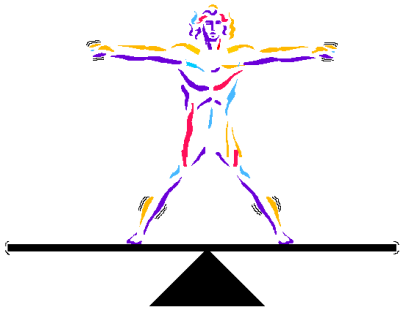
11. Homeostasis, Drugs

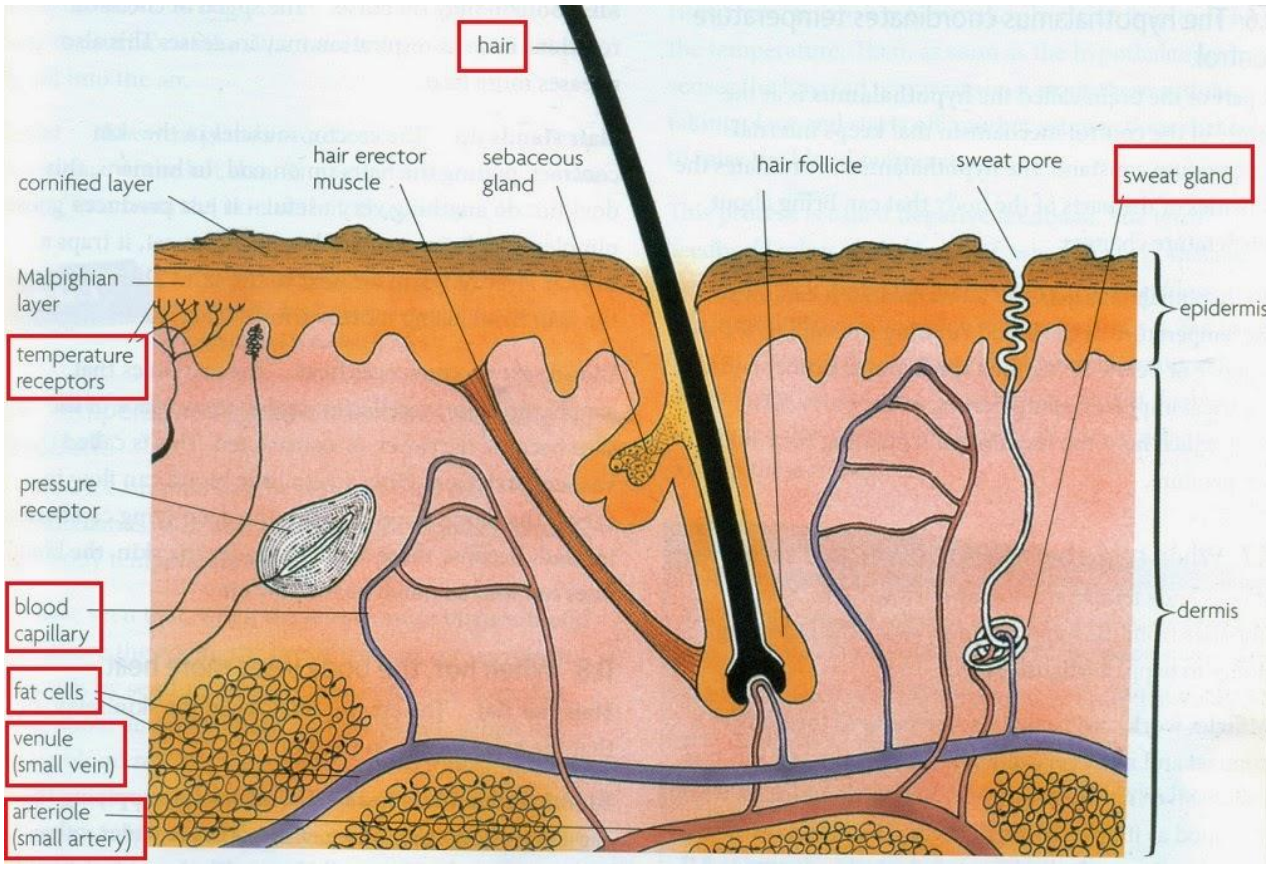
#101 Homeostasis



Homeostasis is the maintenance of a **constant internal environment**, which is vital for an organism to stay healthy. Fluctuations in temperature, water levels and nutrient concentrations … could lead to death.

Temperature regulation is one homeostatic function. Mammals and birds are warm-blooded – they maintain a constant body temperature despite external environment changes.

Human maintain a body temperature of 37^0C – we have mechanisms to lose heat when we get too hot, and ways of retaining heat when we get too cold.

