General Optical Council Approved CET For Optometrists
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Introduction to dermatology

Part 1 – The structure and function of the skin

Dr Penny Thomson and Professor David Thomson begin a new series on the structure of the skin and the management of common skin conditions. CET Module C13583, one general CET point, suitable for optometrists and dispensing opticians

The skin is the largest organ in the body. If you stretched it out, the average adult's skin would cover an area of 2m^2 and weigh approximately 3.6kg, (approximately 16 per cent of the total body weight).[1]

The skin plays a number of vital roles including protection from UV radiation, chemicals and harmful organisms, temperature regulation, sensation and vitamin synthesis (Table 1). Without the skin, we would soon become dehydrated and infected with micro-organisms. In view of the continuous exposure of the skin to light, chemicals and a spectrum of micro-organisms, it is perhaps not surprising that skin conditions are common. Approximately 10 per cent of GP consultations and 6 per cent of hospital referrals relate to skin problems.

Optometrists and dispensing opticians spend much of their time looking at patients' faces and are therefore likely to encounter a wide range of abnormal skin conditions. In this series of articles we will be giving a basic introduction to the structure and function of the skin and a description of common skin conditions, particularly those affecting the face and periorbital skin. We shall also outline the appropriate management of common benign and malignant skin lesions.

TABLE 1

Skin function	Function performed by
Protection from chemicals, micro-organisms, UV radiation	Stratum corneum, melanocytes, Langerhans cell
Prevention water loss	Cells of epidermis
Temperature regulation	Blood vessels, sweat glands
Insulation	Fat in the subcutis
Sensation	Nerve endings and receptors
Lubrication	Sebaceous glands
Vitamin synthesis	Keratinocytes
Calorie reservoir	Subcutaneous fat

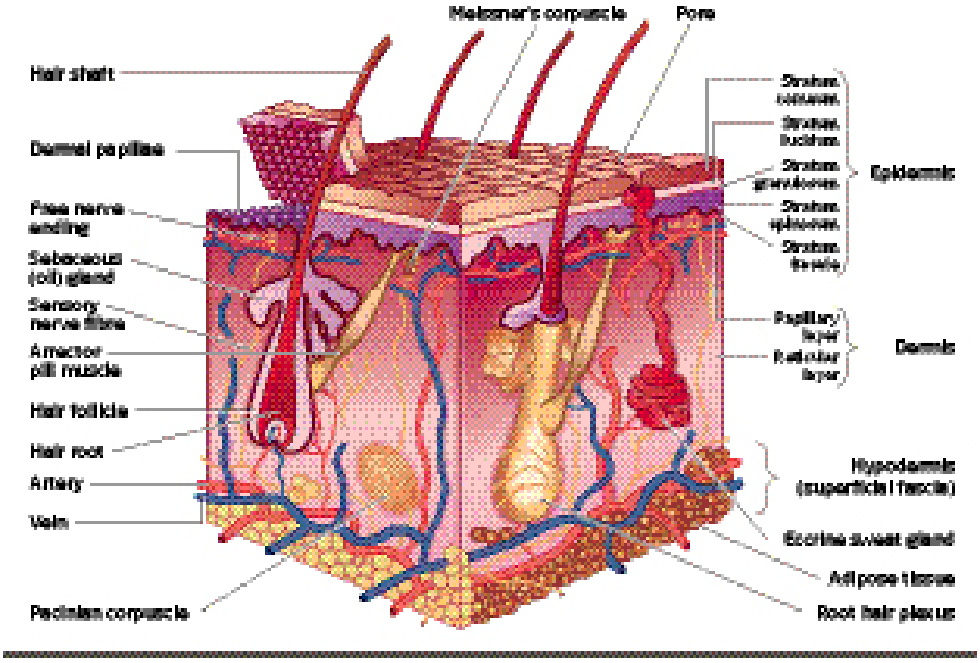


Figure 1 The three layers of the skin

The anatomy of the skin

The skin can be broadly separated into three layers (Figure 1). The outermost layer, known as the epidermis, is the main barrier against the ingress of chemicals and organisms and the egress of fluids from the body. Below this outer layer lies the dermis which contains several specialised structures such as the sweat glands, nerve endings and receptors, blood vessels, sebaceous glands and the hair follicles. Beneath the dermis lies a layer of fat and connective tissue known as the subcutis.

