	Expensive intradermal allergens need to be purchased; a kit should contain at least 40 allergens; it is a cost-effective procedure provided multiple tests are performed within the shelf life of the kit
Allergens tested are those offered by central laboratory	Allergens tested can be individualised for specific area
Animal does not require sedation or clipping Glucocorticoid withdrawal is probably indicated; antihistamines may not interfere with testing	Animal needs sedation and clipping Glucocorticoid and antihistamine withdrawal is needed prior to testing
No check to see if the animals' test has been affected by inadequate drug withdrawal	Use of histamine (positive control) and sterile diluent (negative control) allows investigator to decrease the risk of false negative and positive results
False negative results can be seen in allergic animals that subsequently have positive intradermal allergy tests and successfully respond to vaccines	A higher percentage of dogs produce meaningful positive reactions to intradermal allergy testing than serology
Animal stress during the procedure should not interfere with test results	Animal stress during the procedure may lead to false negative results
Good results are seen with allergen-specific immunotherapy based on serological testing	Response to allergen-specific immunotherapy is recognised as being superior when based on intradermal tests compared to serology

environmental allergens does produce good results and does have significant advantages over intradermal allergy testing (see Table 3.5).

Intradermal allergy testing

Intradermal allergy testing is considered to be the gold standard test for the identification of environmental allergens in atopic dermatitis. It is the author's and indeed most veterinary dermatologists' preferred test. Intradermal allergy testing involves measuring the allergic response in the skin, which is the target reaction for the allergy reaction (Figure 3.23). These tests also have advantages and disadvantages (see Table 3.5).

Trial therapy

A therapeutic trial can be employed in a variety of situations and can be used as a justifiable shortcut when owner's funds are inadequate to allow a more detailed investigation. The use of anti-inflammatories is rarely indicated as a therapeutic trial, and in the author's opinion immunosuppressive therapy in any form should *never* be

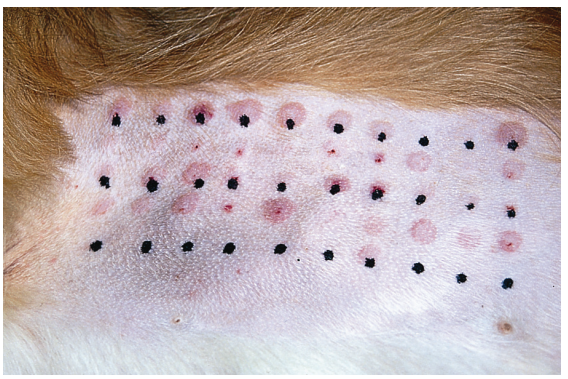

Figure 3.23 Intradermal allergy tests to a variety of environmental allergens. Positive reactions are represented as erythematous weals.

used without stringent efforts to make a diagnosis. Situations where trial therapy may be used include the following:

- Anti-parasitic therapy – in cases of suspected scabies, flea allergic dermatitis.
- Antibiotics – in pustular disease to assess if the aetiology is an infectious or sterile disease.
- Food trial – where a diet is suspected as a cause of the disease – food allergy, zinc responsive disease.
- Drug withdrawal – in cases where the lesions may have been caused by a reaction to a drug.

The reader is referred to the specific sections for more detailed descriptions of further diagnostic tests that may be employed.

In endocrine disease or where the dog or cat is thought to have cutaneous lesions as a manifestation of systemic disease, blood tests may be needed. These may include

- routine haematology and biochemistry,
- viral screens in cats,
- endocrine screen including thyroid function tests,
- dynamic function tests, ACTH stimulation test, low/high dose dexamethasone suppression test.

There will be situations where the dermatologist or veterinary surgeon needs to redirect a skin case to another discipline for further investigation:

- Ultrasonography, e.g. for visualisation of adrenal glands in hyperadrenocorticism or liver architecture in necrolytic migratory erythema.
- Radiography to diagnose calcinosis cutis or underlying bone pathology in acral lick granuloma.
- Electrocardiogram (ECG) may identify cardiac abnormalities seen with hypothyroidism.
- Electromyogram (EMG) to identify abnormal traces seen with dermatomyositis or in endocrine disease.
- Advanced diagnostic imaging, e.g. magnetic resonance imaging (MRI) in cases of chronic ear disease or in pruritus associated with neurological disease.

Once a diagnosis has been made it is important to again discuss with the owner the long-term prognosis for the animal, the success rate for the therapy, and the length of course of the treatment. Is a short course of drugs required or can the owner expect the dog to be on therapy for life? What are the side effects of therapy? What happens if the disease is not treated? What will it all cost? This procedure can often take as long as the initial consultation, but is as important. If the owner appreciates which diagnostic tests have been undertaken and the seriousness of the disease, then long-term client compliance is much better.

