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Title	Basics of equine dermatology
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Published in	Equine Veterinary Education
Publication Date	2015
Link	<a href="https://dspace.library.uu.nl/handle/1874/464736">https://dspace.library.uu.nl/handle/1874/464736</a>
Citation	Sloet van Oldruitenborgh - Oosterbaan, M M & Grinwis, G C M 2015, 'Basics of equine dermatology', Equine Veterinary Education, vol. 28, no. 9, pp. 520-529. <a href="https://doi.org/10.1111/eve.12444">https://doi.org/10.1111/eve.12444</a>
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## Review Article

**Basics of equine dermatology****M. M. Sloet van Oldruitenborgh-Oosterbaan<sup>†\*</sup> and G. C. M. Grinwis<sup>‡</sup>**<sup>†</sup>Department of Equine Sciences, Faculty of Veterinary Medicine, Utrecht University, The Netherlands; and<sup>‡</sup>Department of Pathobiology, Utrecht University, The Netherlands.

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**Keywords:** horse; dermatology; anamnesis; anatomy; skin reaction patterns**Summary**

This is the first article in a series of equine dermatology. The anatomy, reaction pattern of the skin, anamnesis, clinical examination and terminology of lesions are discussed.

**Introduction**

The skin is the largest organ in the body and dermatological problems are a frequent occurrence in equine practice. A great advantage of skin disorders is that they are readily visible and that the skin is easily accessible when specimens need to be taken. The disadvantage is that many skin disorders resemble one another. The combination of case background, thorough anamnesis and thorough physical examination generally enable the clinician to make a (tentative) diagnosis, which can be confirmed with appropriate additional examination. Skin disorders also have the great advantage that gross lesions can easily be photographed digitally. Digital images, together with the case history, extensive anamnesis and thorough physical examination, can then be discussed with colleagues.



**Fig 1:** Tactile hairs around the nose of a horse.

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**Anatomy of the skin****Macroscopy of the skin**

The skin of a horse is largely covered with hairs. The skin beneath the haired areas may or may not be pigmented. The skin around the nose, the udders and the genitalia (be it pigmented or not) is hairless. Tactile hairs are situated around the nose and the eyes (**Fig 1**). They are much larger and longer than ordinary hairs, have an adapted blood and nerve supply, and serve as mechanoreceptors.

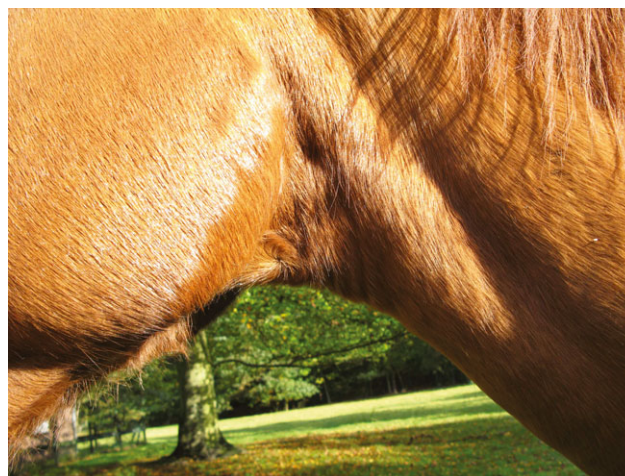
The hair follicles grow at an angle to the skin, and in a direction that is particular to the body part concerned. As a result, an overall pattern emerges, ensuring that rainwater 'runs off' efficiently. Sometimes hairs grow in a different direction in a certain place, referred to as a 'whorl' (**Fig 2**). Body hairs grow to a length, the maximum of which is genetically determined for the particular breed and under certain conditions. Equine hairs grow in cycles comprising three major stages:

**Anagen**

The growth stage in which hair is produced by mitosis of the cells in the hair bulb and the dermal papilla supplies nourishment to the hair bulb. At the start of this stage a new hair is formed that presses out the old hair. The new hair progressively elongates and emerges above the surface of the skin.

**Catagen**

The hair has reached maximum length, growth stops and the hair loosens from the hair matrix.



**Fig 2:** The hairs in a whorl or crown have a different alignment from the other body hairs.



**Fig 3:** A zebra only has a chestnut on the front limb.



**Fig 4:** Chestnuts grow slowly but steadily and excess horn breaks off.



**Fig 5:** Although this horse suffering from colic had been shod, the front hooves have worn down in the course of a few days.

**Telogen**

This is the quiescent stage and there is no hair growth.

In conditions that prevail in Western Europe, horses shed in the spring and autumn. Growth of the mane, tail and fetlock hair is continuous and so these hairs are not shed.

