Cambridge OL

Biology

CODE: (5090)

Chapter 13 and chapter 14

Excretion and coordination and control

Chapter 13 – Excretion

Excretory materials include
» The waste products of its chemical reactions
» The excess water and ions taken in with the diet
» Hormones not able to be used again.

Urea and similar waste products from the breakdown of proteins contain the element nitrogen. For this reason, they are often called **nitrogenous waste products.**

The hormones produced by the **endocrine glands** (Chapter 14) affect the rate at which various body systems work. Adrenaline, for example, speeds up the heartbeat. When hormones have done their job, they are changed in the liver and excreted by the kidneys. The nitrogenous waste products, excess ions and spent hormones are excreted by the kidneys as a watery solution called **urine**

Excretory organs

Lungs

The lungs supply the body with oxygen, but they are also excretory organs because they get rid of carbon dioxide. Carbon dioxide is a waste product of aerobic respiration (see Chapter 10). They also lose a lot of water vapour, however, this loss is unavoidable and is not a method of controlling the water content of the body (Table 13.1).

Kidneys

The kidneys remove urea and other nitrogenous waste from the blood. They also take out excess water, ions, hormones (Chapter 14) and drugs.

Liver

The liver breaks down excess amino acids and produces urea.

▼ **Table 13.1** Excretory products

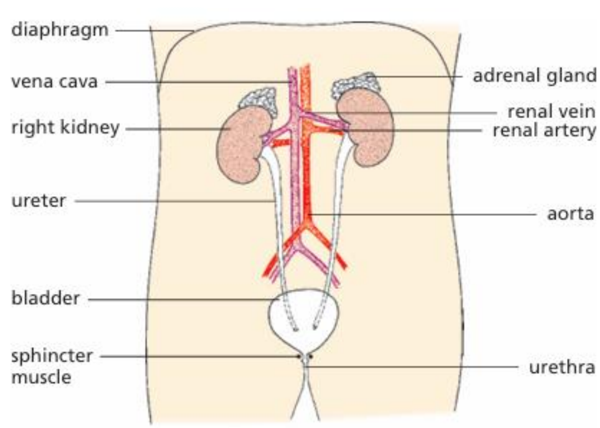
Excretory organ	Excretory products
lungs	carbon dioxide
kidneys	urea and other nitrogenous waste, water, ions, toxins, hormones, drugs

The kidneys

The two kidneys are quite solid, oval structures. They are red-brown, surrounded by a transparent membrane and attached to the back of the abdominal cavity (Figure 13.1).

A tube, called the **ureter**, runs from each kidney to the **bladder** in the lower part of the abdomen

Table 13.2 summarises the functions of parts of the urinary system.



▲ **Figure 13.1** Position of the kidneys in the body

▼ **Table 13.2** Functions of parts of the urinary system

Part	Function
kidneys	the removal of urea and excess water and salt from the blood as urine
ureters	transport urine from the kidneys to the bladder
bladder	stores urine, allowing urination to be controlled
urethra	transports urine from the bladder out of the body

The need for excretion

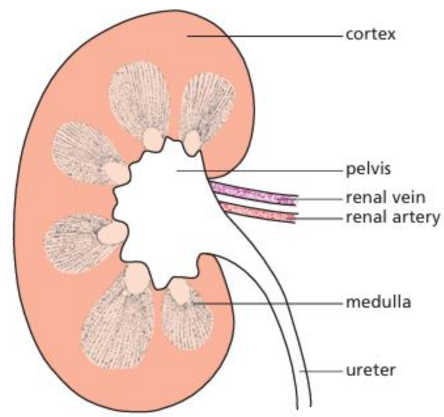
Some of the compounds made in reactions in the body can be toxic (poisonous) if their concentrations build up. For example, ammonia is made in the liver when excess amino acids are broken down. However, ammonia is very alkaline and toxic.

Microscopic structure of the kidneys

The kidney tissue contains many capillaries and tiny tubes, called **renal tubules**. If the kidney is cut down its length, this exposes a dark, outer region called the **cortex** and a lighter, inner zone, the **medulla**. Where the ureter joins the kidney there is a space called the pelvis (Figure 13.4).

Each glomerulus is surrounded by a cup-shaped structure called a **Bowman's capsule**. This leads to a coiled renal tubule. The tubule joins a **collecting duct**, which passes through the medulla to open into the pelvis (Figure 13.6).

There are thousands of glomeruli in the kidney cortex and the total surface area of their capillaries is very large. A **nephron** is a single glomerulus with its Bowman's capsule, renal tubule and blood capillaries (see Figure 13.6).



▲ **Figure 13.4** Section through the kidney to show regions

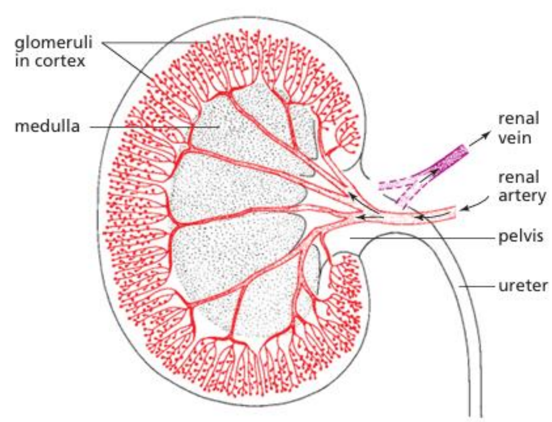
Function of the kidneys

Filtration

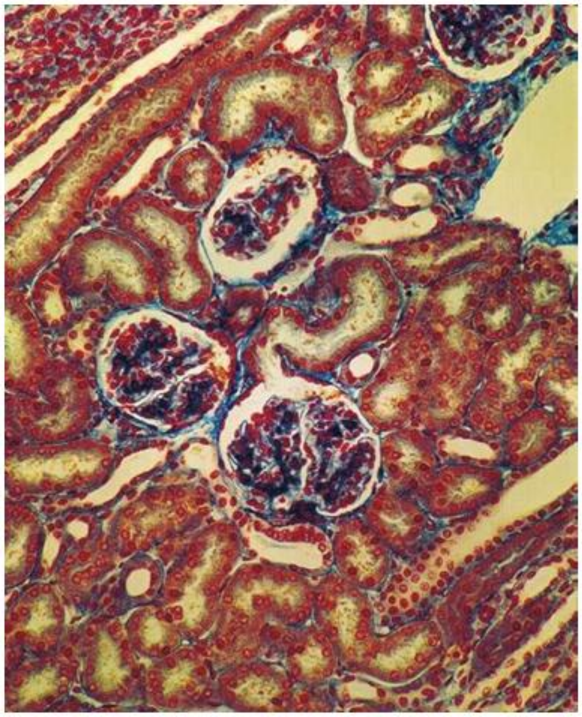
The blood pressure in a glomerulus causes part of the blood plasma to leak through the capillary walls. The red blood cells and the plasma proteins are too big to pass out of the capillary. So, the fluid that does filter through is plasma without the protein.

Reabsorption

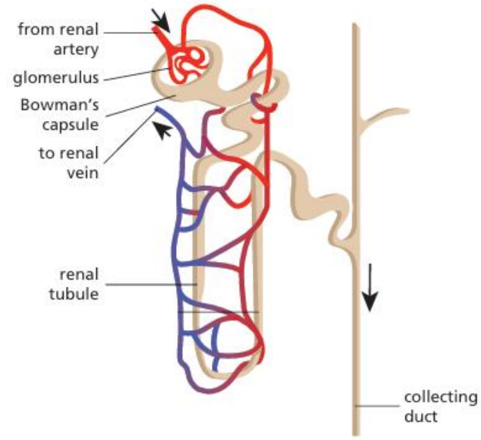
The filtrate from the glomerulus collects in the Bowman's capsule and passes down the renal tubule (Figure 13.8). As it does this, the capillaries that surround the tubule absorb those substances which the body needs back into the blood.