Selected references and further reading

Bloom, P. (2004) Diagnostic techniques in dermatology. In: Campbell, K.L. (ed) *Small Animal Dermatology Secrets*. pp. 21–33. Hanley and Belfus, Philadelphia

Dunstan, R.W. et al. (2004) A guide to taking skin biopsies: a pathologist's perspective. In: Campbell, K.L. (ed) *Small Animal Dermatology Secrets*. pp. 34–42. Hanley and Belfus, Philadelphia

Medleau, L. and Hnilica, K. (2006) Diagnostic techniques. In: *Small Animal Dermatology: A Color Atlas and Therapeutic Guide*. 2nd edn. pp. 12–24. WB Saunders, Philadelphia

Scott, D.W. et al. (2001) Diagnostic methods. In: *Muller and Kirk's Small Animal Dermatology*. 6th edn. WB Saunders, Philadelphia

4 Bacterial skin disease

General

The primary pathogen in the dog is *Staphylococcus intermedius*. Staphylococcus is thought to be a resident of the mucosae, especially the nasal, anal, genital tract areas, and is seeded to the skin through grooming or other activities. It is rare for it to cause an infection without an underlying factor. Almost any skin condition may lead to infection but the most common triggers are allergy, keratinisation disorders and follicular diseases. In deep pyodermas non-resident organisms such as *Pseudomonas* spp., *Actinomyces* spp., *Nocardia* spp. *and Mycobacteria* spp. can be isolated.

Bacterial skin infection in the cat is rare. Subcutaneous abscesses are the most common forms of infection usually due to bite wounds. Feline superficial and deep infections are almost always associated with other underlying disease processes such as metabolic or immunological abnormalities. The primary pathogen in superficial infections is *S. intermedius*. In deep pyoderma many different aerobic and anaerobic bacteria including *Pasteurella multocida*, beta-haemolytic streptococcus, *Actinomyces* spp. *Bacteroides* spp. and *Fusobacterium* spp. can be identified.

Pyoderma can be classified according to depth as follows:

- Surface
- Superficial
- Deep

Surface pyoderma

Outermost layers of the epidermis are involved.
It can be seen as

(a) acute moist dermatitis (hot spot, wet eczema),
(b) intertrigo complex.

Acute moist dermatitis

Cause and pathogenesis

Acute moist dermatitis as its name suggests is a rapidly developing surface bacterial infection that is created by the animal as a result of self-inflicted trauma, which may be licking, rubbing or chewing. It is common in dogs and rare in cats. No breed predilection is recognised. Most cases occur in the summer and autumn. Fleas are the most common inciting trigger.

The site of the lesions can give a clue to the underlying cause. Most lesions are found on the trunk (fleas), tail base (fleas, impacted anal glands), lateral thigh (fleas), neck (allergy) face (otitis) (Figure 4.1). Other causes include the following:

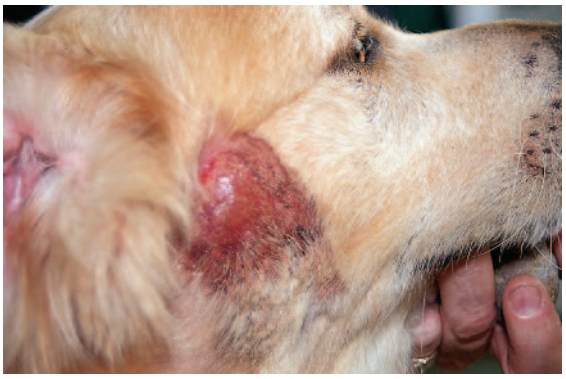

Figure 4.1 Acute moist dermatitis secondary to otitis externa. Typical appearance of erythema with exudation and self-inflicted trauma.

- Allergy – atopy (Figure 4.2), food, flea allergy.
- Ectoparasites – cheyletiella, lice.
- Localised pain – arthritis, soft tissue pain especially anal glands, dental problems.
- Otitis externa.
- Trauma – bites, injection reaction.
- Hygiene – poor coat condition, inadequate grooming (especially long coated dogs).
- Hyperthermia secondary to hyperthyroidism.
- Psychogenic – flanks or tail (especially in oriental cat breeds).

Clinical signs

Localised area of moist erythematous exudation (Figure 4.3). Margins are clearly defined. Typically, the lesion is surrounded by halo of erythematous skin. If the central lesion is surrounded by papules or pustules, so-called satellite lesions, the dermatitis is not confined to the surface and is a superficial or deep pyoderma.

Figure 4.2 Acute moist dermatitis caused through face rubbing in an allergic cat.