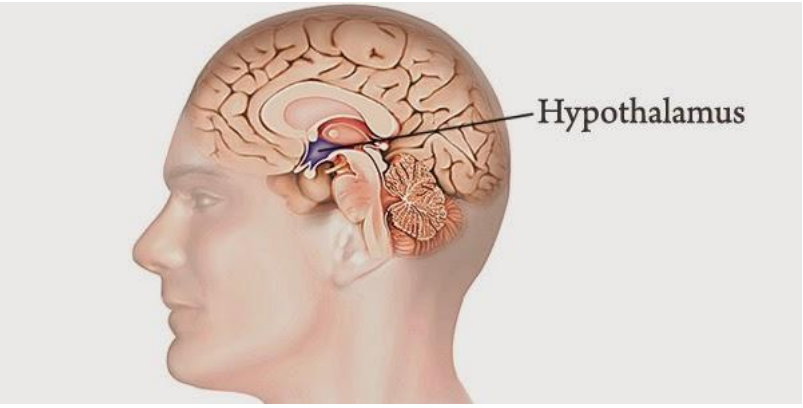


A section through human skin.

The hypothalamus coordinates temperature control

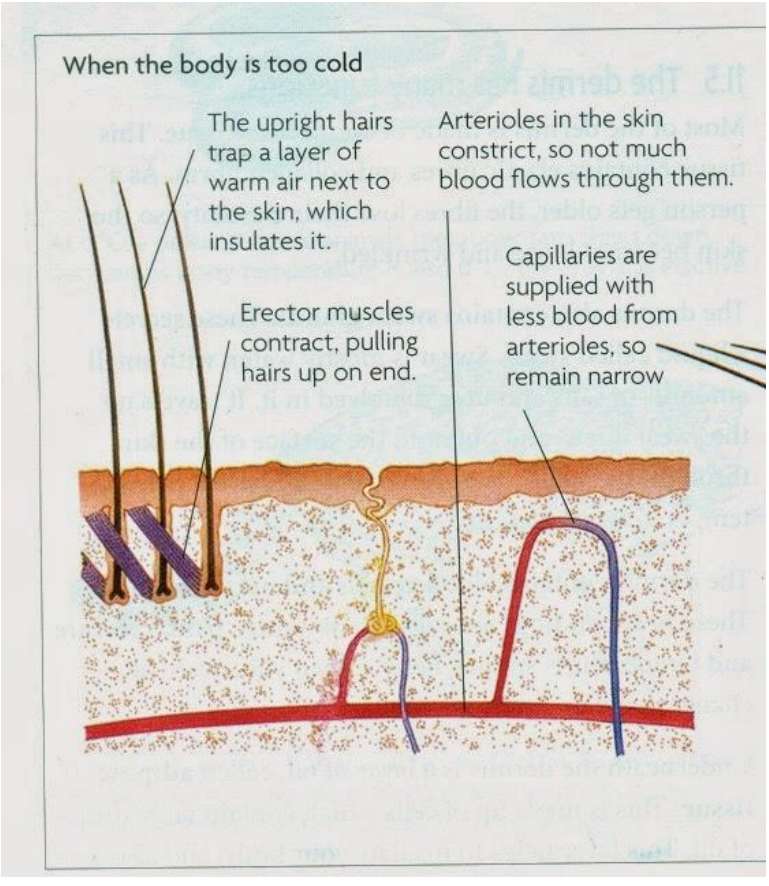
The **hypothalamus** (part of brain) acts like a thermostat. It detects t^o of the blood running through it.

If t^o > or < 37^0C, it sends electrical impulses, along nerves, to parts of the body which function in regulating body t^o.



When you are cold, body produces and saves heat

- *shivering*: muscles contract and relax spontaneously ---> produces heat ---> warms blood
- *vasoconstriction*: arterioles near skin become narrower so little blood can flow through them (the blood flows through the deep-lying capillaries instead)---> conserve heat
- *metabolism may increase* ---> release energy
- *hair stands up.* In human, it just produces 'goose pimples'. But in hair animals (cat), it acts as an *insulator*: trap a thicker layer of warm air next to the skin, prevent skin from loosing more warmth.

