

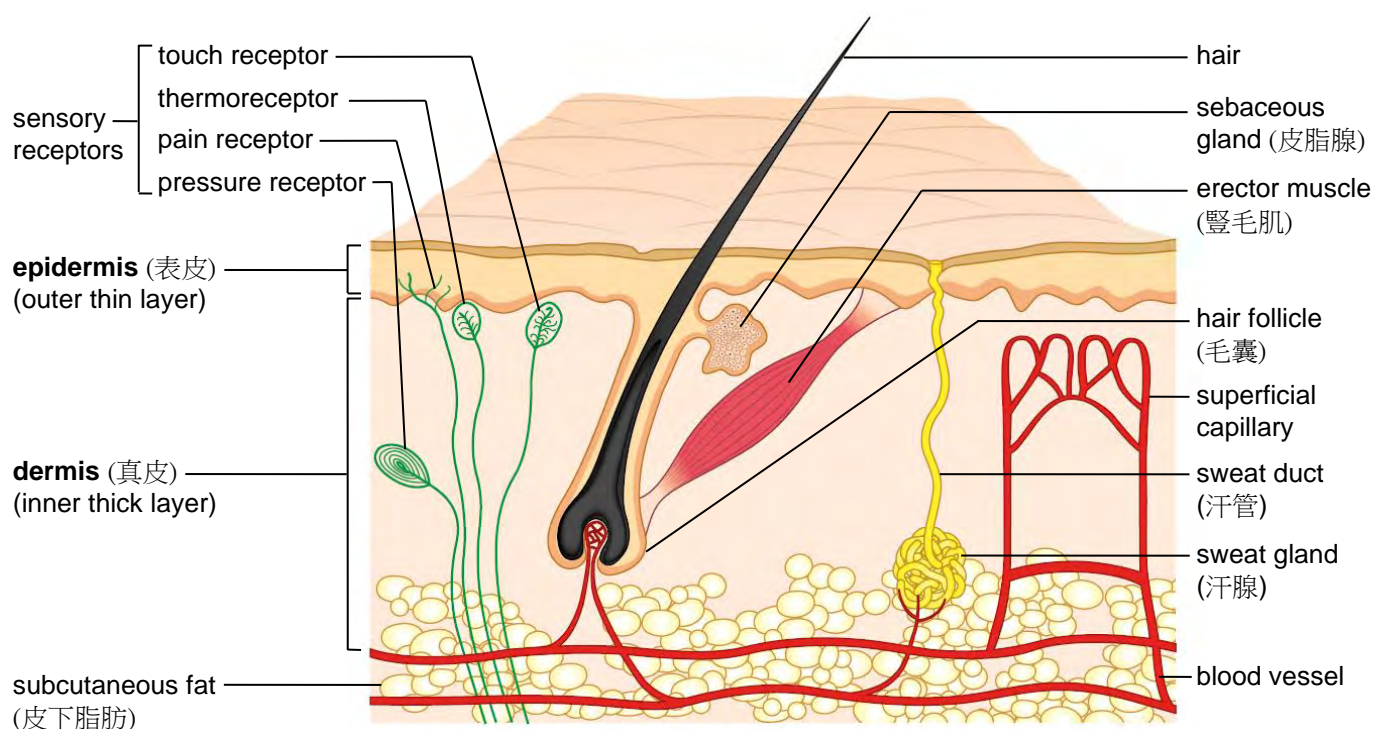
2 Regulation of body temperature

2.1 Importance of regulation of body temperature

- 1 Metabolic reactions in the body are catalysed by **enzymes**. A **stable body temperature** helps **keep enzyme activities** and hence **metabolic rate steady**.
- 2 To keep a stable body temperature, the amount of **heat gain** and **heat loss** must be **balanced**.
- 3 We gain heat mainly from metabolism taking place inside our body, in particular from respiration in the liver and skeletal muscles. Our body also gains heat from the environment or loses heat to it through **radiation** (輻射), **conduction** (傳導), **convection** (對流) and **evaporation** (蒸發).

