



THIS
MODULE ONE
IS IDEAL TO
UNDERSTAND
BASIC
ANATOMY AND
PHYSIOLOGY
OF THE SKIN.



This publication has been endorsed
by the Royal College of Nursing,
Australia, according to approved
criteria.

MODULE 1: ANATOMY & PHYSIOLOGY OF THE SKIN

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To understand how wounds heal it is important to have a basic knowledge of the anatomy and physiology of the skin and the structures that lie within it.

LEARNING OUTCOMES

On completion of this module you should be able to;

- Identify the main structures of the dermis, epidermis and discuss their functions.
- Identify the functions of the skin and describe the physiology involved.
- Discuss how the skin protects itself from infection and damage.
- Discuss how the skin ages.



ANATOMY (The Structure of the Skin)

The skin is the largest organ of the body, it is an organ because it consists of different tissues that are joined to perform specific activities.

The skin has two principle parts (Figure 1.1). The superficial, thinner portion is called the epidermis. The epidermis is composed of epithelial tissue and is attached to the deeper, thicker part called the dermis. The dermis is composed of connective tissue. Below the dermis is a subcutaneous layer, which consists of connective and adipose tissues.

EPIDERMIS

The epidermis is avascular: oxygen and nutrients are supplied by interstitial fluid from the dermis.

The epidermis is composed of stratified keratinised squamous epithelium and contains four principle cells.

About 90% of the epidermal cells are keratinocytes which produce keratin. Keratin helps to waterproof and protect the skin and underlying tissues from heat, light, microbes and many chemicals.

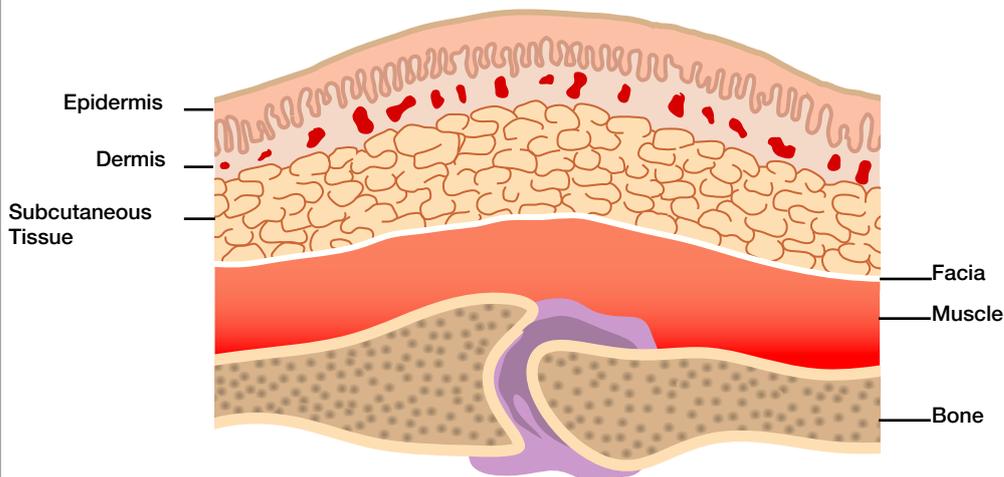


Figure 1.1 The individual layers of the skin

8% of the epidermal cells are melanocytes which produce the pigment melanin.

Langerhans cells are the third cell in the epidermis, they interact with helper T cells (white blood cells) in immune responses.

The merkel cell is the fourth type of cell in the epidermis and is found in the deepest layer of hairless skin. These cells make contact with the end of nerve cells and are thought to function in the sensation of touch.

The epidermis is composed of four or five layers, and has a relatively uniform thickness over the body; typically 0.1mm in the four layer regions. Where exposure to friction is greatest e.g. on the soles of the feet and the palms of the hands it is thicker at 1-2mm and has five layers.