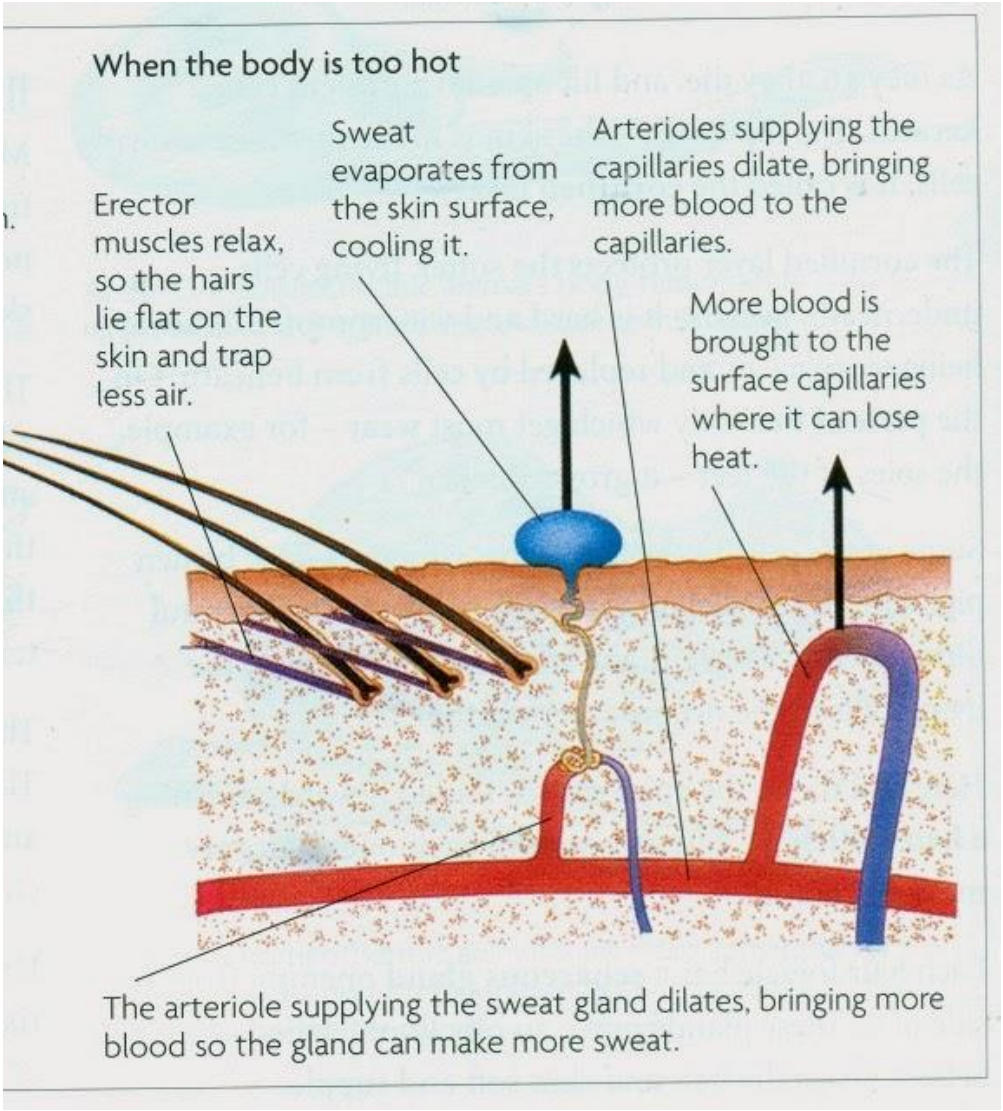


When you are hot, the body loses more heat:

- *sweating*: droplets of sweat evaporate, cooling the body

- *vasodilation*: more blood flows near skin surface ---> lose heat

- *hair lies flat.*



Common misconceptions

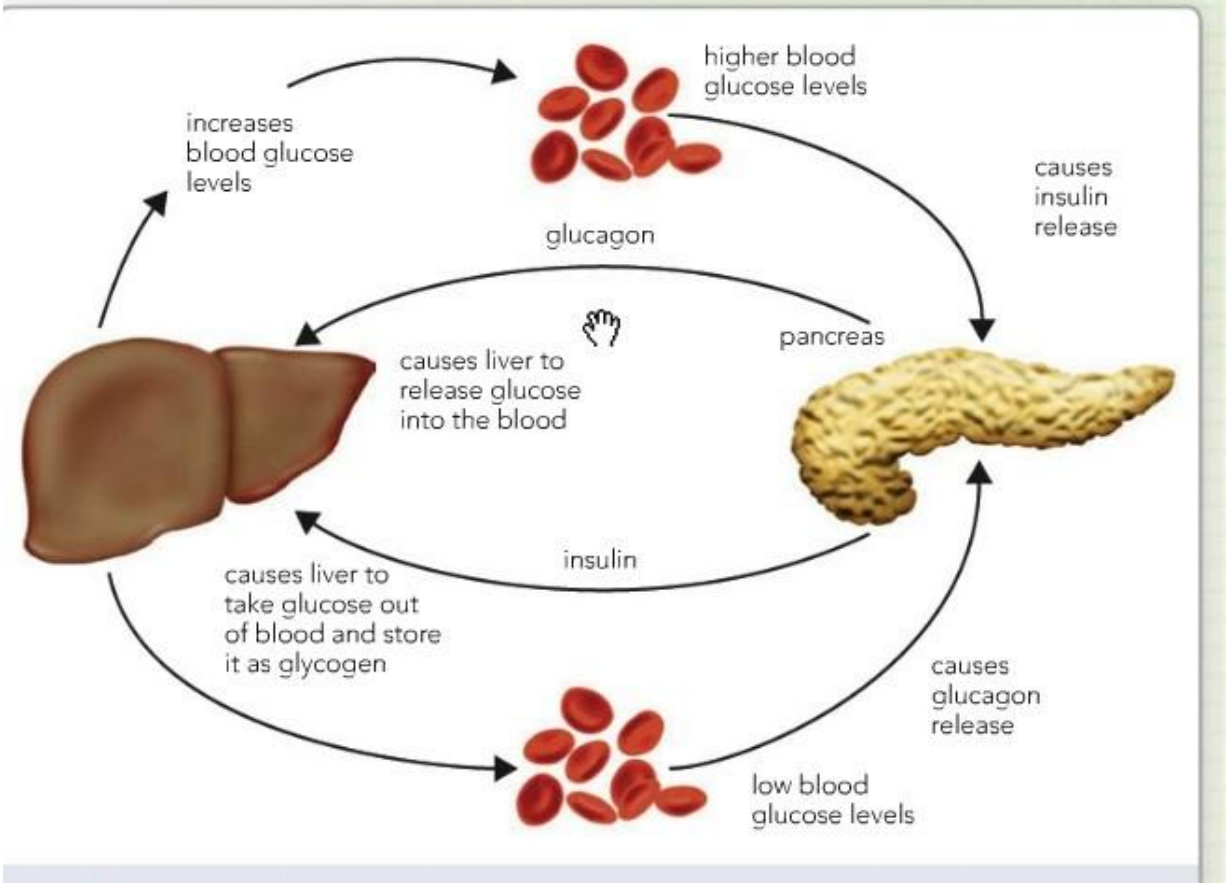
*Remember that the process of vasodilatation and vasoconstriction happen only in arterioles – the do **not** happen in capillaries or veins. When writing about the process, make sure you refer to arterioles.*