2.2 The human skin

- 1 The **skin** covers the surface of our body. It is the main site at which heat exchange between the body and the environment occurs.
- 2 Structure of skin:

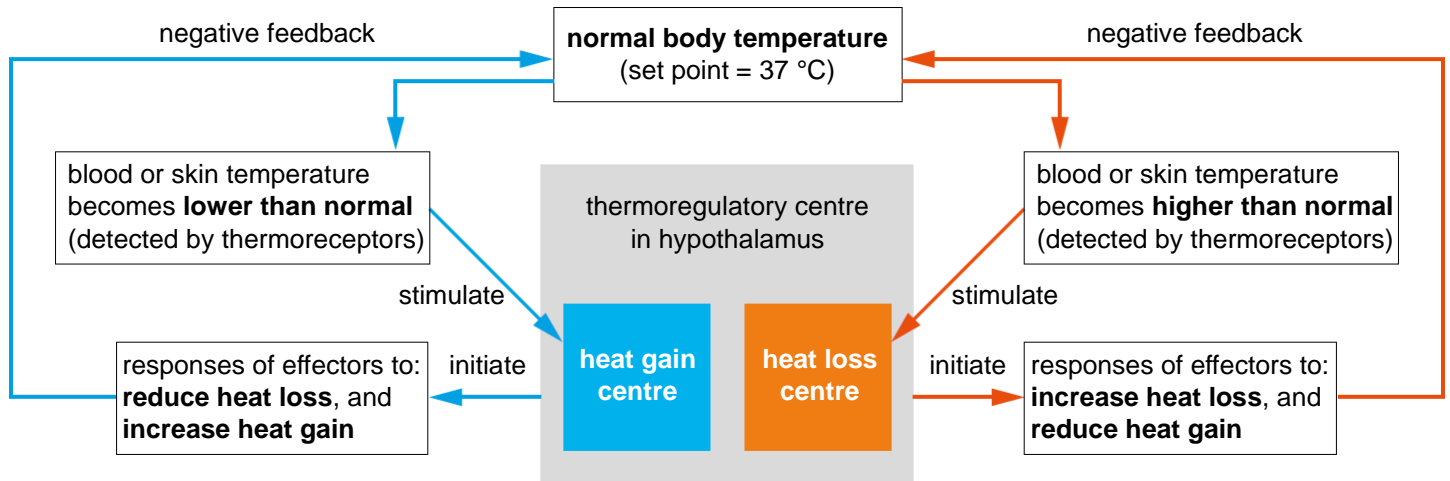


3 Features and functions of different structures of the skin:

Structure of the skin	Features and functions
Epidermis a Outermost layer b Middle layer c Innermost layer	<ul style="list-style-type: none"> - Reduces water loss from the body by evaporation - Protects the body from mechanical injury - Prevents the entry of pathogens - The cytoplasm of the cells gradually replaced by keratin (角蛋白). The cells finally die and become the outermost layer - Carries out mitotic cell division to produce new cells - Contains melanin (黑素) which prevents ultraviolet light from harming the body - Produces vitamin D when exposed to sunlight
Dermis a Sensory receptors b Hair follicles c Erector muscles and hairs d Sebaceous glands e Sweat glands f Blood vessels	<ul style="list-style-type: none"> - Detect stimuli such as temperature change, touch, pressure and pain - Produce hairs - Help regulate body temperature - Secrete sebum (皮脂) that keeps the skin and hair supple and waterproof, and suppresses the growth of microorganisms - Secrete sweat to help regulate body temperature and remove metabolic wastes - Supply oxygen and nutrients to skin cells and remove wastes from them - Help regulate body temperature
Subcutaneous fat	<ul style="list-style-type: none"> - Acts as an insulating layer to reduce heat loss - Acts as an energy reserve