The names of the five layers (strata) of the epidermis are as follows (see Figure 1.2);

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basal



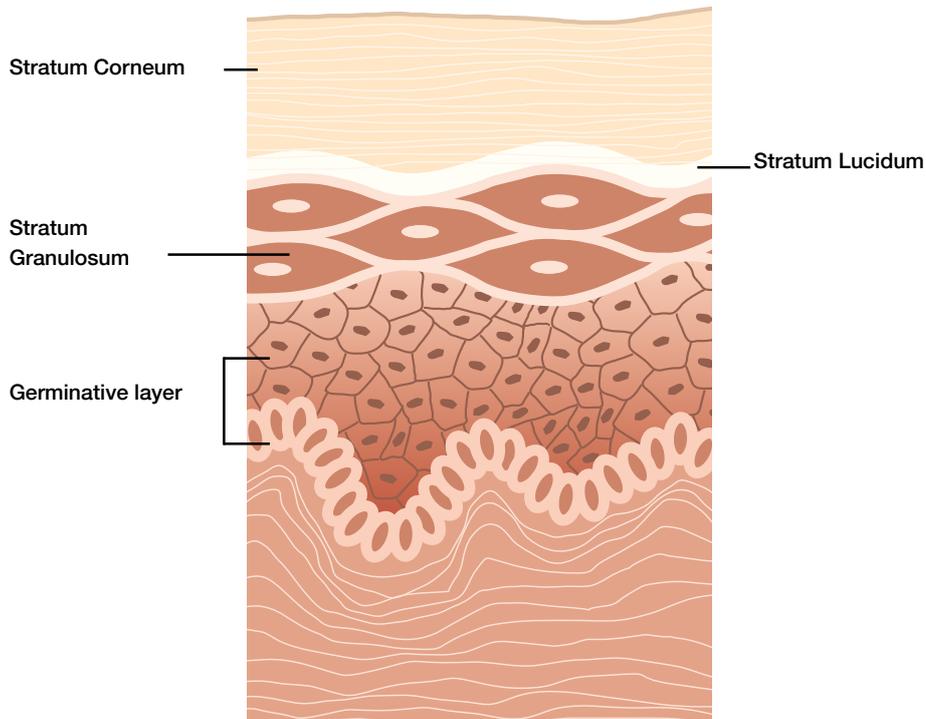


Figure 1.2 The main layers of the epidermis

The cells on the surface of the epidermis are flat, thin, non-nucleated, dead cells, in which the cytoplasm has been replaced by fibrous keratin. These cells are continuously shed and replaced by cells which originated in the basal layers. This process is called keratinisation and takes about 2-4 weeks.

DERMIS

The dermis is the thickest layer of the skin. The dermis ranges in thickness from 2-4mm, it tends to be very thick in the palms and soles and thin in areas such as the eyelids. It is also thicker on the back (posterior) than the front (anterior) of the body.

The dermis is composed of connective tissue containing collagen and elastic fibres, which makes it tough and elastic. When the skin is overstretched rupture of elastic fibres occurs resulting in permanent striae or stretch marks, such as may be found in pregnancy, obesity or weight loss. Collagen is the protein that gives skin its tensile strength, although this ability declines with age, when wrinkles may develop.

Fibroblasts, macrophages and mast cells are the main cells found in the dermis.

There are several structures found in the dermis (Figure 1.3).