#102 Control of blood glucose content

The control of **glucose** concentration in the blood is a very important part of homeostasis.

Two hormones **insulin** and **glucagon)** control blood **glucose** levels.

Both hormones are secreted by the **pancreas** and are transported to the **liver** in the bloodstream.



When blood glucose levels get too high or too low, a person may:

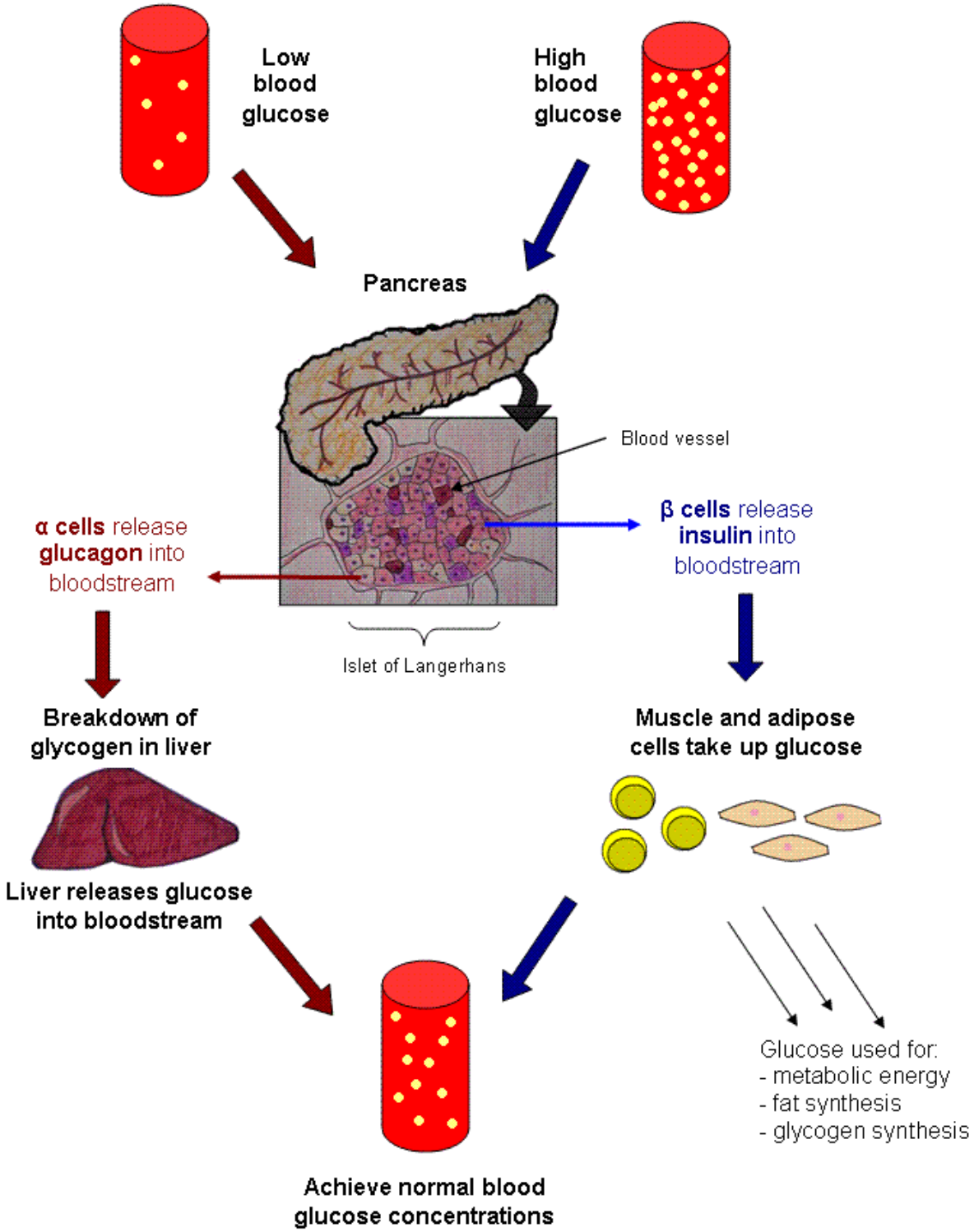
- lose consciousness
- fall into a coma
- die