The horned structures of the skin are the hoof, chestnut and ergot. The ergots are small callosities in the fetlock, which are sometimes only palpable. Chestnuts are possibly vestigial toes; a horse has a chestnut on the medial side of each leg. Zebras have a chestnut on the forelimbs only (**Fig 3**). Hooves, chestnuts and ergots grow continuously. Excess horn breaks off at the ergots and chestnuts (**Fig 4**) or wears down in the hooves.

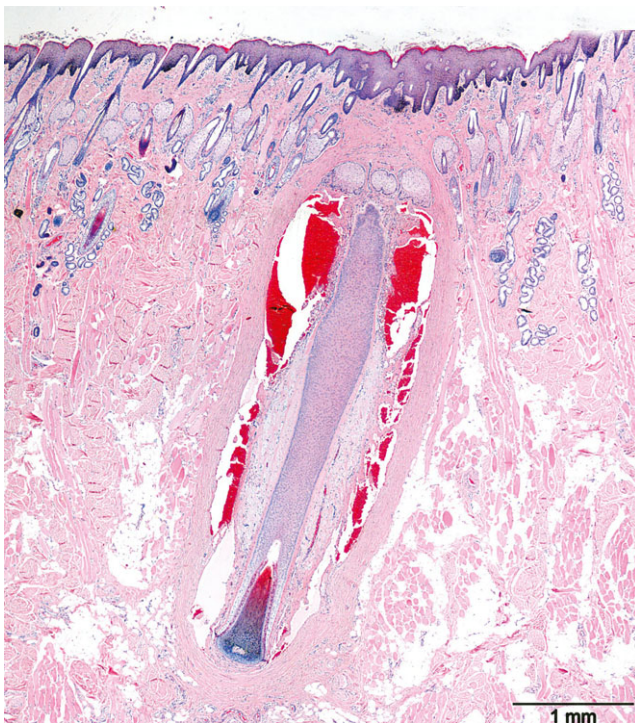
Wear of the hoof, as would occur in natural circumstances, is generally insufficient, or by contrast, too great, in the currently prevailing living conditions of horses and ponies (**Figs 5 and 6**) and so a farrier is required for hoof care.



**Fig 6:** A badly neglected foot of a draft horse.



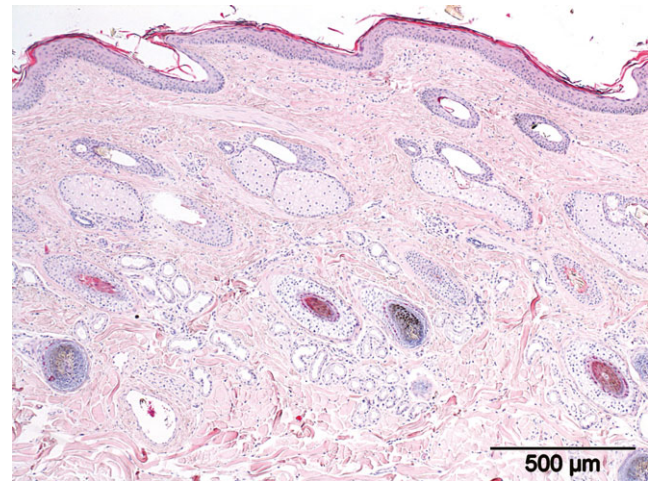
**Fig 7:** Diagram of the structure of the skin in horses (courtesy Professor C. J. G. Wensing). 1. epidermis; 2. hair follicle; 3. hair papilla; 4. hair matrix; 5. hair root; 6. sebaceous gland; 7. sweat gland; 8. *M. arrector pilorum*; 9. hypodermis (subcutis).



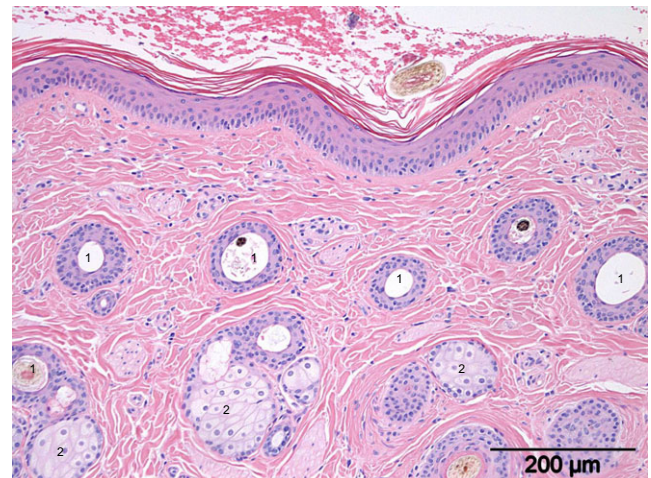
**Fig 8:** Microscopic view of a section of normal skin with a tactile hair surrounded by the sinus.

#### Microscopy of the skin

The skin, when viewed under a microscope, consists of the epidermis (top layer), the dermis and the subcutis (= hypodermis; **Figs 7–10**).