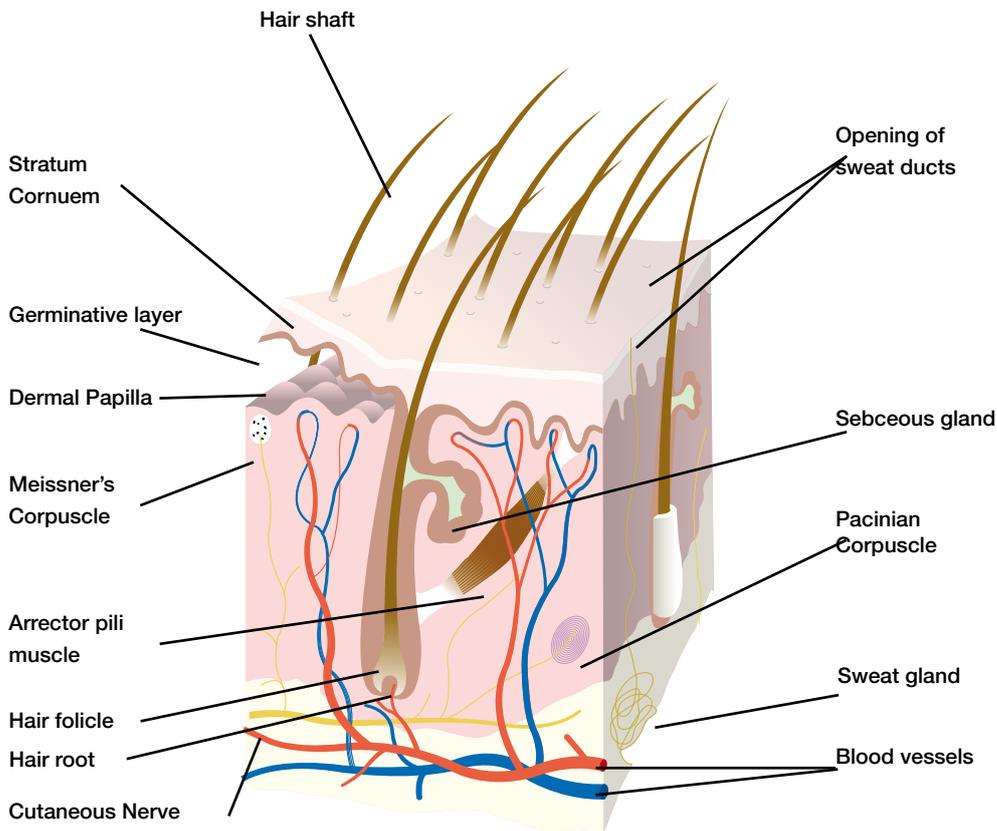


Figure 1.3 Structures within the skin

Blood vessels

Supply oxygen and nutrients to sweat glands and the dermis.

Lymph vessels

The lymphatic system is responsible for the transportation of particulate and liquid material, such as protein from the extracellular compartment of the dermis. Lymph vessels are broad lumen, with single-cell thick walls that transport fluid away from the skin to the lymph nodes, maintaining homeostasis in the tissues.

Sensory nerve endings

The skin is an important sensory organ. Incoming stimuli are received by sensory receptors in the dermis.

Sweat (sudoriferous) glands

There are 2 types of sweat gland, eccrine and apocrine.

1. Eccrine sweat glands are the most common, they are distributed throughout the skin, with a few exceptions e.g. the margins of the lips. They are most concentrated in the palms and the soles. The secretory portion is in the subcutaneous tissue with the excretory duct extending out through the dermis, ending with a pore at the surface of the epidermis.

2. Apocrine sweat glands are found mainly in the skin of the axilla, pubic region and areolae of the breasts. The secretory portion is found within the dermis or subcutaneous layer and the excretory duct opens into hair follicles.

The most important function of sweat is the regulation of body temperature.

Hairs (pili)

Hairs are a growth of the epidermis. Hair follicles are formed by down- growth of the epidermal cells into the dermis or subcutaneous tissue. At the base of the follicle is a structure called the bulb.

As cells at the bulb multiply and are pushed away from their source of nutrients, they die and become keratinised. This is how hair is formed.

Hair above the skin is called the shaft, the remainder is called the root.

Arrector pili muscles

Smooth muscle fibres attached to the hair follicles. They contract under stresses e.g. fright and cold, and pull the hairs vertically.

Sebaceous (oil) glands

Secrete an oily substance called sebum into hair follicles, which helps to keep hair from drying out. They are absent in the palms and soles and vary in size and shape through the rest of the body.

SUBCUTANEOUS LAYER

This is a layer of fat, which lies between the skin and the underlying structures. It provides insulation, an energy reserve and cushioning. There are blood vessels within this layer, which supply the blood vessels of the dermis.

Fibres from the dermis extend into the subcutaneous layer and anchor the skin to it. The subcutaneous layer attaches the dermis to underlying structures and organs.



PHYSIOLOGY (Functions of the Skin)

The skin performs five main functions;

1. Regulation of body temperature
2. Protection
3. Sensation
4. Excretion
5. Synthesis of vitamin D

REGULATION OF BODY TEMPERATURE (Thermoregulation)

In health, the human body regulates its temperature at a fairly constant 37°C even though the environmental temperature varies greatly. This is maintained via a negative feedback system in which the skin plays a major role.

THE SKIN'S ROLE IN HEAT LOSS

There are Thermoreceptors (temperature-sensitive nerve endings) in the skin that detect changes in body temperature.