2.3 Mechanism of body temperature regulation

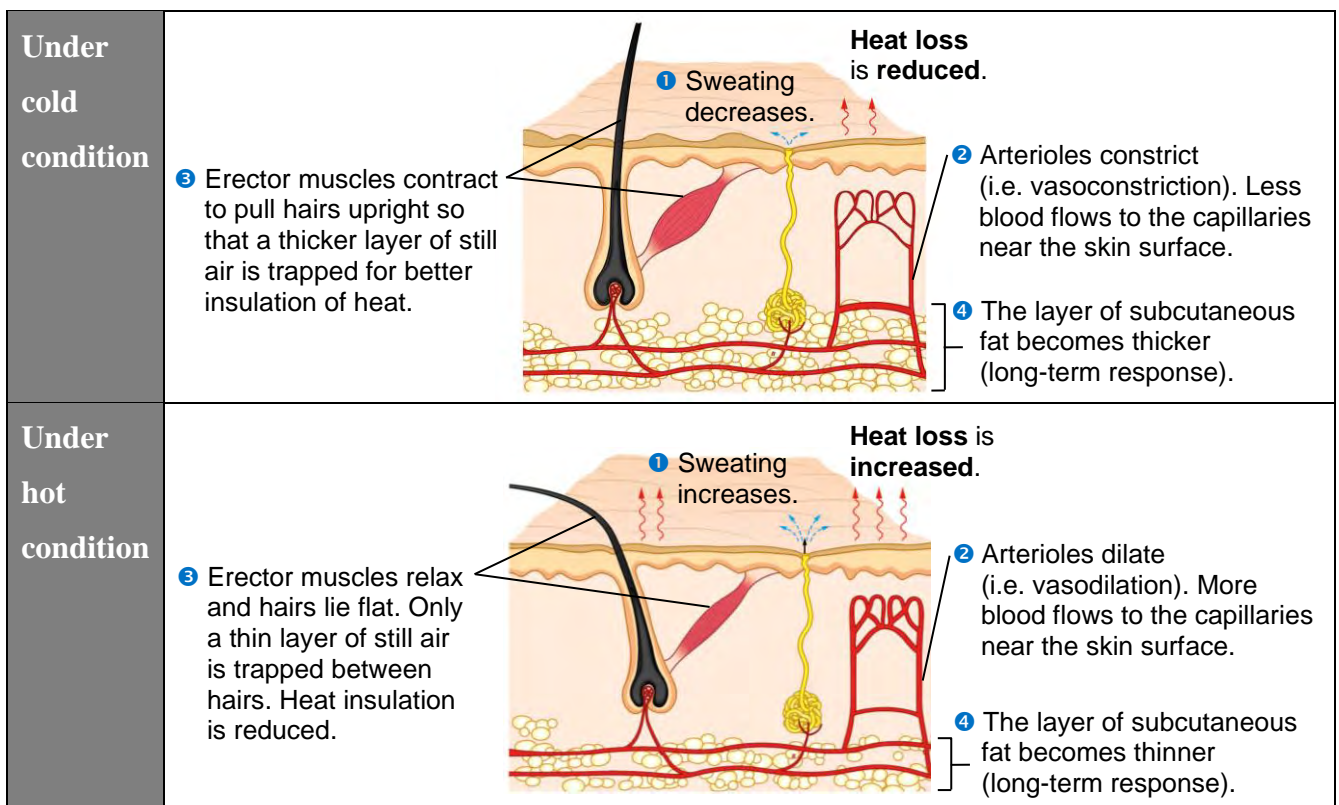
- 1 The **thermoregulatory centre** (體溫調節中樞) in the **hypothalamus** of the brain has two parts: the **heat gain centre** (產熱中樞) and the **heat loss centre** (散熱中樞). These two centres work through a **negative feedback mechanism** to regulate body temperature:



- 2 **Thermoreceptors** (溫度感受器) are present in the hypothalamus and the skin. Those in the hypothalamus detect the temperature of the blood passing through it (i.e. internal temperature) while those in the skin detect the temperature of the skin (i.e. external temperature).

Regulation of body temperature by skin

- 3 Response of the skin under cold and hot conditions:



- 4 In the skin, a **shunt vessel** (分流血管) connects the arteriole and the venule.
- When the **arteriole constricts** under **cold conditions**, **less blood** flows to the **capillaries near the skin surface** and more blood flows through the shunt vessel. As a result, less heat is lost from the body by conduction, convection and radiation.
 - When the **arteriole dilates** under **hot conditions**, **more blood** flows to the **capillaries near the skin surface** and less blood flows through the shunt vessel. As a result, more heat is lost from the body by conduction, convection and radiation.

Regulation of body temperature involving skeletal muscles

- 5 **Shivering** (顫抖) is the **contraction** of **skeletal muscles rapidly** and **repeatedly**. It is **involuntary** and **uncoordinated**.
- 6 During shivering, the rate of respiration in muscle cells is increased in order to release more energy for muscle contraction. This **generates more heat** to keep the body warm.

Regulation of body temperature by hormones

- 7 Under cold conditions, the **thyroid gland** (甲狀腺) secretes **more thyroxine** (甲狀腺素).
- Thyroxine is transported in blood to all parts of the body. It **increases the metabolic rate** of body cells so that **more heat is generated** to keep the body warm.
 - A persistent increased thyroxine secretion is a **long-term response** to a cold environment.

Regulation of body temperature by behavioural means

- 8 **Behavioural means** to regulate body temperature are **voluntary** (i.e. under conscious control of the **cerebrum**). Examples include:

Under cold condition	Under hot condition
<ul style="list-style-type: none"> - Wear more clothes - Take in hot food or drinks - Curl up the body - Stay indoors 	<ul style="list-style-type: none"> - Wear fewer clothes - Take in cold food or drinks - Fan the body - Stay in shady places

2.4 Heat- and cold-related illnesses

- 1 **Heat exhaustion** (熱衰竭), **heatstroke** (中暑) and **hypothermia** (體溫過低) are illnesses related to the body's inability to regulate body temperature. Heat exhaustion and heatstroke result from prolonged exposure to high temperatures while hypothermia results from prolonged exposure to low temperatures.