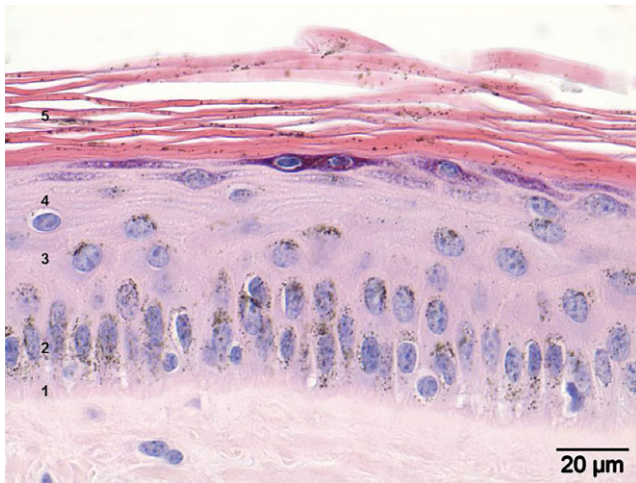


**Fig 9:** Microscopic view of the skin.



**Fig 10:** Microscopic view of the skin in which the hair follicles are cross-sectioned with hair located centrally (1) and sebaceous glands (2).

The epidermis is a multilayered, squamous, keratinised epithelium. Ninety-five percent of the epidermis is made up of keratinocytes, plus melanocytes, Langerhans and Merkel cells. Langerhans cells, which play a part in the immunity of the skin, and Merkel cells, which contribute to the sensory experience of touch, are not visible in standard haematoxylin and eosin stained sections. The melanocytes, which are responsible for pigmentation, protection from solar radiation and stabilisation of free radicals, are sometimes visible. However, when skin sections are made, melanocytes lose their normal appearance with long cytoplasmic extensions (dendrites) as a result of artifactual cytoplasmic shrinkage during tissue processing. There are four layers in the epidermis of the horse: the *stratum basale* (a single layer of proliferating basal cells with mitoses and melanin granules), *stratum spinosum* (several layers thick with a great many desmosomes and tonofilaments for the skin's mechanical strength and elasticity), *stratum granulosum* (3–5 cellular layers with keratohyaline granules for 'waterproofing' the skin,

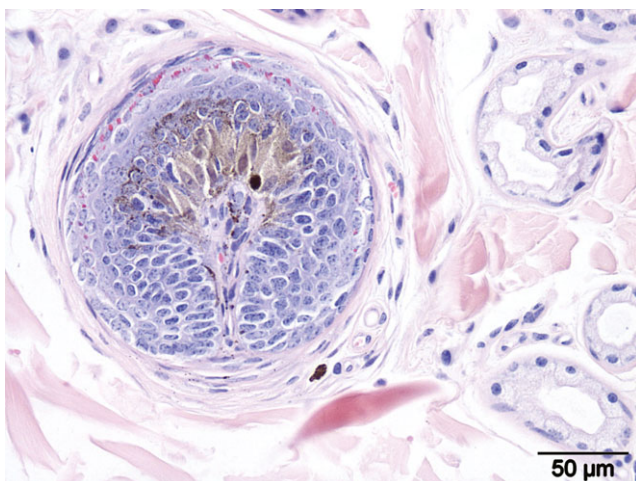


**Fig 11:** Higher magnification of the epidermis with basement membrane (1), stratum basale (2), stratum spinosum (3), stratum granulosum (4) and stratum corneum (5).

and for considerable apoptosis in the upper layer), and *stratum corneum* (sharply demarcated from the stratum granulosum, no nuclei and no cell organelles, splits between the cells filled with material from keratinosomes). In horses, the basement membrane is also generally easily distinguishable in haematoxylin and eosin sections (Fig 11).

The dermis consists mainly of collagen and elastin fibres in a ground substance chiefly made up of glycosaminoglycans and proteoglycans. Cells occur here and there in the dermis; they are primarily fibroblasts (producing ground substance) and dermal dendrocytes (part of the dermal immune system). However, in the normal skin of a horse, mast cells (particularly in the superficial dermis around the blood vessels), lymphocytes (around blood vessels), histiocytes (around blood vessels) and eosinophilic granulocytes (around blood vessels) can be found.

Also embedded in the dermis are hair follicles with hairs, sebaceous glands, hair muscles (*Musculi arrectores pilorum*), sweat glands, blood vessels, lymphatic vessels and nerve fibres.