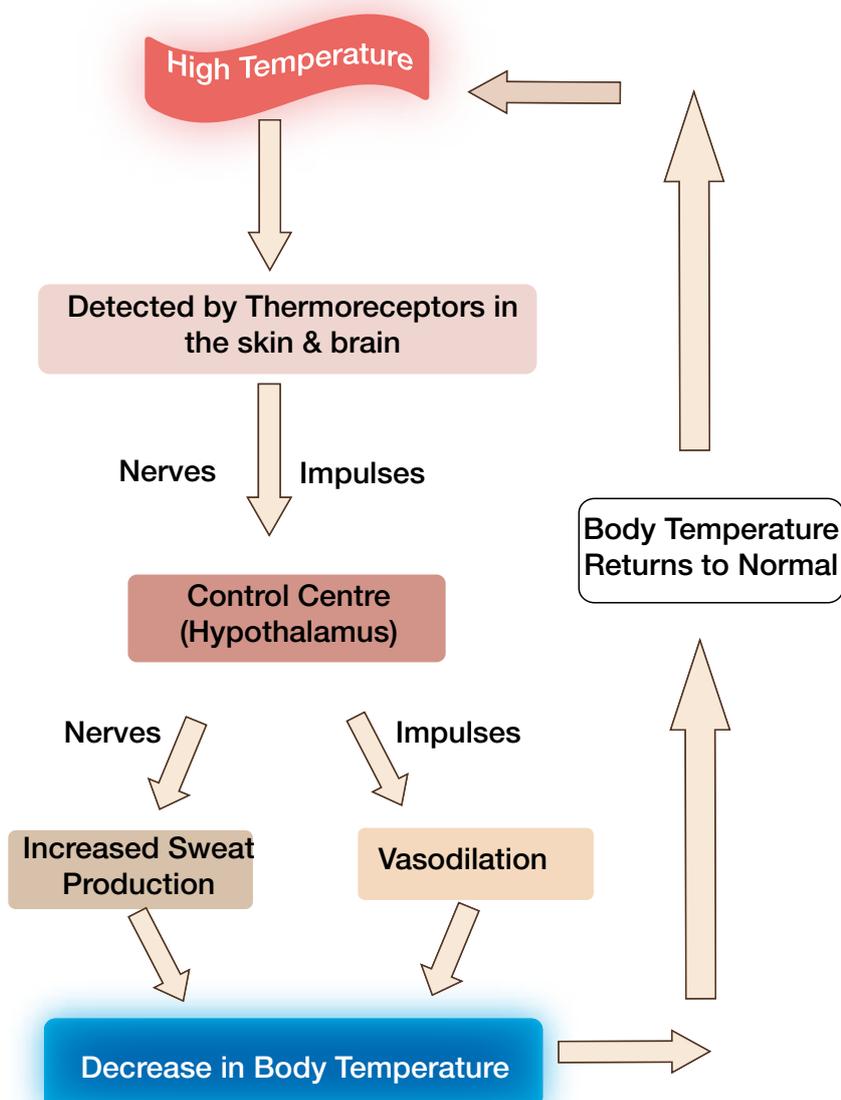


Figure 1.4 Thermoregulation - the skins role in heat loss.





When the body temperature rises, nerve impulses are sent to the temperature control centre in the brain. The temperature control centre then causes a number of events which bring the body temperature back within the normal range, primarily vasodilation and perspiration (sweat production).

Vasodilation - Blood vessels dilate causing more blood to pour into the capillary network and the skin to become warm. This excess heat is lost to the environment via conduction, convection and radiation (see glossary).

Perspiration - The increased temperature of the blood causes activation of the sympathetic nervous system. This stimulates sweat glands to produce perspiration (sweat). The water in sweat then evaporates from the skin. When water evaporates it takes with it a great deal of heat.

At the same time as vasodilation and perspiration the metabolic rate decreases and shivering does not occur.

When the body temperature returns to normal (homeostasis) vasodilation and perspiration ceases.

THE SKIN'S ROLE IN HEAT CONSERVATION

In response to a drop in body temperature, changes occur that help to conserve heat and, at the same time, promotes the production of heat at a faster rate. This is again achieved via a negative feedback response.