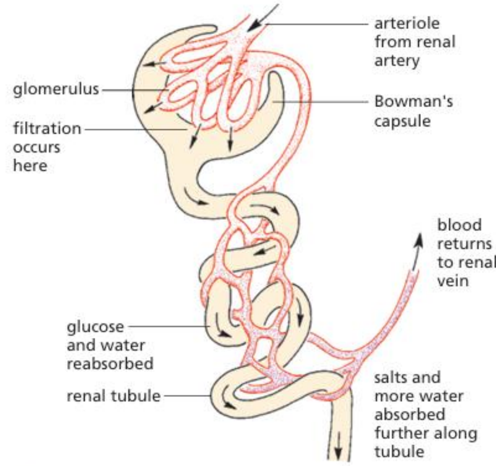
▲ **Figure 13.5** Section through kidney to show distribution of glomeruli



▲ **Figure 13.6** Glomeruli in the kidney cortex (×300). The three glomeruli are surrounded by kidney tubules sectioned at different angles. The light space around each glomerulus is the Bowman's capsule



▲ **Figure 13.7** There are up to 4 million nephrons in a kidney. Only one is shown here, and not to scale



▲ **Figure 13.8** Part of a nephron (glomerulus, Bowman's capsule and renal tubule)

Formation of urine

Urea, water and ions not needed by the body pass down the kidney tubule into the pelvis of the kidney. From here the fluid, now called urine, passes down the ureter to the bladder. Table 13.3 shows some of the differences between the contents of blood plasma and urine.

▼ **Table 13.3** Composition of blood plasma and urine

	Plasma/%	Urine/%
water	90–93	95.0
urea	0.03	2.0
ammonia	0.0001	0.05
sodium	0.3	0.6
potassium	0.02	0.15
chloride	0.37	0.6
phosphate	0.003	0.12

The bladder can expand to hold about 400 cm3 of urine. The urine cannot escape from the bladder because a band of circular muscle, called a **sphincter**, is contracted. This shuts off the exit.

The liver and its role in producing proteins

As well as being an excretory organ, the liver plays a very important role in assimilating amino acids. Assimilation means the absorption of substances, which are then built into other compounds in the organism (see Chapter 8).

The liver and its role in dealing with excess amino acids

Unlike surplus glucose and fats, excess amino acids cannot be stored in the body. They are broken down by the liver, removing the nitrogen-containing part to form ammonia.

Key definitions

Deamination is the removal of the nitrogen-containing part of amino acids to form urea.

Chapter 14 – Coordination and control

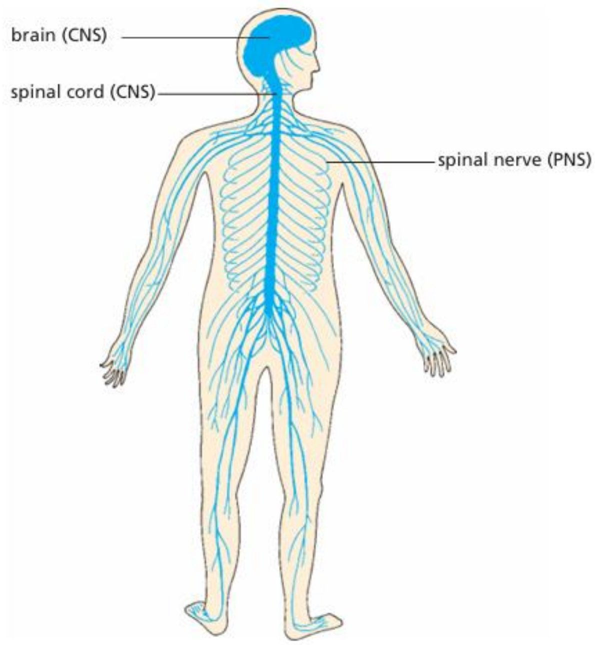
▲ **Figure 14.1** Coordination. The badminton player's brain is receiving sensory impulses from his eyes, ears (sound and balance) and muscle stretch receptors. Using this information, the brain coordinates the muscles of his limbs so that even while running or leaping he can control his stroke

Coordination and response

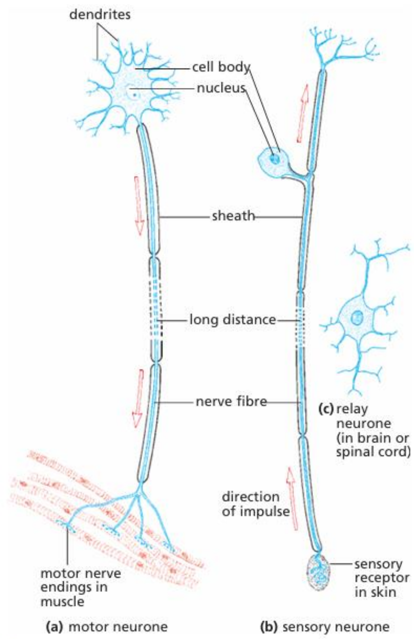
Coordination is the way all the organs and systems of the body are made to work efficiently together (Figure 14.1). If, for example, the leg muscles are being used for running, they will need extra supplies of glucose and oxygen. To meet this demand, the lungs and heart respond.

Nervous control in humans

The human nervous system is shown in Figure 14.2. The brain and spinal cord together form the central nervous system (CNS). Nerves carry electrical impulses from the central nervous system to all parts of the body, making muscles contract or stimulating glands to produce enzymes or hormones. Electrical impulses are electrical signals that pass along nerve cells (**neurones**).



▲ **Figure 14.2** The human nervous system



▲ **Figure 14.3** Nerve cells (neurones)

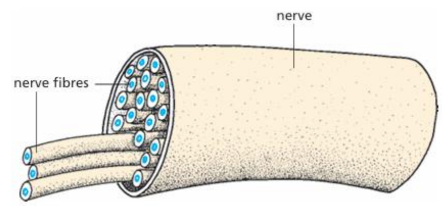
Glands and muscles are called **effectors** because they act when they receive nerve impulses or hormones.

The nerves, outside the brain and spinal cord, that connect the body to the central nervous system make up the **peripheral nervous system (PNS).**

Nerve cells (neurones)

The central nervous system and the peripheral nerves are made up of nerve cells called neurones. Three types of neurone are shown in Figure 14.3. **Motor neurones** (also called effector neurones) carry impulses from the central nervous system to muscles and glands. **Sensory neurones** carry impulses from the sense organs to the central nervous system.

Relay neurones (also called connector or multipolar neurones) are neither sensory nor motor. They make connections to other neurones inside the central nervous system. Junctions where neurones connect with each other are called **synapses**.



▲ **Figure 14.4** Nerve fibres grouped into a nerve

Some of the nerve fibres are very long. The cell bodies of the nerve fibres are found in the spinal cord. Those fibres connected to the foot run inside the nerves continuously to the skin of the toes or the muscles of the foot. A single nerve cell may have a fibre 1 m long.

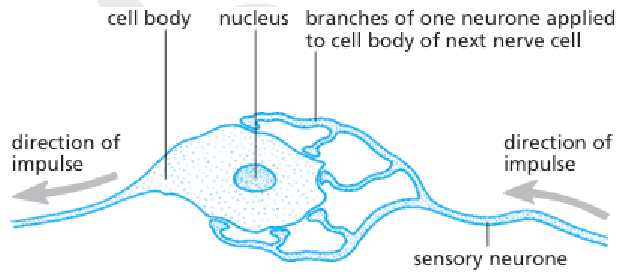
Synapses

> **Key definitions**
> A **synapse** is a junction between two neurones.

Although nerve fibres are insulated, it is necessary for impulses to pass from one neurone to another. An impulse from the fingertips must pass through at least three neurones before reaching the brain, and so producing a conscious sensation.

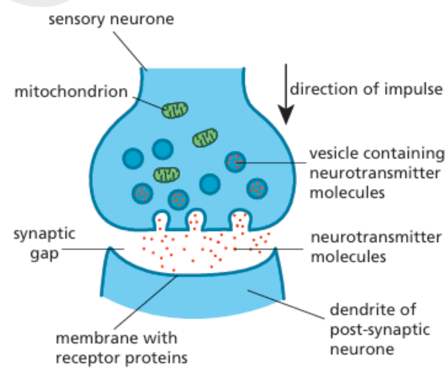
How a synapse transmits an electrical impulse

When an impulse arrives at the synapse, **vesicles** in the cytoplasm are stimulated to release a tiny amount of the **neurotransmitter molecules** (Figure 14.6). The molecules rapidly diffuse across the **synaptic gap** and bind with neurotransmitter **receptor proteins** in the membrane of the neurone on the other side of the synapse.



▲ **Figure 14.5** Synapses between nerve neurones

Sometimes several impulses need to arrive at the synapse before enough transmitter molecules are released to cause an impulse to be fired off in the next neurone.