Too little glucose ---> Cells can not release enough energy they need. Brain cells are especially dependent on glucose for respiration, and die quite quickly if they are deprived of it.

Too much glucose in the blood ---> water moves out of cells and into the blood by osmosis ---> Cell has too little water to carry out normal metabolic process.

The control of blood glucose concentration is carried out by the pancreas and the liver.

Pancreas secretes **insulin** and **glucagon**: 2 hormones that work side-by-side.

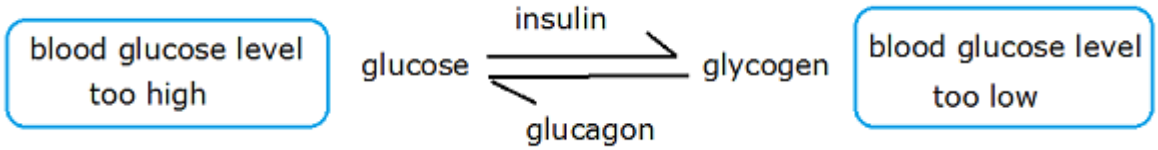


Left-side: When glucose levels drop below normal, glycogen is broken down to glucose, which is released into the bloodstream.

glucagon: glycogen ---> glucose

Right-side: Excess glucose is stored in the liver and muscles as the polysaccharide glycogen (animal starch).

insulin: glucose ---> glycogen
↑ respiration rates ---> cells consume more glucose



Try this

Copy and complete the paragraph using some of the words in the list below.

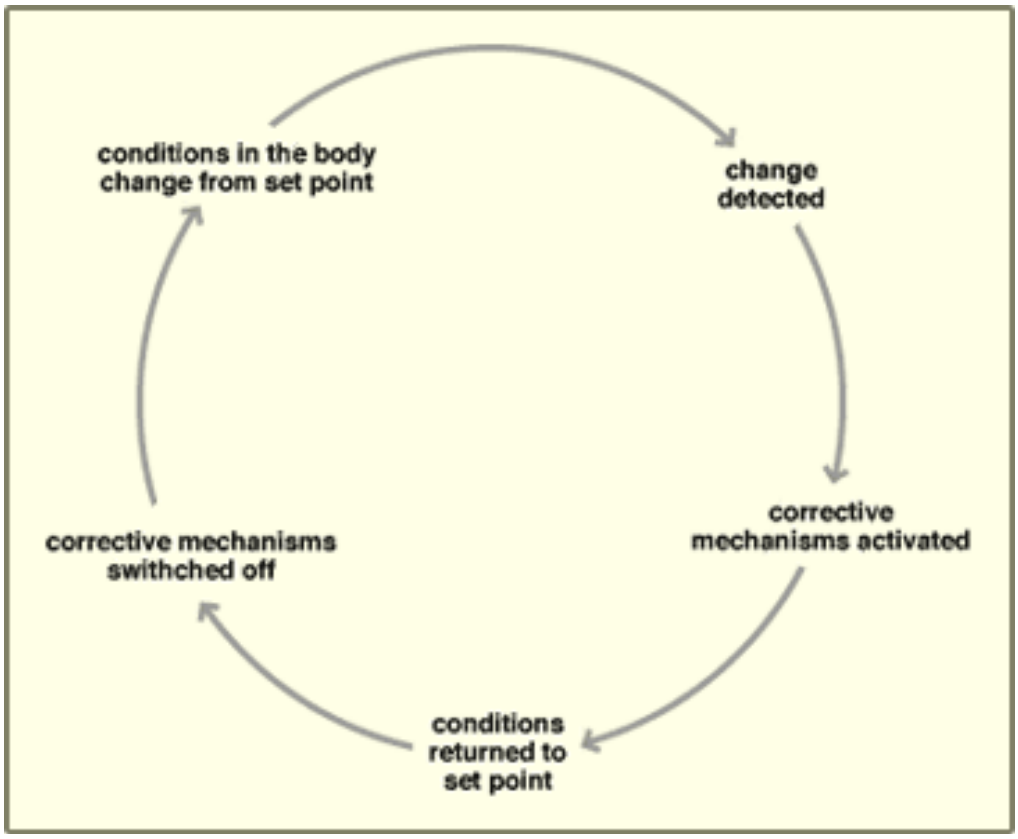
excretion glucose glycogen insulin liver oestrogen pancreas secretion starch stomach sucrose