The epidermis

The epidermis layer ranges in thickness from approximately 0.1mm on the eyelid to 1.4mm on the palms and soles.[1] There are also variations in epidermal thickness with age and gender. The epidermis interlocks with the dermis by means of downwards undulations known as epidermal ridges. These mirror the upward projections of the dermis which are called dermal papillae (Figure 2). The epidermis is composed of four main types of cells, namely keratinocytes, melanocytes, Langerhans cells and Merckle cells.

Keratinocytes

Keratinocytes are arranged in four layers lying on a basement membrane. The first layer of keratinocytes on the basement membrane is called the basal layer (stratum basale) and it is here that the cells undergo division. One of the two cells produced stays on the basement membrane to continue dividing and the other will start its journey upwards to the top of the epidermis. The keratinocytes in the basal cell layer are attached to the basement membrane by means of specialised structures known as hemidesmosomes. As the keratinocytes progress upwards, they pass through the prickle cell layer (stratum spinosum) and the granular layer (stratum granulosum), slowly changing shape from columnar to flattened disc-like cells. At the same time they become coated in a lipid-rich film which helps bind the cells together

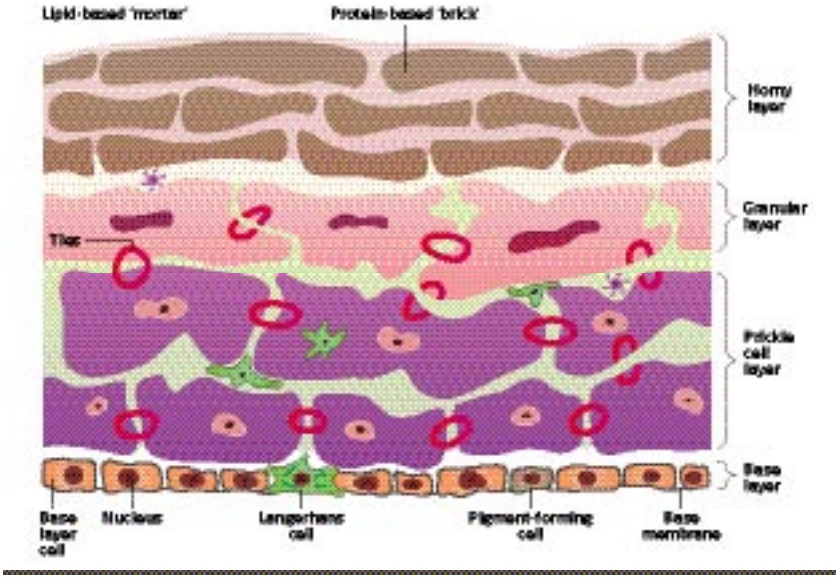


Figure 2

and retain water. The top layer is called the stratum corneum or horny layer and forms a tough but flexible barrier between the body and the outside world. From this layer, the corneocytes (as the keratinocytes are now called), which have now lost their cell nucleus and are dead cells, are shed into the environment where they make a major contribution to household dust. On average it takes 28 days for a newly formed cell to migrate from the basal layer to the stratum corneum through to being shed at the skin surface.

One of the most important functions of the keratinocytes is to produce vitamin D. The vitamin D precursor is synthesised in the keratinocytes and converted to cholecalciferol when exposed to ultraviolet radiation. Cholecalciferol is then transported to the kidneys in the blood stream where it is activated to vitamin D which is important for normal bone growth and may protect against some types of cancer.

Melanocytes

Melanocytes account for 5-10 per cent of the cells on the basement membrane. As the name suggests, their primary function is to produce melanin, particularly when stimulated by UV light. It is this process that gives a colour to the skin. Melanocytes are also found in the retina, ear and the brain and are neuroectodermal in origin, having migrated from the neural crest in the foetus.

Melanin comes in two forms:

- Eumelanin which gives the skin a black-brown colour
- Phaeomelanin which gives the skin a red-yellow colour

Skin colour/tone is produced by a mixture of these two types of melanin. The density of melanocytes does not vary significantly between skin types. Racial differences in skin colour are largely attributable to differences in the amount and rate of production of melanin.