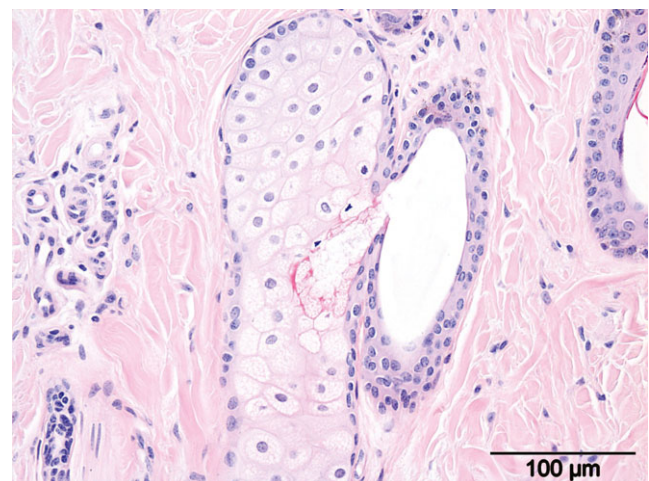
**Fig 12:** Higher magnification of a hair follicle at the level of the hair bulb with, at the right side, also sections of a sweat gland.

Horses have one hair per hair follicle. Each hair has its own *Musculus arrector pili*, a smooth muscle running from the hair root to the skin surface. They play a role in erection of the hairs and emptying of the sebaceous glands. These skin muscles are not very well developed in the horse. A hair grows out of a hair bulb (Fig 12). Hair follicles are divided into three parts. The infundibulum runs from the surface of the epidermis to the opening of the sebaceous gland, the isthmus runs from the opening of the sebaceous gland to the attachment of the *M. arrector pilorum*, and the inferior segment running from the attachment of the *M. arrector pilorum* to the dermal hair papilla.

The sebaceous glands are holocrine glands, which empty via a drainage channel in the hair follicle (Fig 13). Sebaceous glands mostly occur around the mucocutaneous junctions, the upper eyelid, the mane, the udder and the coronary band. The production of these glands is primarily regulated hormonally. Sebum keeps the skin supple and ensures adequate moisture balance of the skin. Androgen hormones stimulate production, whereas oestrogens and corticosteroids curb it.

The sweat glands are apocrine glands situated like curved tubules in the skin. Sweat glands are responsible for thermoregulation, for excretion of some residues and for production of aromatic products (pheromones). Sweat glands are found in the haired skin and are located somewhat deeper than the sebaceous glands. Sweat glands have their own drainage channel to the surface of the epidermis. The way in which they are controlled is only partially known; it is based on a complex interaction of neurogenic and humoral factors.

The cutaneous blood vessels in the skin consist of arterioles, arterial and venous capillaries and venules, and form a complex system that is important for the metabolism of the skin, but also for thermoregulation. Moreover, the cutaneous blood vessels play an important part in the skin's defence mechanisms. They form three intercommunicating plexuses: a superficial plexus just below the epidermis (serving the epidermis and the upper part of the hair follicles, amongst other things), a middle plexus at the level of the sebaceous glands (serving, for example, the sebaceous glands, *Musculi arrectores pilorum*), and a deep plexus



**Fig 13:** Higher magnification of a sebaceous gland in which the outlet from the sebaceous gland to the hair follicle is visible.

located at the junction between deep dermis and subcutis (serving the deep parts of the hair follicles, sweat glands and subcutis). These three plexuses are interconnected.

The lymphatic system of the skin is organised in a subcutaneous lymphatic plexus. The lymph vessels are essential for feeding the skin, because they control the flow of fluid in the skin.

The cutaneous nervous system comprises small cutaneous nerve fibres, which mainly follow the blood vessels. These fibres have multiple functions, including touch, vascular tone and regulation of the secretion of the glands. The skin of the face is innervated by branches of the trigeminal nerve, the rest of the body skin by nerves emerging from the spine. The area innervated by the branches of one nerve emerging from the spine is called a dermatome. The nerve supply comprises afferent sensory nerve fibres and efferent autonomic nerve fibres.

The subcutis, also known as the hypodermis or panniculus, is mainly made up of adipose tissue, collagen and elastin fibres. In most areas of the body the skin is connected to the underlying muscle tissue, fascia or bone by means of the subcutis. However, that is not the case everywhere: in the lips, eyelids, ear and anus, for example, the skin is in direct contact with the underlying muscle tissue or fascia.

The top layer of the subcutis lies in folds (papilla adiposae) between the hair follicles and the sweat glands. The functions of the subcutis are protection by shock absorption (prevention of trauma), storage of energy reserves, thermoregulation and insulation, and maintenance of surface contours. The muscle fibres in the adipose tissue enable the skin to move, for instance to dislodge insects. Fat storage in the subcutis can sometimes assume pathological forms, as with very overweight horses and ponies. Fat redistribution can also occur with pituitary *pars intermedia* dysfunction (formerly also known as Cushing's disease).

## Reaction pattern of the skin

The skin has only a limited number of possible reaction patterns. They can be divided into epidermal and dermal changes.

### Epidermal changes

The main changes that can occur in the epidermis relate to epidermal growth and/or differentiation, changes in epidermal cell adhesion, inflammatory changes in the epidermis, and changes in its pigmentation.