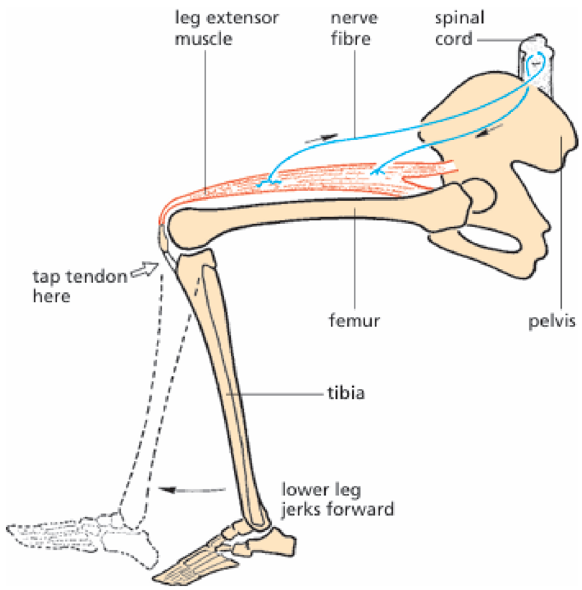
▲ **Figure 14.6** Structure of a synapse

They slow down the speed of nerve impulses slightly because of the time taken for the chemical to diffuse across the synaptic gap

The reflex arc

One of the simplest situations where impulses cross synapses to produce action is in the **reflex arc.**

When a particle of dust touches the **cornea** of the eye, you will blink; you cannot stop yourself blinking. A particle of food touching the lining of the windpipe will set off a coughing reflex that you cannot stop. When a bright light shines in the eye, the **pupil** contracts (see 'Sense organs' later in this chapter).



▲ **Figure 14.7** The knee-jerk reflex

The sequence of events in a simple reflex arc is shown below.

stimulus (tapping the tendon below the kneecap)

↓

receptor (stretch receptor)

↓

sensory neurone

↓

co-ordinator (spinal cord)

↓

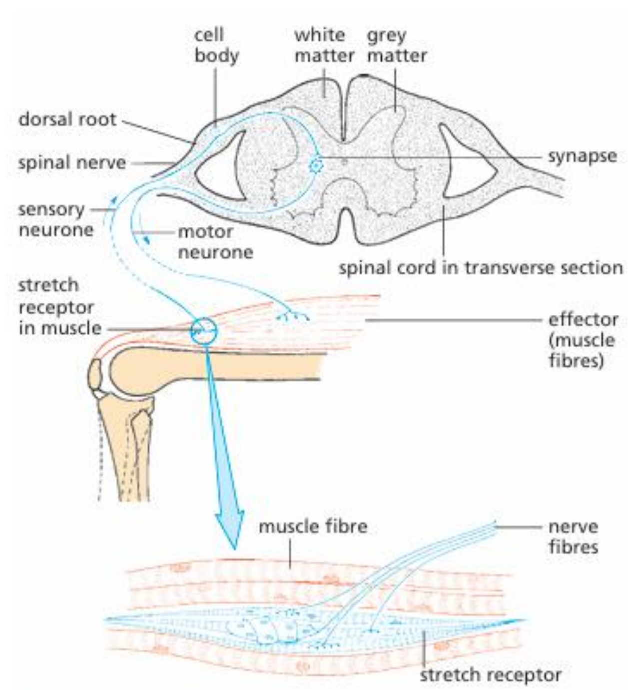
motor neurone

↓

effector (leg extensor muscle)

↓

response (leg extensor muscle contracts, making the leg kick forwards)



▲ **Figure 14.8** The reflex arc. This reflex arc only needs one synapse for making the response. Most reflex actions need many more synapses (1) to adjust other muscles in the body and (2) to send impulses to the brain

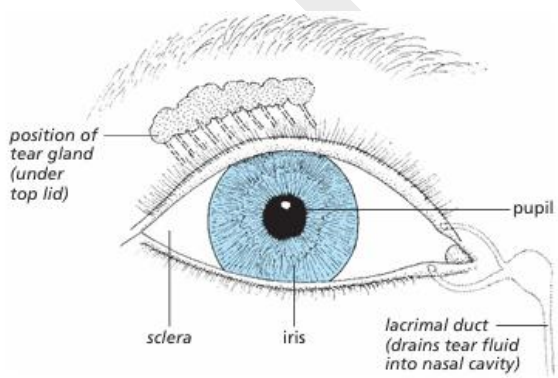
Sense organs

The eye

Note: Details of functions of sclera, conjunctiva, humours, choroid and tear glands are not a syllabus requirement. However, they are included here to put parts seen in a diagram of the eye in context

The **lens** is a transparent structure held in place by a ring of fibres called the **suspensory ligament.**

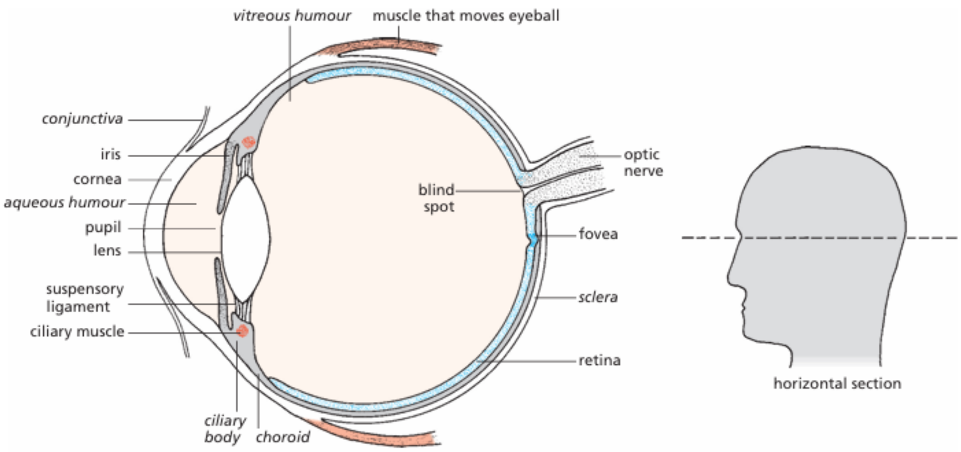
The choroid layer lies between the retina and the sclera, and contains many blood vessels. In the front of the eyeball, it forms the iris and the **ciliary body**. The ciliary body produces aqueous humour and contains **ciliary muscles,** which control the thickness of the lens.



▲ **Figure 14.10** Appearance of right eye from the front

▲ **Figure 14.11** The blind spot. Hold the book about 50 cm away. Close your left eye and concentrate on the cross with your right eye. Slowly bring the book closer to your face. When the image of the dot falls on the blind spot it will seem to disappear

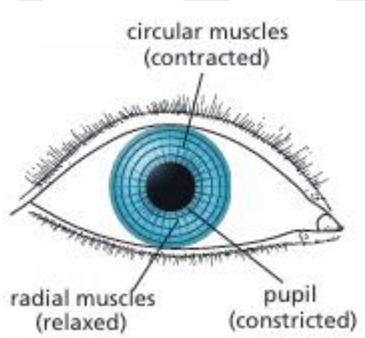
The retina contains light-sensitive cells. Some of these are sensitive to light of various colours and others form images in shades of grey. Cone cells are concentrated in one part of the retina called the **fovea.**



▲ **Figure 14.9** Horizontal section through left eye

The pupil reflex

The change in size of the pupil is caused by exposure of the eye to different light intensities (Figure 14.13). If the light intensity is high, it causes a contraction in a ring of muscle fibres (circular muscle) in the iris. This makes the pupil



▲ **Figure 14.13** The iris reflex

enlarge and allows more light to enter. The circular and radial muscles act **antagonistically.**

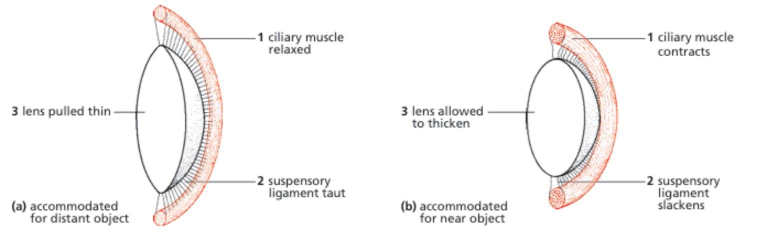
▼ **Table 14.1** Functions of parts of the eye

Part	Function
cornea	a transparent, curved layer at the front of the eye that **refracts** the light entering and helps to focus it
iris	a coloured ring of circular and **radial muscle** that changes the size of the pupil, controlling how much light enters the pupil
lens	a transparent, convex, flexible, jelly-like structure that refracts light to focus it onto the retina
retina	a light-sensitive layer made up of rods, which detect light of low intensity, and cones, which detect different colours
optic nerve	transmits electrical impulses from the retina to the brain
ciliary muscles	the muscles form a circular band around the lens and are involved in controlling the shape of the lens
suspensory ligaments	the suspensory ligaments link the muscles to the lens and are also involved in controlling the shape of the lens
fovea	a central part of the retina where cone cells are most concentrated to detect coloured light

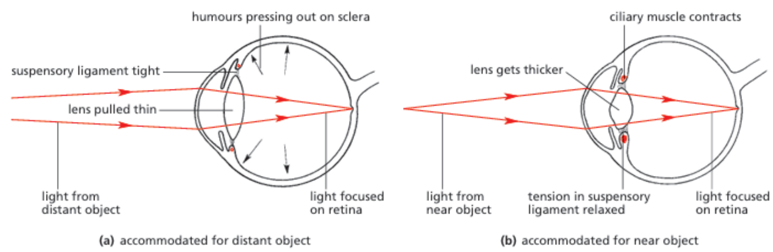
Accommodation (focusing)

The eye can produce a focused image of either a near object or a distant object. To do this the lens changes its shape, becoming thinner for distant objects and fatter for near objects.