The bloodstream transports a sugar called _____ . The blood sugar level has to be kept constant in the body. If this level falls below normal, a hormone called glucagon is released into the blood by an endocrine organ called the _____ . The release of a substance from a gland is called _____. Glucagon promotes the breakdown of _____ to increase the blood sugar level. If the blood sugar level gets too high, the endocrine organ secretes another hormone called _____ into the blood. This hormone promotes the removal of sugar from the blood and its conversion to glycogen in the _____ [6 marks].

Answer

glucose , pancreas, secretion, glycogen, insulin, liver.

#103 Negative feed back in homeostasis



Temperature and glucose blood levels regulation involve **negative feedback:**

- a **change** from normal conditions (body temperature, blood glucose levels…)

- triggers a **sensor**,

- stimulates a **response** in an **effector**.

Glucose blood levels regulation

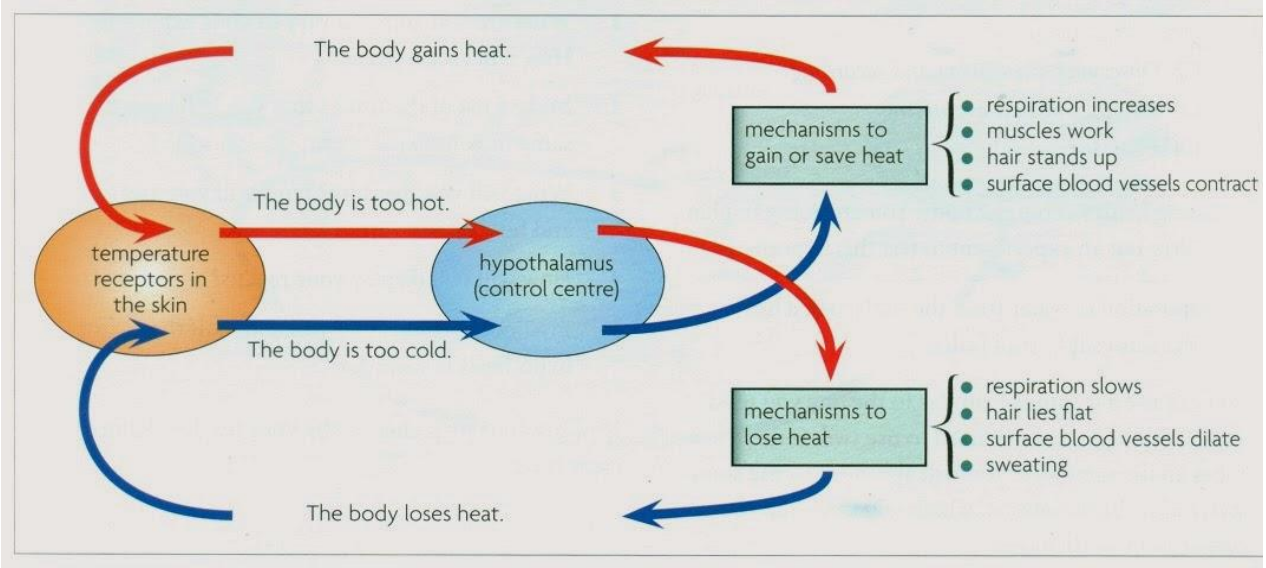
- If **glucose** levels rise, the sensor will instruct an effector (the **pancreas**) to secret **insulin** ---> glucose levels drop below normal.

- If glucose levels drop, the sensor will instruct the pancreas to stop secreting insulin ---> glucose levels rise.

- This is negative **feedback** – the change is fed back to the effector.

Temperature regulation

- All the time, the hypothalamus is monitoring small changes in the temperature of your blood.
- If temperature rise above normal, actions take place that help to **reduce** it.
- If temperature is lower than normal, the hypothalamus stops these actions and start actions that help to **raise** the blood temperature.
- This is **negative** feedback - the information that the blood has cool down **stop** the hypothalamus making your skin to increase heat loss.



Maintaining temperature in steady state.