Changes in epidermal growth and/or differentiation include hyperkeratosis, pseudocarcinomatous hyperplasia, necrosis, apoptosis and neoplasia. Examples of changes in epidermal cell adhesion are oedema and acantholysis.

Inflammatory changes affecting the epidermis comprise exocytosis, microabscesses and pustules, and crusts. Hyperpigmentation, hypopigmentation, pigmentary incontinence, leucotrichia and leucoderma are examples of pigmentation changes.

### Dermal changes

The foremost changes that can occur in the dermis relate to its inflammation or degeneration with deposition of certain substances in the dermis. Examples of inflammatory changes of the dermis are hyperaemia, oedema, perivascular and periadnexal infiltrates of leucocytes and the formation of

granulomas. The description of cellular infiltrates in the dermis is generally based on the type of infiltrating cells and the pattern in which they occur and can give direction towards a specific skin disease. Degenerative dermal deposits are found mainly in the form of amyloidosis or calcinosis. Degenerative changes may also involve collagen degeneration and atrophy.

With some skin conditions these basic changes are found in various combinations. Very few skin conditions entail entirely distinct pathognomonic histological changes. Thus a diagnosis can usually only be made when the anamnesis, the clinical examination and the histological changes are jointly assessed. Good collaboration between clinician and pathologist is, therefore, essential if a reliable diagnosis is to be reached.

### Changes in the subcutis

The main change that can affect the subcutis and, in particular, the fat cells in the subcutis, is inflammation which may cause panniculitis or steatitis. In addition, neoplasia of fat tissue can occur.

## Clinical examination

There is a more or less set protocol for examining patients with skin disorders. It proceeds as follows:

- Case background
- Anamnesis
- Clinical examination
- Further examination

Clinical examination is in two parts: general clinical examination and clinical examination of the skin. If required, closer clinical examination can take place: on the one hand addressing organ systems other than the skin, and on the other hand further examination of the skin, for example a parasitological, bacteriological or mycological examination.



**Fig 14: Chronic progressive lymphoedema in a 15-year-old Friesian, formerly also known as condylomatous greasy heel.**

### Case background

Age, breed and sex are important data for differential diagnosis. For instance, some breeds are predisposed to certain skin conditions, like the predisposition of Friesians and cold-blooded horses for chronic progressive lymphoedema (CPL), formerly often known as condylomatous greasy heel (Fig 14). In addition, some conditions are age-related, such as papillomas in young animals (Fig 15) or to a particular colour, such as melanoma in greys (Fig 16).

### Anamnesis

Adequate time should be taken for the anamnesis (history). It is often better to speak to the person who looks after the horse on a daily basis (not always the owner). A reliable, comprehensive anamnesis is very important to understand the aetiology and development of the disorder and environmental factors that might have played a part in its commencement and continuation.

Important questions that need to be asked with anamnesis of skin disorders are:



Fig 15: Papillomas in a yearling.

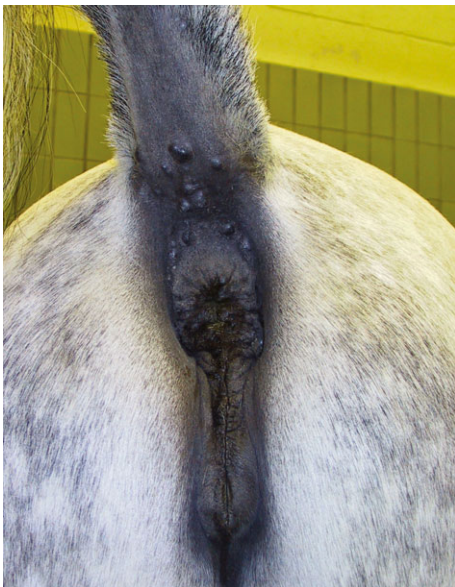


Fig 16: Melanomas under the tail and round the anus in a grey horse.

- 1 The nature, type and development of the change in the skin.
  - What is the problem and how long has it been present?
  - How did the problem start and where on the body?
  - How old was the animal when the problem started?
  - What did the changes in the skin (lesions) look like initially?
  - Did the lesions come about suddenly or gradually?
  - What changes have taken place over time?
  - What course has the disorder taken (season-related, stationary, improved or worsened)?
- 2 Behaviour and presentation of the case.
  - Is there itching (scratching, biting, rubbing, stamping) and, if so, where?
  - Is the itch slight, moderate or severe?
  - Does itching lead to lesions?
  - Is itching season-related?
  - Is there evidence of reduced performance?
  - Is there evidence of a behaviour change or restlessness?
  - Are there other clinical signs besides itching?
- 3 The case's environment in the widest sense.
  - What feed does the patient get?
  - What kind of ground cover is there in the stall/stable?
  - Are there, apart from the patient, other horses or ponies in the patient's surroundings with problems?
  - Does the disorder also occur in other animal species?
  - Prior to the onset of the disorder, were new animals introduced in the surroundings?
  - How is the horse/pony housed (nature and type of stable, pasture)?
  - Is there contact with other horses or other species?
  - Has the animal been out of the country?
- 4 Medication in the form of injections, tablets, ointments or washes.
  - Are medicines being used for the skin disorder or washes performed (or have they been) – and what is/was the effect?
  - Is the case receiving medication for other conditions (side effects)?
- 5 Zoonotic aspects.
  - Are there people in the surroundings who also have skin complaints (owner, carer, family members)?
  - If so, what are the skin (or other) complaints?