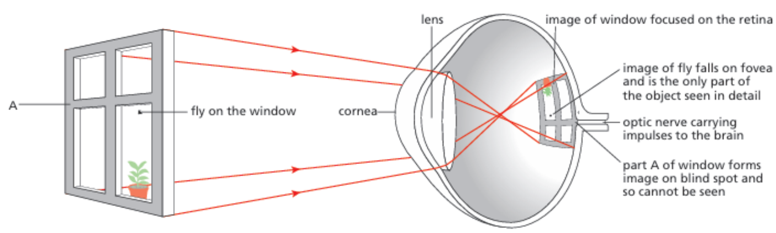
The eye is now **accommodated** (i.e. focused) for distant objects (Figures 14.14(a) and 14.15(a)). To focus a near object, the ciliary muscle contracts to a smaller circle and this takes the tension out of the suspensory ligament (Figures 14.14(b) and 14.15(b)).



▲ **Figure 14.14** How accommodation is brought about



▲ **Figure 14.15** Accommodation



▲ **Figure 14.16** Image formation in the eye

Hormones

> **Key definitions**
> A **hormone** is a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs.

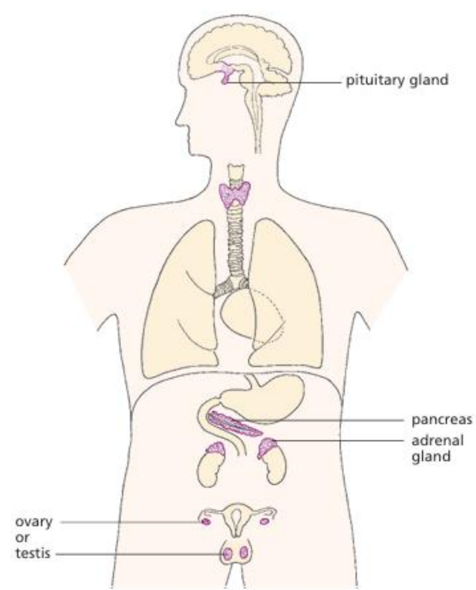
A different kind of coordination is brought about by the **endocrine system**. This system depends on chemicals, called hormones, which are released into the bloodstream from special glands, called **endocrine glands.**

Insulin, for example, may stay in the bloodstream for just 4–8 hours before being broken down. Table 14.2 compares control by the endocrine and nervous systems.

Responses of the body to hormones are much slower than responses to nerve impulses. They firstly depend on the speed of the circulatory system and then on the time it takes for the cells to change their chemical activities. Many hormones affect long-term changes like growth rate, **puberty** and pregnancy.

▼ **Table 14.2** Endocrine and nervous control compared

Endocrine	Nervous
transmission of chemicals	transmission of electrical impulses
transmission through blood	transmission in nerves
slow transmission	rapid transmission
hormones dispersed throughout body	impulse sent directly to target organ
long-term effects	short-term effects



▲ **Figure 14.19** Position of endocrine glands in the body

Adrenal glands

Adrenal glands are attached to the back of the abdominal cavity, one above each kidney (see also Figure 13.1), and produce the hormone adrenaline. Adrenaline has obvious effects on the body, including the liver and the heart:

» In response to a stressful situation, nerve impulses are sent from the brain to the adrenal gland, which releases adrenaline into the blood.

» Its presence causes breathing to become faster and deeper. This may be particularly clear as we pant for breath.

» The heart beats faster, resulting in an increase in pulse rate. This increase in heart rate can be quite worrying, making us feel as if our heart is going to burst out of our chest.

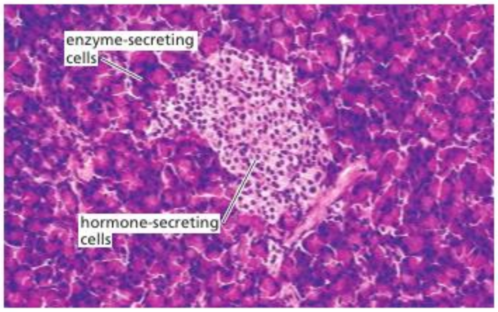
» The pupils of our eyes dilate, making them look much blacker.

» In the liver it stimulates the conversion of glycogen to glucose. The glucose passes into the bloodstream. Its increased concentration increases the heart rate.

» Adrenaline has an important role in the control of metabolic activity. Increased levels of glucose available to cells enable them to respire faster, making more energy available.

The pancreas

The pancreas is a digestive gland that secretes enzymes into the duodenum through the pancreatic duct (Chapter 8). It is also an endocrine (ductless) gland. Most of the pancreas cells produce digestive enzymes, but some of them produce hormones. The hormone-producing cells are arranged in small, isolated groups called islets (Figure 14.20).



▲ **Figure 14.20** Section of pancreas tissue showing an islet (×250)

The pancreas also produces another hormone called **glucagon.**

Pituitary gland

This gland is attached to the base of the brain. It produces many hormones. For example, the pituitary releases into the blood **follicle-stimulating hormone (FSH) which**, when it reaches the **ovaries**, makes one of the follicles start to mature and produce **oestrogen**. **Luteinising hormone (LH),** also known as lutropin, is also produced from the pituitary and, together with FSH, stimulates ovulation

Reproductive organs

The ovaries and testes produce hormones as well as gametes (sperms and **egg cells**), and their effects are described in Chapter 16. One of the hormones from the ovary, oestrogen, prepares the uterus for the implantation of the **embryo** by making its lining thicker and increasing its blood supply. After ovulation, the ovary produces **progesterone**. While progesterone levels remain high, the lining of the uterus is maintained. The hormones **testosterone** (from the **testes**) and oestrogen (from the ovaries) play a part in the development of the **secondary sexual characteristics.**

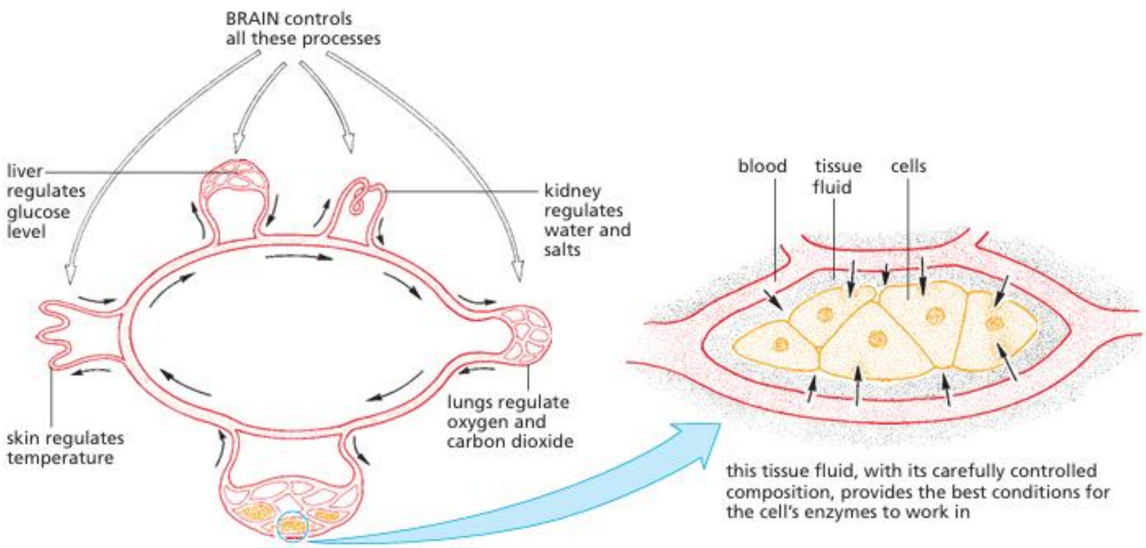
Homeostasis

Key definitions

A **hormone** is a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs.