#104 Drugs: antibiotics, heroin, alcohol

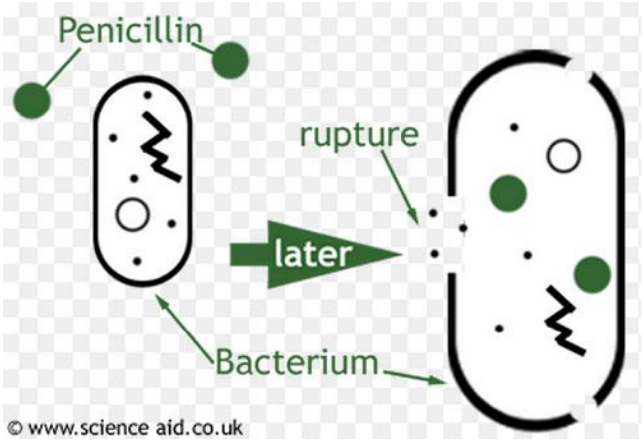
Drug is any substance taken into the body that modifies or affects **chemical reactions** in the body. Drug used in **medical care**, or to relieve mild pain, are very helpful to us. However, some people **misuse drugs**, so that they cause harm to themselves and to others around them.

1. Antibiotics kill bacteria in the body

Antibiotics are substances that **kill bacteria** or prevent their growth, but do not harm other living cells. Most of them are made by **fungi**. It is thought that the fungi make antibiotics to kill bacteria living near them – bacteria and fungi are both decomposers, so they might compete for food.

The first antibiotic to be discovered was **penicillin**. It is made by the fungus *Penicillium.* Penicillin kills bacteria by:

preventing the production of peptidoglycan that form the **cell wall**:
---> the cell continue to grow without dividing or developing new cell wall
--->the wall gets weaker ---> ruptures (lysis).

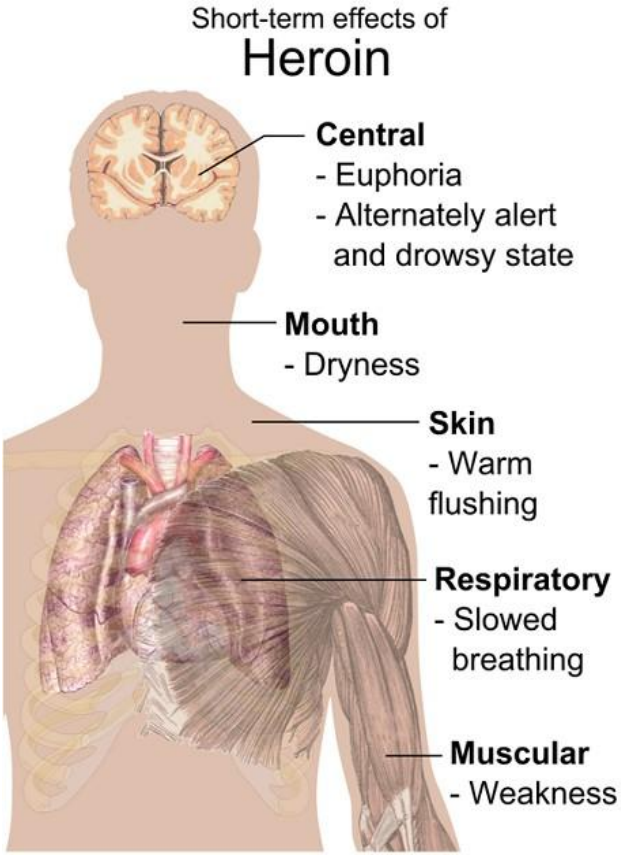


Since the **discovery** of penicillin in 1928, many more antibiotics have been developed and used to treat bacterial infections. Some bacteria have mutated and become resistant to antibiotics, but new drugs are constantly being developed and tested.

Antibiotics do **not** work **against viruses**. Many antibiotics kill bacteria by damaging their cell walls. Viruses do not have **cell walls**, so they are unharmed by antibiotics. It is difficult to develop drugs that kill viruses without damaging the body's tissues.