When the anamnesis is conducted it is important to remember that an owner has often already tried 'everything' before consulting the veterinarian and that the owner or

caretaker will only recount the whole process after further probing. It is worth repeating several questions, formulated somewhat differently, in order to check the answers.

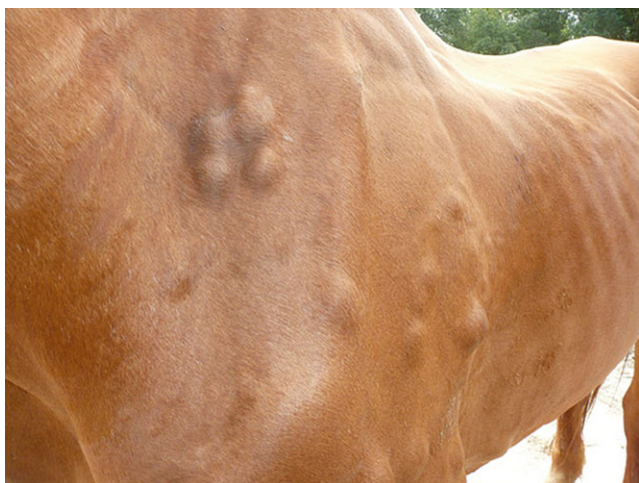
### General and dermatological examinations

The clinical examination of the skin case is twofold: a general clinical examination and the clinical examination of the skin (dermatological examination). The main objective of the former is to find indications for a possible disorder other than just the skin complaint for which the animal has been submitted. For instance, a horse with chronic skin problems, as well as serious weight loss and greatly enlarged lymph nodes, could have lymphoma (**Fig 17**). During general clinical examination, respiration, pulse, body temperature, mucosa and lymph nodes are observed. In addition, a (short) examination is made of the skin, coat and horny structures. If necessary, examination of the organ systems – lungs or heart – follows.

Effective dermatological examination consists of a systematic inspection of the patient as a whole. Examination of the skin focuses on the general aspect of the coat and recording the changes in any skin (lesions). In addition, the thickness of the coat, possible changes in coat colour, alignment and sheen of the hairs, loose or broken hairs, grooming condition and the presence of chafed or hairless patches.

An inspection is also made for lice eggs (nits) or bot fly eggs, and whether ectoparasites are visible (lice can certainly be detected with the naked eye, as 'moving matter') and whether skin lesions occur. A magnifying glass with a small light (**Fig 18**) can be extremely useful in that respect. The inspection is not only aimed at seeing where the lesions are located, but also the type of lesions and the configuration in which they occur. Lesions can be symmetrical, generalised or localised. The localisation of skin lesions is important for a correct differential diagnosis and it is important to record them.

When a disorder occurs, the skin may exhibit a number of changes, which are clearly discernible macroscopically. With respect to the reaction pattern of the skin, these are



**Fig 17:** A 19-year-old Royal Warmblood Studbook of the Netherlands mare with weight loss and, within 3–4 months, increasingly large lumps over the entire body which, with histological examination, proved to be lymphoma (courtesy Huub van Wijk).



**Fig 18:** A magnifying glass with a small light is very useful when inspecting details.

changes, which on the whole occur at the level of the epidermis, the hair follicles, the dermoepidermal interface and the subcutis. Aetiological diagnosis based on visible changes is often not always possible. Characteristics such as breed, age and localisation of the lesions are also important in diagnostics. Elementary changes in the skin, which occur in various skin disorders, can be divided into primary and secondary lesions. Primary lesions occur spontaneously and directly reflect the underlying disorder. Secondary lesions result from trauma (scratching, rubbing), but may also be induced by treatment with chemical products such as medication. It is important to try to distinguish between the two types of lesions, by looking at the skin closely and describing the lesions carefully. Some lesions belong in both groups. They are either primary or secondary, depending on the nature of the disorder. Primary lesions can be disguised by secondary infections and trauma resulting from itching.

It has long been less customary to use strict terminology for all types of lesions with horses, yet a meticulous description of the lesions is worthwhile. Consequently, the terminology applied for dogs and cats will also be reviewed here. It is worth bearing in mind that not all types of lesions can be distinguished macroscopically.