Homeostasis is the process of maintaining a consistent state of being in a state of constant equilibrium. It involves various systems in the body, such as the endocrine system, which maintains glucose levels in the blood, and the tissue fluid, which keeps the body's composition within narrow limits. Enzymes, which control chemical reactions in living cells, are sensitive to changes in temperature or acidity, and a slight drop in temperature or rise in acidity can slow down or stop an enzyme. The kidneys, liver, and brain cells are examples of homeostatic organs that help maintain homeostasis.

Temperature regulation is another example of homeostasis, as it ensures vital chemical reactions continue at a predictable rate. Warm-blooded animals, such as birds and mammals, have an advantage over variable-temperature animals, as they can control their body temperature to some extent. However, if their body temperature falls, their vital chemistry slows down, making them more vulnerable to predators. Warm-blooded animals must consume enough food to maintain their body temperature, usually above their surroundings.



▲ **Figure 14.22** The homeostatic mechanisms of the body

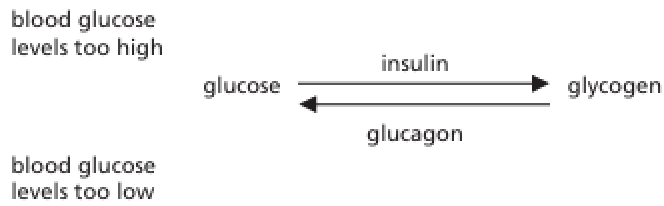
Homeostasis and negative feedback

Homeostasis works through a system of control called negative feedback (Figure 14.23). The outgoing impulses counteract the effects produced by the incoming impulses.

In the same way, a fall in body temperature will be detected and will trigger impulses that produce **vasoconstriction** and shivering.

Controlling the levels of blood glucose

The pancreas releases hormones glucagon and insulin to regulate blood sugar levels. Glucagon restores blood sugar levels by converting glycogen into glucose, while insulin stimulates liver cells to absorb glucose and store it as glycogen. Insulin also increases glucose uptake in cells for respiration, converts carbohydrates to fats, and slows protein to carbohydrate conversion, promoting homeostasis.



The blood glucose concentration after 8 hours of not eating typically ranges between 90 and 100 mg. After a carbohydrate meal, it may rise to 140 mg, but returns to 95 mg. The liver converts excess glucose to glycogen, which is stored in the liver. Blood glucose levels below 80 mg can cause brain cell damage, convulsions, and coma. Hyperglycemia, a condition causing damage to vital organs, increases the risk of heart disease, stroke, kidney disease, and nerve problems.

If anything goes wrong with the production or function of insulin, the person will show the symptoms of **diabetes**.

Type 1 diabetes

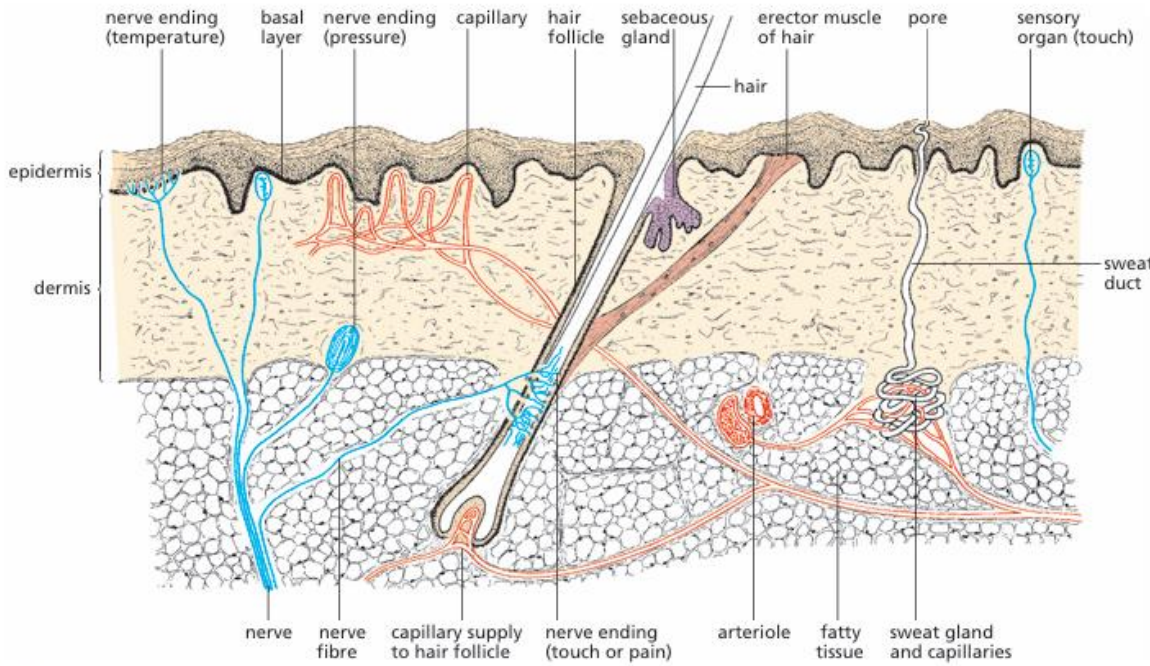
Type 1 diabetes occurs when pancreatic islet cells don't produce enough insulin, causing low blood glucose levels. This form, also known as insulin-dependent diabetes, requires regular insulin injections to control blood sugar levels. Symptoms include increased blood glucose concentration, frequent urination, and weight loss. Diabetics with Type 1 diabetes need a controlled diet, regular exercise, blood tests, and insulin injections to maintain healthy blood sugar levels.

Skin structure

Hair erector muscles are attached to each of the hairs. When they contract, the hairs become erect. The thickness of the epidermis and the quantity of hairs vary in different parts of the body (Figure 14.25). The dermis contains connective tissue with hair follicles, sebaceous glands, **sweat glands,** blood vessels and nerve endings. There is usually a layer of fatty tissue (a fat deposit) beneath the dermis.

The skin and temperature control

Heat is lost from the body surface by conduction, convection, radiation and evaporation. The **insulating** properties of fatty tissue in the dermis help to reduce the amount of heat lost. Some mammals living in extreme conditions, like whales and seals, make much greater use of this: they have thick layers of blubber to reduce heat loss more effectively.



▲ **Figure 14.24** Generalised section through the skin

The two processes of heat gain and heat loss normally balance each other, but any imbalance is corrected by a number of methods, including those described below.

▲ **Figure 14.26** Sweating. During vigorous activity the sweat evaporates from the skin and helps to cool the body. When the activity stops, continued evaporation of sweat may overcool the body unless it is removed with a towel

Overheating

» More blood flows near the surface of the skin, allowing more heat to be exchanged with the surroundings.

» Sweating – the sweat glands secrete sweat on to the skin surface. When this layer of liquid evaporates, it takes heat from the body and cools it down (Figure 14.26)

Overcooling

» Less blood flows near the surface of the skin, reducing the amount of heat lost to the surroundings.

» Sweat production stops, so the heat lost by evaporation is reduced.

» Shivering – uncontrollable bursts of rapid muscular contraction in the limbs release heat as a result of respiration in the muscles.

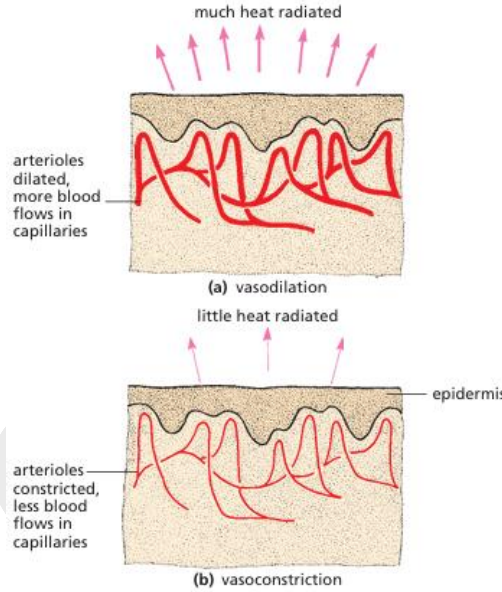
» Hair erector muscles contract, pulling the hairs so that they stand upright. In doing so, they trap air against the surface of the skin, which helps to insulate it against further heat loss.