Melanocytes are dendritic cells with long cytoplasmic processes (dendritic processes) extending out from the central body of the cell and weaving in between the keratinocytes where they each make contact with about 30 keratinocytes. The melanocytes produce melanin in small packages called melanosomes and these are passed down the dendritic processes and then transferred to the keratinocytes. The melanosomes form a 'cap' over the nucleus of the keratinocyte to protect it from UV radiation damage.

Langerhans cells

Langerhans cells are formed in the bone marrow and are part of the body's immune system. They are found in the epidermis and the dermis and are involved in immune responses. They also have long dendritic processes and their cytoplasm is unique in containing a rod-shaped organelle called the Birbeck granule – the purpose of which remains undetermined. The dendritic processes snake between the keratinocytes where they come into contact with foreign proteins (antigens) and micro-organisms that have managed to penetrate the outer skin barrier. The Langerhans cells take up the antigens and digest them into small fragments which they then display at their cell surface. The Langerhans cells can migrate to the regional lymph nodes where they come into contact with lymphocytes (white blood cells) which are then stimulated

to produce a clone of cells which will now recognise this particular antigen when it is next encountered.

Merkle cells

Merkle cells, which are also of neuroectodermal origin, are found intermittently along the basement layer of the epidermis and are thought to be involved in the sensation of fine touch and light pressure.

The dermis

The dermis varies in thickness from approximately 0.6mm on the eyelid to 3mm on the back.[1] It contains cells and fibres lying in an amorphous ground substance and provides support for various structures performing specialised functions.

The dermis is divided into two layers: the upper papillary dermis which interdigitates with the epidermis and the lower reticulate dermis.

Approximately 70 per cent of the fibres in the dermis are bundles of collagen while the remainder are reformed of elastin. The collagen fibres give the dermis strength while the elastin fibres provide a degree of elasticity.

The dermis contains cells such as fibroblasts which make collagen and elastin. Langerhans cells, which are involved in the skin's immune action, can also be found in the dermis. Mast cells and white blood cells which have migrated from the bloodstream are also found in the dermis. Running through the dermis are blood vessels such as arteries, capillaries and veins which bring nutrients and oxygen to the skin and take away carbon dioxide and other waste materials. The lymphatics are channels where extracellular fluid is collected and these start to form in the papillary dermis then join to form larger lymph channels which eventually drain into the lymph nodes.

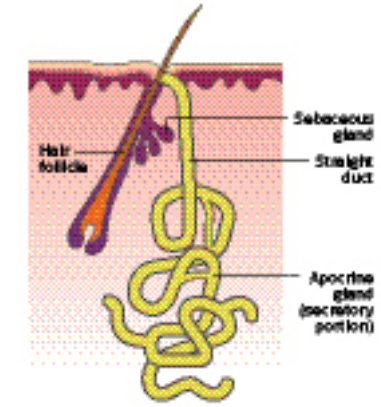


Figure 3 Diagram of a sweat gland

The dermis also contains the following specialised structures.

Sweat glands

Sweat glands are finely coiled tubes lying in the reticular dermis with a duct leading to an opening on the skin surface (Figure 3). The sweat is produced in the coiled part of the gland and has a pH between 4 and 6.8. Sweat is composed of water, sodium, potassium, urea and ammonia. The highest density of sweat glands is on the palms, soles, under the arms and the forehead. It is estimated that there are 2.5 million sweat glands in the adult skin. They are stimulated by the sympathetic nervous system and help to regulate the temperature of the body. Evaporation of sweat from the skin surface helps to keep the body cool and sweat production can reach two litres per hour.

Keeping the body temperature at a constant 37°C is important for the various biochemical reactions that are taking place. Blood vessels in the dermis also play a part in thermoregulation by expanding or contracting thus modulating the heat loss.

Hair follicles

Hair is produced by all parts of the skin apart from the skin on the palms of the hands, the soles of the feet and the glaborous skin found on lips and genitalia. In most animals, hair plays a role in temperature conservation but this is not the case in humans where hair probably has a role in sexual attraction. Hair grows at about 0.4mm every hour and goes through three phases: anagen when the hair actively grows and can last from three to seven years, catagen which lasts three to four weeks when the hair rests and finally telogen when the hair is shed. The average number of head hairs shed in one day is 100. The hair follicles are closely associated with the sebaceous glands and are linked to the arrector pili muscles which allow the hairs to 'stand on end' for example in the cold or with anxiety (Figure 4).