A drop in body temperature is detected by thermoreceptors and nerve impulses are sent to the temperature control centre. In response to this, the hypothalamus secretes thyrotropin-releasing hormone and discharges nerve impulses, this causes a number of responses which help promote heat conservation and production.

The skin plays the following role in heat conservation:

The nerve impulses from the hypothalamus stimulate sympathetic nerves causing vasoconstriction. This decreases the flow of warm blood through the skin and therefore the amount of heat lost.

At the same time heat production is increased through the effect of thyroid hormones on metabolism, an increase in cellular metabolism and shivering.

PROTECTION

The skin, along with its derivatives, for example hair, nails, glands and nerve endings, forms the integumentary system (Integere means to cover over, or protect).

The skin is a physical barrier that protects underlying tissues from minor mechanical blows, bacterial and viral invasion, dehydration, and ultra violet radiation.

Protection from mechanical assaults. (e.g. pressure and friction) This is mainly provided by the tough fibroelastic tissue of the dermis, collagen and elastin.

Bacterial and viral invasion

When intact, the skin is virtually impermeable to microorganisms. There are also cells in the skin that are involved in the immune response.

DEHYDRATION

The skin prevents excessive fluid and electrolyte loss to maintain homeostasis. This ability to prevent fluid loss is destroyed in burns patients who lose excessive amounts of fluid through their skin. This process is also interfered with in patients with leg ulcers.

Protection from UV radiation

This is provided by melanin which is produced by melanocytes, and is the pigmentation that provides people with their individual skin colours.

SENSATION

The skin forms the largest sensory organ of the body. Nerve receptors located in the skin are sensitive to pain, touch, temperature and pressure. These nerve endings are found throughout the whole organ but they are more concentrated in areas such as the fingertips and lips.

Skin sensation enables the body to protect itself from the environment. The information they provide can be acted upon both at the reflex level and consciously.

EXCRETION

There is a very small amount of carbon dioxide exchanged through the skin. The skin is also a minor excretory route for urea, sodium chloride and aromatic substances like garlic.

SYNTHESIS OF VITAMIN D

In the presence of ultraviolet (UV) light from the sun, 7-dehydrocholesterol is converted into vitamin D. Vitamin D circulates in the blood and is used in the mineralization of bone, along with calcium and phosphate. It is also thought to be important for muscles and general health, and may also help prevent other disease such as cancer, diabetes and heart disease.

When dietary intake of vitamin D is sufficient, the production of vitamin D by the skin is not essential for health.

It is recommended that 2-3 exposures of sunlight per week in the summer months (April to September) are enough to achieve healthy Vitamin D levels that last throughout the year. Each episode of exposure should be no more than 20-30 minutes. Over exposure should be avoided as this may lead to sun burn and an increased risk of skin cancer.

People who get very little sunlight on their skin are at risk of Vitamin D deficiency. Elderly people who have thinner skin are also at risk as they are unable to produce as much vitamin D; additionally certain medical conditions such as Crohn's Disease, Coeliac disease and some types of liver and kidney disease are at risk of vitamin D deficiency.



AGEING SKIN

As the skin ages,

- The blood supply to the dermis weakens, the elastic fibres and the amount of collagen is reduced, resulting in wrinkling.
- The reduction in blood supply also means there is less oxygen and nutrients delivered to the skin. The skins capacity to repair does reduce with age.
- There is a reduction in sebum secretion and sweating, causing dry course itchy and scaley skin.
- The epidermis becomes thinner and flatter, there is a decrease in the number of pigment producing cells (melancytes) which results in liver spots in pale skinned individuals. The elderly are also at an increased risk of skin induced cancers and skin cancer.
- As the epidermis thins and sensory receptors diminish in capacity, so the incidence of injuries and infections increase.
- As the hypodermis becomes thinner, the elderly are more prone to pressure damage, bruising and small hemorrhage.
- There is slower healing in the older person as epidermal turnover time is increased.
- Vascularity decreases in subcutaneous tissue, as the vascularity of the sacrum decreases, less external pressure is needed to stop the blood flow than in younger people.
- Overheating and increased sensitivity to temperature changes caused by loss of efficiency of the sweat glands and diminished dermal blood supply may result in a reduction in the ability to lose heat.