Vasodilation and vasoconstriction

Vasodilation – the widening of the arterioles in the dermis allows more warm blood to flow through blood capillaries near the skin surface, resulting in heat loss (Figure 14.27(a)).

Vasoconstriction – narrowing (constriction) of the arterioles in the skin reduces the amount of warm blood flowing through blood capillaries near the surface (Figure 14.27(b)).

Sensory nerve endings in the skin respond to heat loss or gain, while the brain detects changes in core temperature through blood temperature monitoring. The **hypothalamus** contains a thermoregulatory center, coordinating responses to temperature changes.



▲ **Figure 14.27** Vasodilation and vasoconstriction

Revision questions

1. The lungs and the kidneys are excretory organs of the human body.
(a) (i) Define the term excretion.
(ii) State an excretory product that is passed out through the lungs.
(iii) Outline the role of the liver in excretion

(b) Fig. 4.1 is a vertical section of the kidney

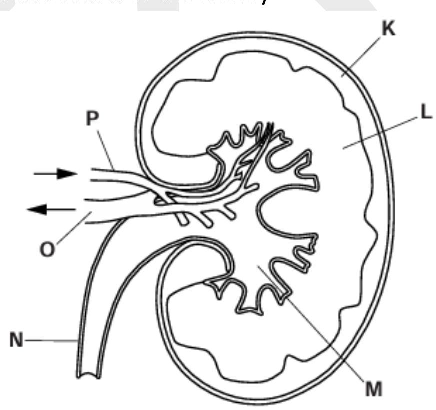


Fig. 4.1

Table 4.1 shows the functions of parts of the kidney.

Complete the table by:

- naming the part of the kidney that carries out each function
- using letters from Fig. 4.1 to identify the part of the kidney named.

One row has been completed for you.

Table 4.1

function	name of part	letter from Fig. 4.1
blood is filtered		
concentration of urine is determined	medulla	**L**
urine flows to the bladder		
blood is carried into the kidney		
blood flows out of the kidney		

(c) People with kidney disease are often treated in renal dialysis clinics. Their blood passes through tubes lined with a special membrane for about three hours.

(i) State two waste substances that are removed from the blood by dialysis.

(ii) Kidney patients may be given a kidney transplant. State one advantage and one disadvantage of kidney transplants compared with dialysis.

2. Fig. 5.1 shows a cross-section of a kidney.
(a) Name the structures labelled, E, F and G as shown in Fig. 5.1.

(b) Explain the function of the renal capsule in the kidney.

(c) Glucose is reabsorbed, back into the blood, by active transport. Define active transport.

(d) Give one example, other than glucose, of a substance that is reabsorbed into the blood from the renal tubule.

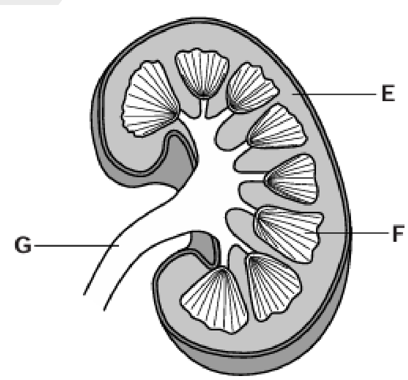


Fig. 5.1

(e) Dialysis is a treatment for kidney disease. Fig. 5.2 shows a dialysis machine.

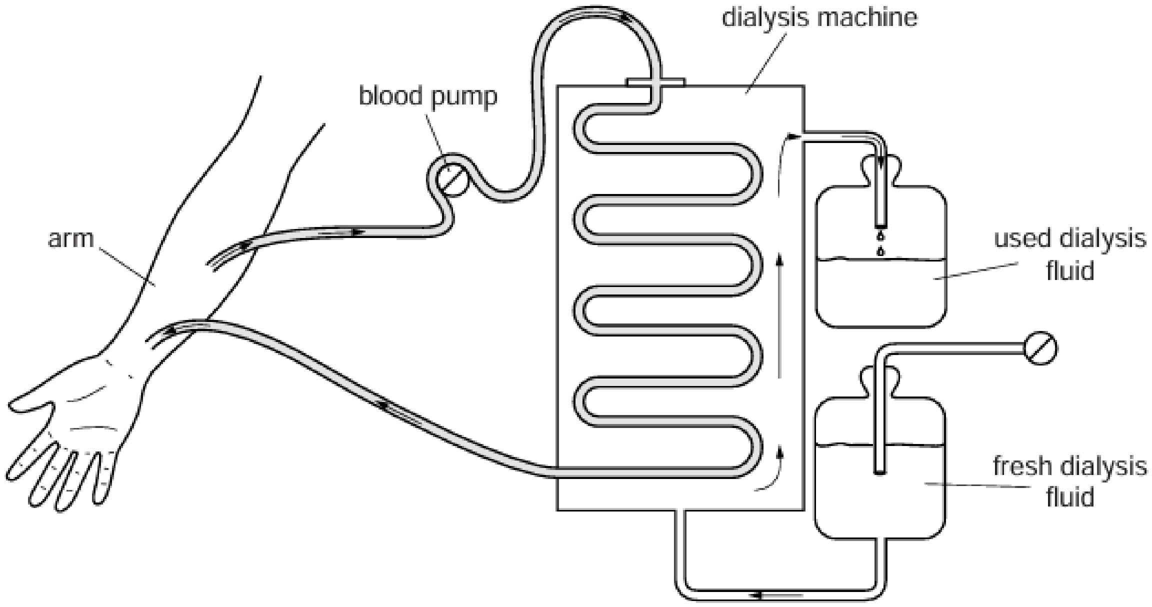


Fig. 5.2

(i) The composition of the dialysis fluid changes as it passes through the dialysis machine. Complete Table 5.1 using the words ‘low’, ‘high’, ‘same’ or ‘none’ to show how the concentration of each substance changes in the dialysis fluid. The last one has been done for you

Table 5.1

	concentration of substance in:		
substance	blood before dialysis	**used** dialysis fluid	**fresh** dialysis fluid
glucose	normal		
salts	high		
urea	high		
toxins	high	high	low

(ii) Explain how a dialysis machine filters blood.

(f) Kidney transplants are the most common organ transplants. Describe the advantages of a kidney transplant compared with dialysis.

(g) Before a kidney is transplanted, it is important to match the tissue type of the donor with the tissue type of the recipient.

3. a) Define the term excretion.

Fig. 2.1 is a diagram of a kidney tubule and its blood supply.

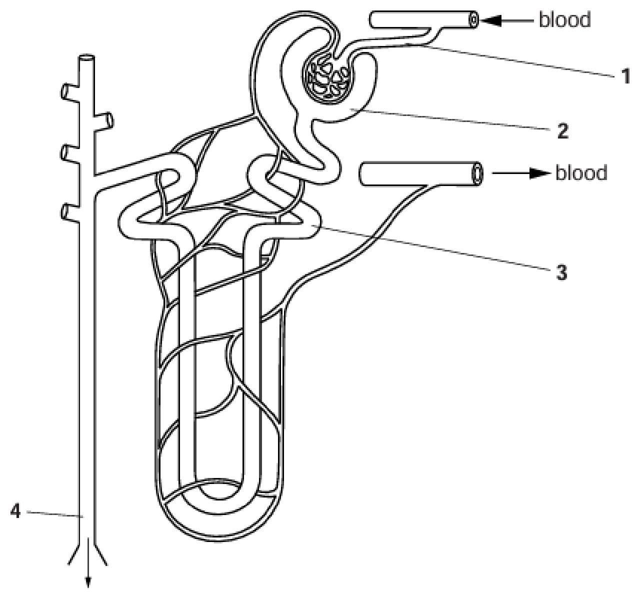


Fig. 2.1

(b) The concentrations of solutes in the fluids at regions **1**, **2**, **3** and **4** were determined. The results are shown in Table 2.1.

Table 2.1

substance	concentration / g dm^{-3}			
	region **1**	region **2**	region **3**	region **4**
glucose	0.9	0.9	0.2	0.0
protein	82.0	0.0	0.0	0.0
salts	8.0	8.0	9.6	16.5
urea	0.2	0.2	0.2	20.0

State the substance or substances in Table 2.1 which:

State the substance or substances in Table 2.1 which:

(i) has molecules which are too large to be filtered;

ii) has molecules which are small enough to be filtered but is completely reabsorbed from the fluid in the kidney tubule;

(iii) increases in concentration as fluid moves along the kidney tubule.