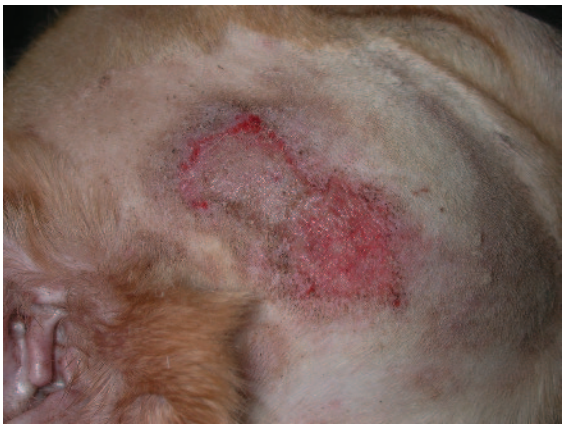

Figure 4.3 Area of acute moist dermatitis without satellite lesions.

Differential diagnosis

- Superficial or deep localised pyoderma
- Demodicosis
- Dermatophytosis
- Neoplasia especially mast cell tumour, sebaceous gland adenocarcinoma (dog), squamous cell carcinoma (cat)
- Eosinophilic granuloma (cat)
- Ulcerative dermatitis with linear subepidermal fibrosis (cat)

Diagnosis

- History, e.g. presence of otitis, poor flea control.
- Clinical signs – the presence of satellite lesions suggest a deeper infected process, which requires more aggressive antibiotic treatment.
- Skin scrape.
- Cytology – reveals degenerate neutrophils and often mixed bacteria.
- Fungal culture.

Treatment

- Check for underlying causes, especially if a recurrent problem. Flea control is important in all cases.
- Clip area (if necessary under sedation).

- Use a collar or equivalent to break self-perpetuating itch/scratch cycle.
- Topical therapy should be used to
  - dry the skin, e.g. 5% aluminium acetate or calamine lotion applied 2–3 times daily for 2–7 days;
  - cleanse the skin, e.g. antibacterial shampoo containing acetic acid, benzoyl peroxide, chlorhexidine, ethyl lactate used prior to drying agents;
  - decrease pruritus, e.g. topical antibiotic and steroid combinations for short-term use only (up to 7 days), e.g. fusidic acid/betamethasone.
- Systemic glucocorticoid therapy may be used if there is no evidence of bacterial colonisation beyond the surface, e.g. prednisolone 1 mg/kg po sid (dogs) or 2 mg/kg po sid (cats) for 5–10 days.

Intertrigo complex (skin fold pyoderma)

Cause and pathogenesis

Intertrigo complex occurs where skin folds become colonised with pathogenic organisms. Other factors that contribute are the maceration of the skin through overgrooming, tear staining or urine scalding. Bacterial involvement is common but intertrigo can occur where bacteria are seen in conjunction with or with only yeast and/or surface demodex. Different anatomical locations provide different micro-environments to allow commensal organisms to multiply and cause disease. These include most commonly the following:

- Bacteria – *S. intermedius, Pseudomonas* spp. (Figure 4.4)
- Yeast – *Malassezia pachydermatis* (dog), *Malassezia sympodialis* (cat)
- Ectoparasites – *Demodex canis* (dog), *Demodex gatoi* (cat)

Types of intertrigo (see Table 4.1)

- Lip fold
- Facial fold
- Vulval fold
- Tail fold

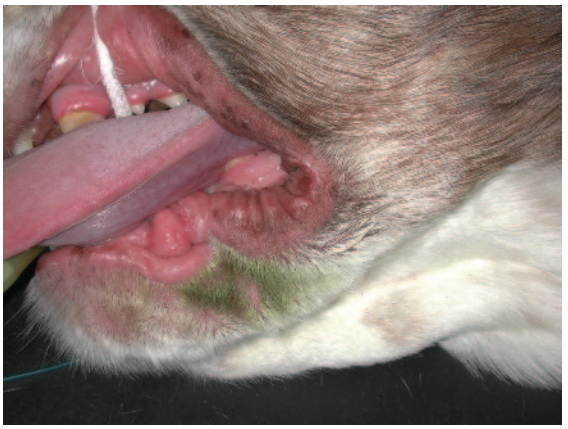

Figure 4.4 Pseudomonas colonisation of lip fold in a spaniel.

- Body fold
- Interdigital folds
- Scrotal folds

Diagnosis

- Cytology of lesions with direct impression smear or acetate tape stained with Diff-Quik to look for bacteria and yeast.
- Skin scrapings to check for parasite involvement (See section on diagnosis for techniques).
- Culture and sensitivity is rarely needed.

Treatment

Medical therapy:

- Medical therapy is preferable where possible but is often life long.
- Cleansing of the infected area can be undertaken with medicated wipes, shampoos or sprays.
- Topical cleansing dependent on pathogen:
  - Bacteria – acetic acid, benzoyl peroxide, chlorhexidine or ethyl lactate.
  - Yeast – boric acid, clotrimazole, ketoconazole or miconazole.
- Topical protectants/creams depend on pathogen:
  - Gram positive bacteria – fusidic acid, neomycin.
  - Gram negative bacteria – silver sulphadiazine, polymyxin.
  - Yeast – clotrimazole, miconazole.