#### Primary lesions

**Macula:** This is a circumscribed, flat discolouration of the skin. With haired skin, the discolourations are often difficult or impossible to see. There are:

- Red maculae resulting from hyperaemia (erythema) or haemorrhages in the dermis. They can also be bluish in colour.
- Brown to black maculae resulting from a local build-up of pigment in the basal part of the epidermis; pigment

changes can also be the consequence of modified production of melanin.

- White maculae caused by local depigmentation, possibly occurring following inflammation, for example an interface dermatitis or pressure from articles of tack (**Fig 19**).

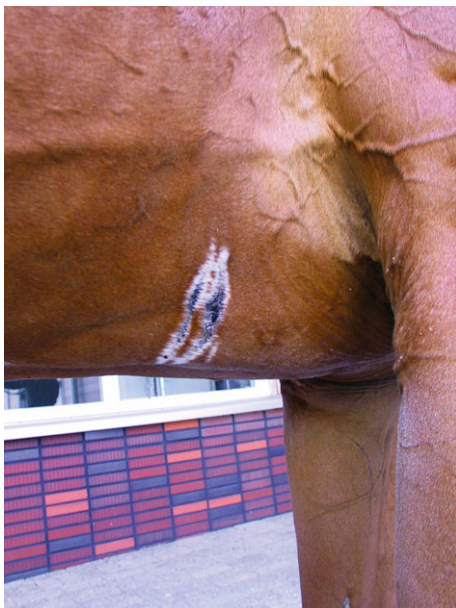
**Papule, plaque:** A papule is a circumscribed, firm elevation of the skin measuring less than 2.5 cm. The papule's colour is usually red (though often not visible on account of hair growth). Papules that coalesce are called plaques: flat elevations which can also stem from a tumour. Depending on the morphogenesis, two types of papule are distinguishable:

- The epidermal papule comprising a thickening of the epidermis due to hyperplasia, for instance, inflammation or oedema.
- The subepidermal papule, which is formed by a thickening of the dermis due to a cell increase (inflammation or tumour).

**Nodule or node:** Nodules are small, precisely circumscribed dermal elevations (lumps), which penetrate into the deep dermis. They are the result of accumulations of cells due to neoplasia or inflammation. Lesions smaller than 1 cm are called nodules, whilst the larger ones are called nodes.

**Urtica or wheal:** An urtica is a circumscribed elevation with a flat surface; it is caused by oedema in the dermis. Urticae, which can suddenly appear and disappear, often accompany an allergic reaction. When they occur in generalised areas, this is referred to as urticaria (**Fig 20**), so called after the reaction to contact with the cells of the *Urtica dioica* (stinging nettle).

**Vesicles and bullae:** A vesicle is a small blister filled with fluid (oedema, blood). Blisters often have a thin wall, meaning they can burst easily. These can be divided into:



**Fig 19: Depigmentation caused by pressure from a girth.**



**Fig 20: Horse with acute urticaria.**

- Intraepithelial vesicles, for instance resulting from extensive intercellular (spongiosis) and intracellular (hydropic degeneration) oedema and degeneration of desmosomes (acantholysis).
- Subepidermal vesicles, in which blister-formation has brought about a separation between epidermis and dermis. Blisters with a diameter of more than 5 ml are called bullae.

**Pustules:** A pustule is a small, circumscribed elevation of the skin resulting from an accumulation of pus in and/or under the epidermis (abscess formation). With intraepidermal localisation, it is also referred to as impetigo. Pustules can be a secondary development from vesicles.

**New formation:** A tumour (swelling) can either be neoplastic or reactive (inflammation) of nature. Generally the term tumour is used for neoplasms.

#### Secondary lesions

**Squamae or scales:** Squamae are loose scales or flakes of horn that are found between the hairs (**Fig 21**). They can be caused by an inflammation of the skin. Scales may occur as primary lesions, for example primary seborrhoea. The underlying disturbance can be increased production (hyperkeratosis) or impaired exfoliation (dyskeratosis).

**Crusts:** Crusts (scabs) are attached to the skin. They are mainly made up of dried serum, pus or blood, plus horn and/or sebum.

**Collarettes:** Collarettes occur after a pustule or vesicle has burst. The upper layer of the *stratum corneum* (the 'roof') has become detached. What remains is a circular rim of epidermal tissue.

**Erythema:** This is a red discolouration of the skin that is not sharply defined. It usually results from licking, though vasodilation can be a cause (in that case, the erythema can be considered a primary lesion).

**Alopecia:** This is hair loss. The patch may be sharply circumscribed, but can also be diffuse. Alopecia may result from trauma as caused by rubbing, or from a serious disorder that occurred several weeks earlier, whereby the hairs have all entered the telogen phase. Alopecia also occurs as a primary lesion, for example with an immune-mediated disorder (**Fig 22**) and can be idiopathic as well. Therefore, in such cases, a primary lesion exists.