(c) State three structures through which the fluid from region 4 passes as it leaves the body

(d) One role of the kidney is to maintain the concentration of the blood plasma. Name the process of maintaining constant conditions within the body.

4. Fig. 3.1 shows a vertical section of a kidney.

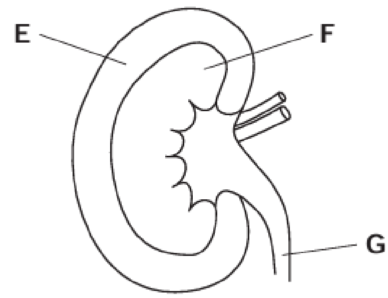


Fig. 3.1

a) Name the parts E, F and G.

(b) Substances move into and out of cells in kidney tubules. Fig. 3.2 shows four processes, H, J, K and L, that occur in cells lining the kidney tubule. The net movement of substance is shown by an arrow, in each case.

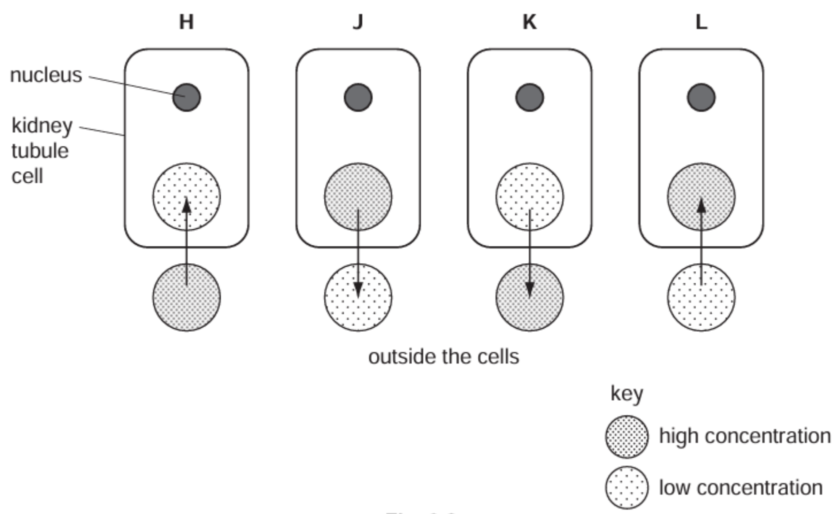


Fig. 3.2

i. Complete Table 3.1 by stating the letter, H, J, K or L, which identifies each of the processes. Give a reason for each answer.

Table 3.1

process		reason
diffusion of oxygen		
active uptake of sodium ions		

(ii) Glucose is filtered from the blood. Usually all of it is reabsorbed by the kidney tubules so that there is none present in the urine. Name the part of the kidney where filtration occurs.

(iii) Use Fig. 3.2 to describe how kidney tubules reabsorb glucose from the filtrate.

(c) When plants are grown in a solution that includes a poison that prevents respiration, the roots continue to absorb water, but do not absorb many ions.

4. A healthy kidney controls the excretion of urea and other waste products of metabolism from the blood. After kidney failure there are two possible treatments: dialysis or a kidney transplant. Fig. 4.1 shows how blood and dialysis fluid move through a dialysis machine.

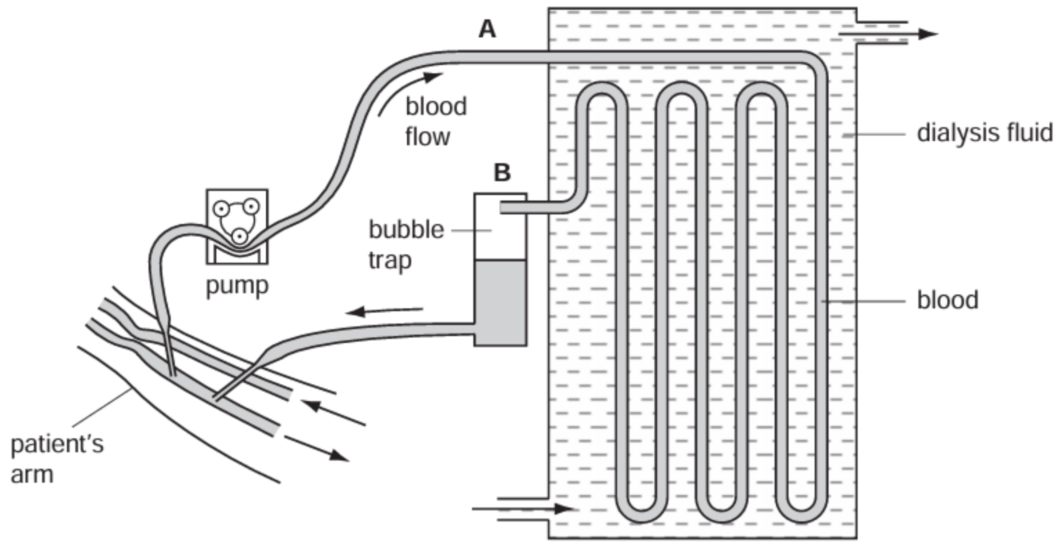


Fig. 4.1

(a) Describe the changes that occur to the blood as it flows through the dialysis machine from A to B.

(b) Discuss the advantages of kidney transplants compared with dialysis

(c) Two brothers have to make a difficult decision. One brother, with blood group AB, has kidney failure and is on dialysis. The healthy brother has agreed to donate one of his kidneys to his brother. He has to have a blood test.

Their father has blood group A and their mother has blood group B. The brothers have a sister who has blood group O

(i) Explain how this girl has blood group O when her parents have different blood groups. You **must** use the space below for a genetic diagram to help your answer.

Use the symbols I^A, I^B and I^O to represent the alleles involved in the inheritance of blood groups.

parental phenotypes	blood group A	×	blood group B
parental genotypes	....	×	....
gametes	....	+	....
girl's genotype		....	
girl's phenotype		....	

ii) The healthy brother can only donate the kidney to his brother if they both have the same blood group. What is the probability that the healthy brother also has blood group AB?

5. a) Define the term excretion.

Fig. 2.1 shows a dialysis machine for treating people who have kidney failure. The dialysate (dialysis fluid) is a solution of glucose and salts.

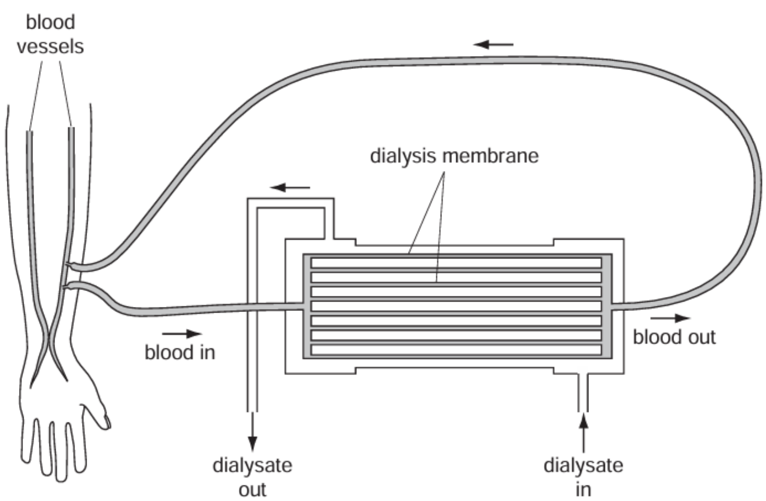


Fig. 2.1

(b) Explain how, when the patient is receiving dialysis treatment

(i) the loss of plasma proteins and red blood cells is prevented

(ii) the normal glucose concentration of the blood is maintained.

(c) A person with kidney failure received regular dialysis treatment for 17 days. Fig. 2.2 shows how the concentration of urea in the blood changed over the 17 days.

(i) State how many times the person received dialysis treatment.

ii) Calculate the decrease in the concentration of urea in the blood from the beginning of dialysis until the end of the treatment.

iii) Describe the changes that occur in the urea concentration in the blood over the period shown in Fig. 2.2. You will gain credit for using the data in Fig. 2.2 in your answer.

(iv) Explain the changes in urea concentration in the blood as shown in Fig. 2.2.