Sebaceous glands

The sebaceous glands are usually found in the same sites as hair but are particularly common on the scalp, the face, the chest and back. They normally lie in association with a hair follicle and produce an oily material called sebum from a lobulated gland. The function of sebum is not clear but it may be involved in lubrication and disinfection of the skin and it has some antibacterial and antifungal properties. Sebum excretion is under hormonal control particularly testosterone stimulation.

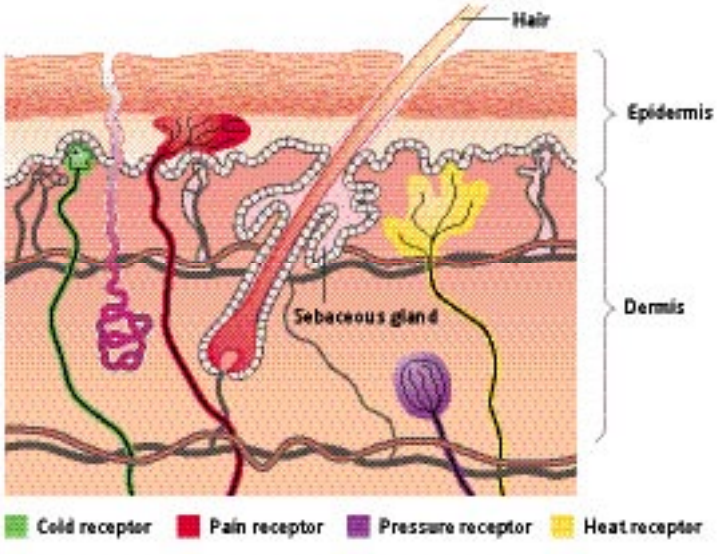
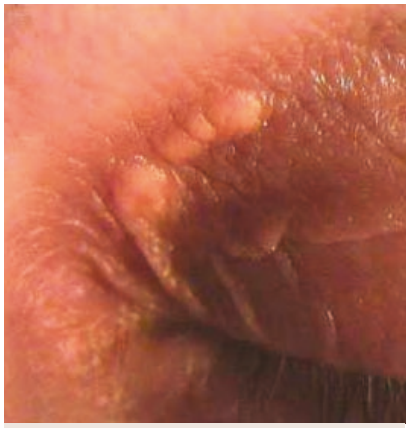


Figure 4 Diagram of a hair follicle and sebaceous gland



● In the next article in this series, infectious and inflammatory conditions of the skin will be described with particular reference to conditions affecting the face and periorbital skin

The meibomian glands in the eyelid are sebaceous glands which are not associated with a hair follicle.

Nerve cells
The skin has an abundant supply of nerve endings, which originate in the dorsal root ganglia of the spinal cord. The nerve endings detect sensations such as pain, temperature and itching. There are specialised receptors such as the Pacinian corpuscle which detects pressure and vibration and the Meissner's corpuscle which plays a role in the sensation of touch. The highest concentration of nerve fibres is found in the hands, face and genital areas. ●

References
1 Dermatology – An Illustrated Colour Text, David J Gawkrodger
2 Clinical Dermatology – JAA Hunter, JA Savin and MV Dahl Second Edition
3 Textbook of Dermatology Volume 1 – Rook, Wilkinson and Ebling

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MULTIPLE-CHOICE QUESTIONS – take part at opticianonline.net

1 What percentage of GP consultations concern problems of the skin?

A 1 per cent
B 10 per cent
C 20 per cent
D 30 per cent

2 Which of the following is NOT associated with the epidermis?

A Langerhans cell
B Merckle cell
C Keratinocytes
D Fibroblasts

3 What is the thickness of the eyelid epidermis?

A 0.01mm
B 0.1mm
C 1mm
D 10mm

4 What is the main role of Langerhans cells?

A Immunity
B Structural support
C Colouration
D Sensory reception

5 What is the thickness of the dermis of the eyelid?

A 0.06mm
B 0.6mm
C 3mm
D 6mm

6 Skin maintains a constant healthy body temperature of how much?

A 36.2°C
B 36.8°C
C 37°C
D 38°C

Successful participation in this module counts as one credit towards the GOC CET scheme administered by Vantage and one towards the Association of Optometrists Ireland's scheme. The deadline for responses is April 15 2010