**Excoriations or erosions:** These apply to superficial defects in which the epidermis is damaged and the basement membrane is intact. They can be caused by rubbing.



**Fig 21:** Extensive flaking in a seriously sick horse, suffering, amongst other things, from untreated bacterial dermatitis.



**Fig 22:** Alopecia in a 15-year-old Crossbred Arabian gelding with alopecia areata.



**Fig 23:** Lichenification caused by rubbing of the mane crown brought about by insect sensitivity (summer eczema).

**Ulcers:** An ulcer is a deep epidermal defect that extends into the dermis and entails damage of the basement membrane. If the ulcer is linear it is termed a fissure. Scars often occur once the ulcer has healed.

**Lichenification:** Lichenification refers to an extensive thickening of the skin with a pronounced accentuation of the skin's surface relief. It results from repeated trauma, such as scratching (**Fig 23**).

**Hyperpigmentation:** The skin has a dark colour due to increased production of melanin. Hyperpigmentation is often accompanied by lichenification. Hyperpigmentation can also be congenital or idiopathic.

**Comedo:** A comedo ('blackhead') consists of a dilated hair follicle filled with keratin and sebum. The plural of 'comedo' is 'comedones'.

### List of problems and differential diagnosis

The results of the clinical examination are recorded, possibly using a diagram to show the localisation of certain major defects (**Fig 24**) or preferably digital photos.

With all the data from the initial clinical examination, a list of problems is drawn up, as well as a list of the most probable differential diagnoses. It is worth noting them in the patient's dossier and then systematically going through the list. The owner's wishes will also determine whether further examination is carried out and expenses may play a significant role here.

### Authors' declarations of interests

No conflicts of interest have been declared.

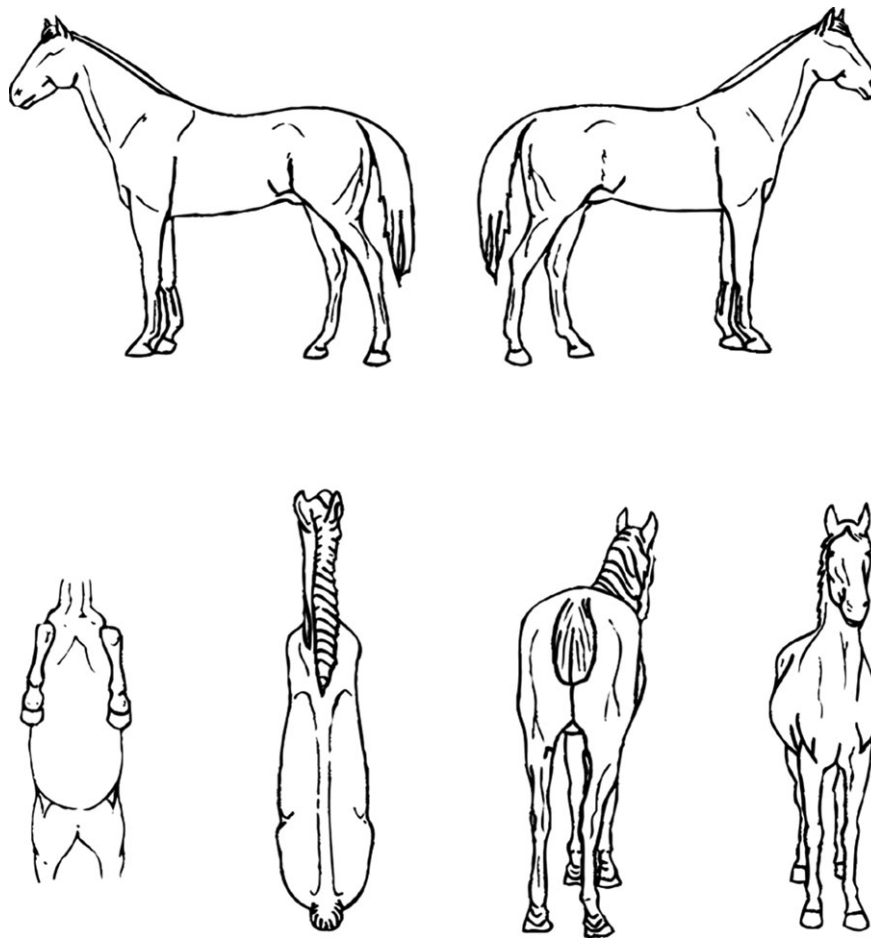


Fig 24: Diagram on which to indicate the localisation of changes in the skin and skin lesions.

### Ethical animal research

Ethical review not applicable for this review article.

### Source of funding

None.

### Authorships

Both authors contributed to writing this review article.