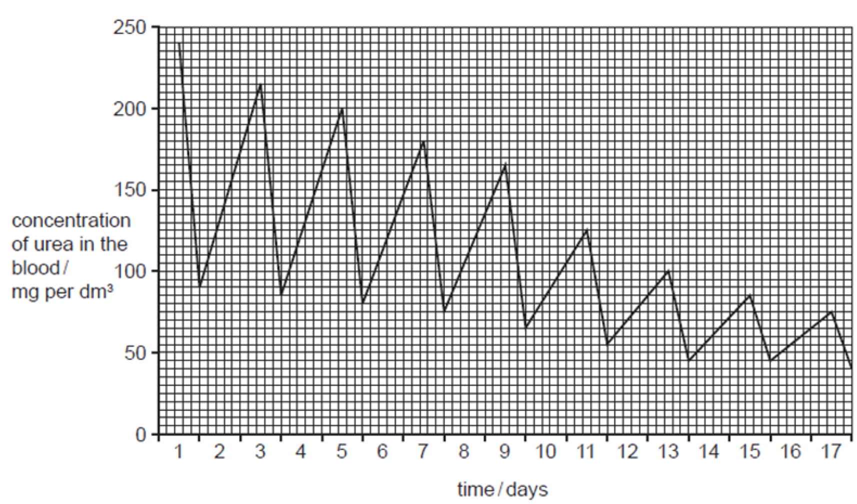


Fig. 2.2

6. The nervous system coordinates the responses of animals to changes in their environment. (a) Fig. 2.1 shows the arrangement of the nervous system in a mammal. CompleteFig. 2.1 by writing the names of the missing parts of the mammalian nervous system in the boxes.

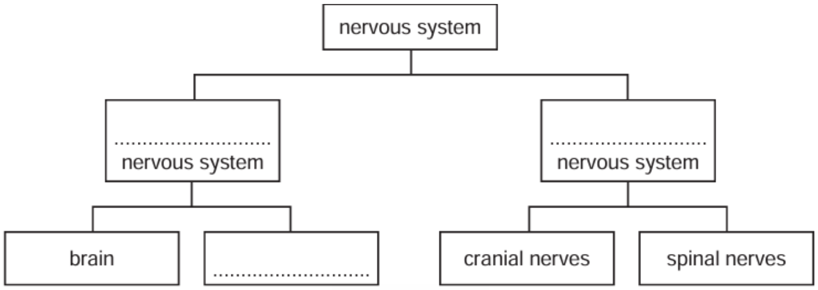


Fig. 2.1

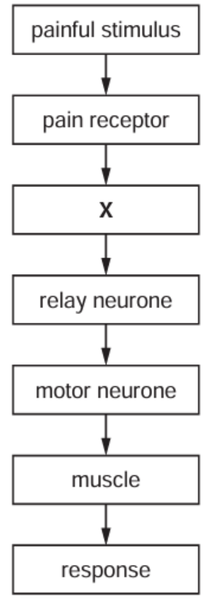


Fig. 2.2

(b) Fig. 2.2 is a flow chart that shows how an involuntary action is controlled

(i) State the structure found at X.

(ii) State the type of involuntary action shown by the flow chart.

(iii) State two ways in which a voluntary action differs from an involuntary action.

(c) Fig. 2.3 shows three pots of seedlings that have been kept in different conditions.

pot **P** pot **Q** pot **R**

Fig. 2.3

(i) State the conditions in which pots P and Q were kept.

(ii) State the name of the growth response shown by the seedlings in pot R.

(iii) Explain the advantage to the seedlings of this growth response.

(iv) Auxins control the growth responses of seedlings.

Explain how auxins control the growth response of the seedlings in pot R.

7). 2 Fig. 3.1 is a diagram of human skin in cold weather.

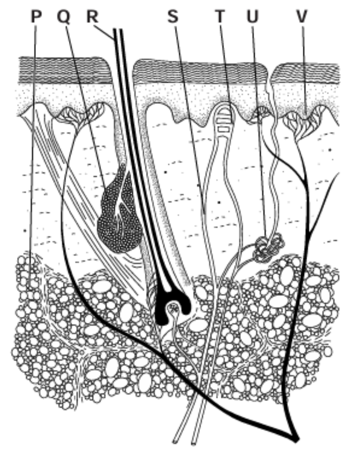


Fig. 3.1

(a) Table 3.1 shows the responses of the skin to cold weather. Complete the table by:

• naming the parts of the skin that respond to cold weather

• using the letters (P to V) from Fig. 3.1 to identify these parts of the skin.

Table 3.1

responses of skin to cold weather	name of part	letter from Fig. 3.1
stands upright to trap air		
constricts to reduce blood flow to skin		
stops producing sweat		

(b) The response of the skin to cold weather is an involuntary action. Explain how an involuntary action differs from a voluntary action

(c) Describe how the nervous system coordinates the response of the skin to cold weather

(d) Explain how negative feedback is involved in the control of body temperature.

8. Fig. 2.1 shows a diagram of the liver and the blood vessels that enter and exit from it

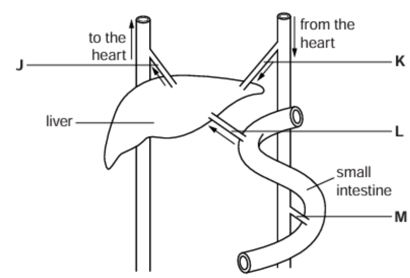


Fig. 2.1

(a) Name blood vessel L

(b) Blood vessel J is a vein. State two structural features of veins and explain how each feature is related to its function of returning blood to the heart

(c) Blood samples were taken from each of the blood vessels J, K, L and M two hours after a meal of rice. Table 2.1 shows the concentration of glucose in these blood samples.

Table 2.1

blood vessel	blood glucose concentration / mg per 100 cm^3
J	135
K	128
L	181
M	133

Calculate the percentage increase in blood glucose concentration between blood vessel J compared with L. Express your answer to the nearest whole number. Show your working

(d) Control of blood glucose by the liver is an example of homeostasis.

(i) Explain how the liver lowers blood glucose concentration when it is too high.

(ii) Name one other factor in the human body that is also controlled by homeostasis.

(e) Amino acids are processed by the liver. Describe this process.

9. Fig. 3.1 is a diagram that shows the control of blood glucose concentration.

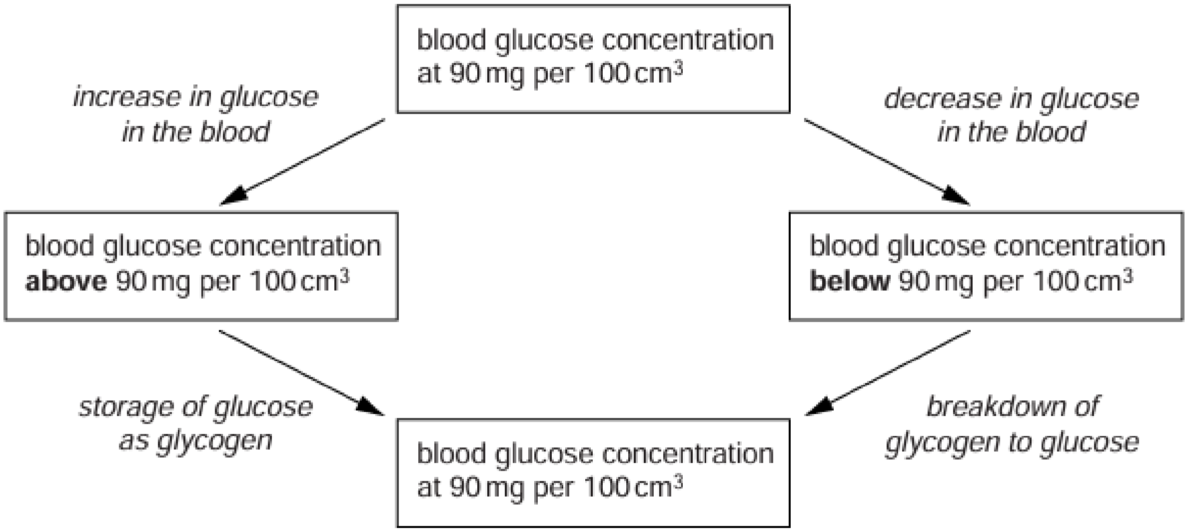


Fig. 3.1

(a) (i) State one reason why the concentration of glucose in the blood increases.

(ii) State one reason why the concentration of glucose in the blood decreases.

(iii) Name two places in the body where glycogen is stored.

(b) Explain how an increase in glucose concentration is controlled in the body

(c) If the blood glucose concentration is very high there is a decrease in the water potential of the blood. This may damage the red blood cells. Explain how a decrease in water potential of the blood may damage red blood cells