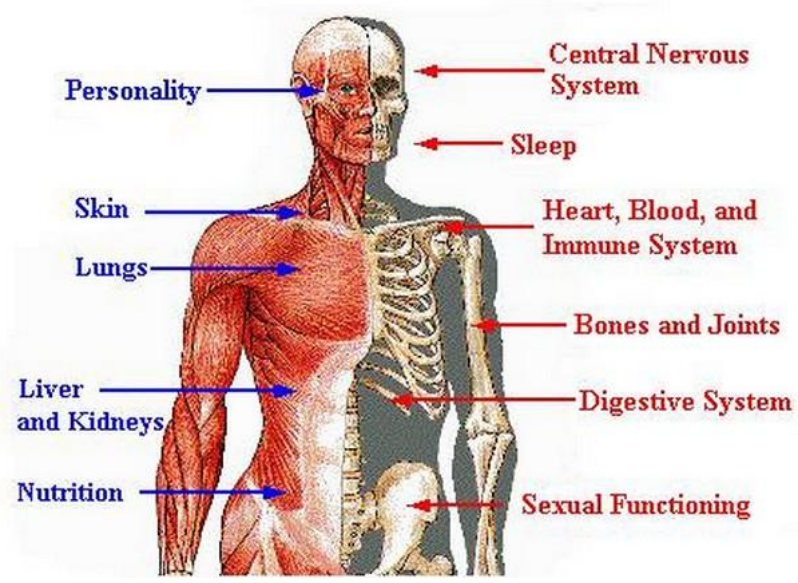
2. Effects of heroin abuse

- **Heroin** is a powerful **depressant**.
- It is a narcotic, producing a dream-like feeling of relaxation and reducing severe pain.
- It is very **addictive**, leading to dependency (addiction).
- **Withdrawal** symptoms can be very unpleasant – involving cramp, sleeplessness, violent vomiting, sweating and hallucinations.
- The body develops a tolerance to the drug, so an addict needs to take increasing amount to achieve the same feeling. This leas t the risk of **overdosing** on the drug.
- When injected using unsterilized and shared needles, there is a risk of infections such as **hepatitis** and **HIV.**
- Addiction creates **financial problems** leading to family breakdown, **criminal activity** and sexual promiscuity.



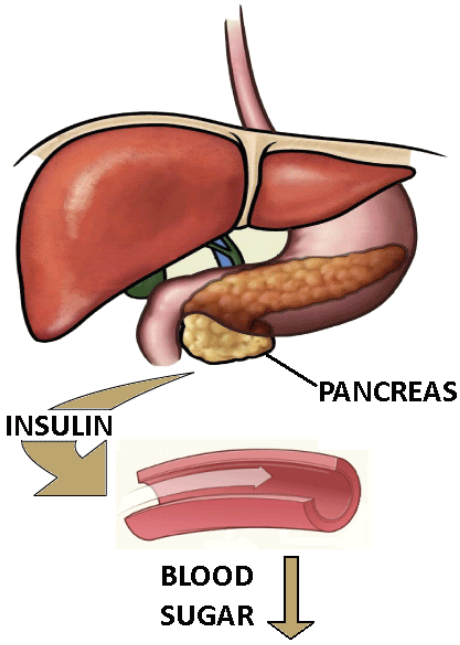
3. Effects of excessive consumption of alcohol

- Small amounts – alcohol can relax the body and create a sense of wellbeing.
- Alcohol is a **depressant**: larger amounts slow down the transmission of electrical impulses in the brain, so reactions are depressed, coordination is impaired and reasoned judgments become difficult. Mood swings involving violence can result.
- Increase **reaction time** makes driving and handling machinery dangerous.
- Poor judgments may leads to criminal activity and sexual promiscuity.
- Long-term excessive drinking can lead to **addiction** (alcoholism).
- This can lead to **financial** difficulties and family problems.
- As the liver removes alcohol from the blood, heavy drinking can leas to **liver damage** such as cirrhosis.
- Drinking can cause **brain damage**, peptic ulcers in the stomach and obesity.
- Drinking during **pregnancy** can damage the fetus, increase the risk of miscarriage or premature birth, and reduce the average birth weight.



Alcoholism Health Issues.

#105 Summary of homeostasis, excretion, drugs



- **Homeostasis** is the maintenance of a constant internal environment. It is achieved using **negative feedback**.

- Organisms that can control their internal body temperature are called **homeotherms**. Mammals and birds are homeotherms. All other animals are **poikilotherms**, meaning that they have only limited ways of controlling their temperature.

- The control of body temperature in humans involves the **hypothalamus**, the **skin** and **muscles**. When the body becomes too hot, **sweating** and **vasodilatation** increase the rate of heat loss from the skin. When the body becomes too cold, **shivering** increases heat production, and **vasoconstriction** reduces the rate of heat loss from the skin.

- The **pancreas**, working in conjunction with the **liver**, controls blood **glucose** concentration. When this rises too high, the pancreas secretes **insulin** which causes the liver to remove glucose from the blood and convert it to **glycogen**. When blood glucose concentration falls to low, the pancreas secretes **glucagon** which causes the liver to convert glycogen to glucose.

- **Excretion** is the removal from the body of waste products of metabolism. The main excretory products of mammals are **CO_2**, **urea, salts** and excess **H_2O**.

- Mammals excrete CO_2 from the **lungs** and urea from their **kidneys**.

- **Urea** is produced in the **liver** from excess amino acids. It is transported in solution in blood plasma to the kidneys, where it is excreted in **urine**.

- **Urine** is made in the **nephrons** of each kidney. First, blood is filtered. Then any substances to be retained in the blood are reabsorbed. The fluid that is left in the nephron flows into the **ureters** and then to the **bladder**, before leaving the body as urine through the **urethra**.

- A **drug** is a substance that effects chemical reactions in the body.Many drugs are used in **medicine**. For example, **antibiotics** are used to kill bacteria that are causing disease in the body.

- **Heroin** is a depressant that is often addictive. Use of heroin often leads to crime and misery for the user's family. People who inject heroin run a high risk of infection with HIV.

- **Alcohol** is also a depressant. Drinking alcohol lengthens reaction time, reduced self-control and may cause aggression, causing serious problems for friends and family. Some people become addicted to alcohol. Over time, the liver is damaged by excessive alcohol intake.