When you are ready, please complete the following “Test Your Knowledge” section . . .



TEST YOUR KNOWLEDGE

1. What is the function of Keratin?

- a. Keratin helps waterproof and protect the skin and underlying tissues from heat, light, microbes and many chemicals.
- b. Keratin is the pigment of the skin which protects the skin from harmful effects of sunlight.
- c. Keratin is the protein that gives skin its tensile strength.

2. The epidermis is composed of stratified keratinized squamous epithelium and four principle cells. What are the four principle cells – Please tick four.

- a. Keratinocytes
- b. Langerhan cells
- c. Stratum Corneum
- d. Meissner Corpuscle
- e. Collagen
- f. Melanocytes
- g. Merkel cell

3. What is thought to be the function of Langerhans cells?

- a. Langerhans cells interact with helper T cells in immune responses.
- b. Langerhans cells make contact with the end of nerve cells and are thought to function in the sensation touch.
- c. Langerhans cells produce a substance which helps waterproof and protect the skin and underlying tissues from heat, light, microbes and many chemicals.

4. What is the process of Keratinisation?

- a. The process of transportation of particulate and liquid material.
- b. The process by which cells are continuously shed and replaced by cells which originate in the basal layer.
- c. The process of secretion of an oily substance called sebum into the hair follicles, which helps to keep hair from drying out.

5. What is the dermis composed of to make it tough and elastic.

- a. Connective tissue containing collagen and elastic fibres.
- b. Lymph vessel with single cell thick walls.
- c. Fibroblasts, macrophages and mast cells.

6. What are the two types of sweat glands? Tick two

- a. Arrector pili muscles
- b. Eccrine sweat glands
- c. Sebaceous glands
- d. Apocrine sweat glands

7. The skin performs five main functions, pick three out of this list

- a. Regulation of body temperature
- b. Vasodilation
- c. Perspiration
- d. Protection
- e. Sensation
- f. Supply of Oxygen





8. What stimulates sweat glands to produce perspiration?

- a. The increased temperature of the blood stimulates sweat glands to produce perspiration.
- b. Vasodilation stimulates sweat glands to produce perspiration.
- c. An increase in metabolic rate stimulates sweat glands to produce perspiration.

9. The skin is a physical barrier that protects underlying tissue from. Pick three from the list below.

- a. Bacterial and viral invasion
- b. Excretion
- c. Synthesis of Vitamin D
- d. Dehydration
- e. Sensation
- f. Protection from mechanical assaults

10. What is the role of melanin?

- a. Melanin provides protection from bacterial and viral invasion of the skin.
- b. Melanin plays a role in protecting the skin from ultra-violet radiation.
- c. Melanin helps waterproof the skin.

11. What are the elderly more prone to if the hypodermis is thinner?

- a. Pressure ulcers
- b. Bruising
- c. Small Haemorrhages
- d. All of the above

12. Tick the correct statement in regards to ageing skin.

- a. Blood supply weakens, the elastic fibres and the amount of collagen is reduced resulting in wrinkling.
- b. Blood supply strengthens, the elastic fibres and the amount of collagen is reduced resulting in wrinkling.
- c. Blood supply weakens, the elastic fibres and the amount of collagen is strengthened resulting in stretching.
- d. Blood supply increases, the elastic fibres and the amount of collagen in strengthened resulting in wrinkling.

13. What are the nerve receptors located in the skin sensitive to?

- a. Temperature, protection, pain, excretion.
- b. Pain, touch, temperature, pressure.
- c. Touch, temperature, synthesis, pain.
- d. Synthesis, pain, protection, touch.

14. Discuss the case of a patient in your care and identify the factors affecting his/her skin.

For the answers please refer to Appendix 1.

DECLARATION OF COMPLETION

To understand how wounds heal it is important to have a basic knowledge of the anatomy and physiology of the skin and the structures that lie within it.

Learning outcomes

On completion of this module you should be able to;

- Identify the main structures of the dermis, epidermis and discuss their functions.
- Identify the functions of the skin and describe the physiology involved.
- Discuss how the skin protects from infection and damage.
- Discuss how the skin ages.

I hereby certify that I have fulfilled the learning outcomes outlined above.

Signed

Date



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