

Organisation

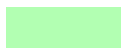
Specification 8461 · AQA

Free edition

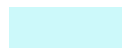
Revision notes for one topic, free to download.

These are the summary notes only. The full edition of this booklet also carries the worked examples, the required practicals and the formula sheets, with every topic in one place.

Colour Codes



Definitions



Diagrams



Notes and warnings



Sub-topic headings

This booklet is a study aid written from the published specification.
It is not affiliated with, endorsed by or approved by AQA.

Free to download and share for personal study.
Please do not sell or republish it as your own.
For enquiries, please email pcfgyrdi@gmail.com

Define Tissue

- a group of cells with a similar structure and function.

Define Organ system

- a group of organs which work together to form organisms.

Define Active site

- the part of an enzyme molecule where the substrate binds; its shape is complementary to the substrate.

Define Amylase

- a carbohydrase that breaks down starch to simple sugars.

Define Lipase

- an enzyme that breaks down lipids (fats) to glycerol and fatty acids.

Define Emulsify

- to break fat into small droplets, increasing the surface area for lipase to act on.

Define Pacemaker

- a group of cells in the right atrium that controls the natural resting heart rate.

Define Health

- the state of physical and mental well-being.

Define Benign tumour

- a growth of abnormal cells contained in one area, usually within a membrane, that does not invade other parts of the body.

Define Organ

- an aggregation of tissues performing specific functions.

Define Enzyme

- a biological catalyst; a protein molecule that speeds up a specific reaction because of the shape of its **active site**.

Define Denatured

- when the shape of an enzyme's active site is changed so the substrate no longer fits and the enzyme stops working.

Define Protease

- an enzyme that breaks down proteins to amino acids.

Define Bile

- an alkaline liquid made in the liver and stored in the gall bladder that neutralises stomach acid and emulsifies fat.

Define Double circulatory system

- a system in which blood passes through the heart twice for each complete circuit of the body.

Define Coronary heart disease

- a non-communicable disease in which fatty material builds up inside the coronary arteries, narrowing them.

Define Risk factor

- an aspect of a person's lifestyle, or a substance in their body or environment, linked to an increased rate of a disease.

Define Malignant tumour

- a cancer whose cells invade neighbouring tissues and spread in the blood to form secondary tumours.

Define Transpiration

- the loss of water vapour from the leaves, which pulls water up the xylem in the transpiration stream.

Define Translocation

- the movement of dissolved sugars through phloem tissue from the leaves to the rest of the plant.

2.1 Principles of organisation

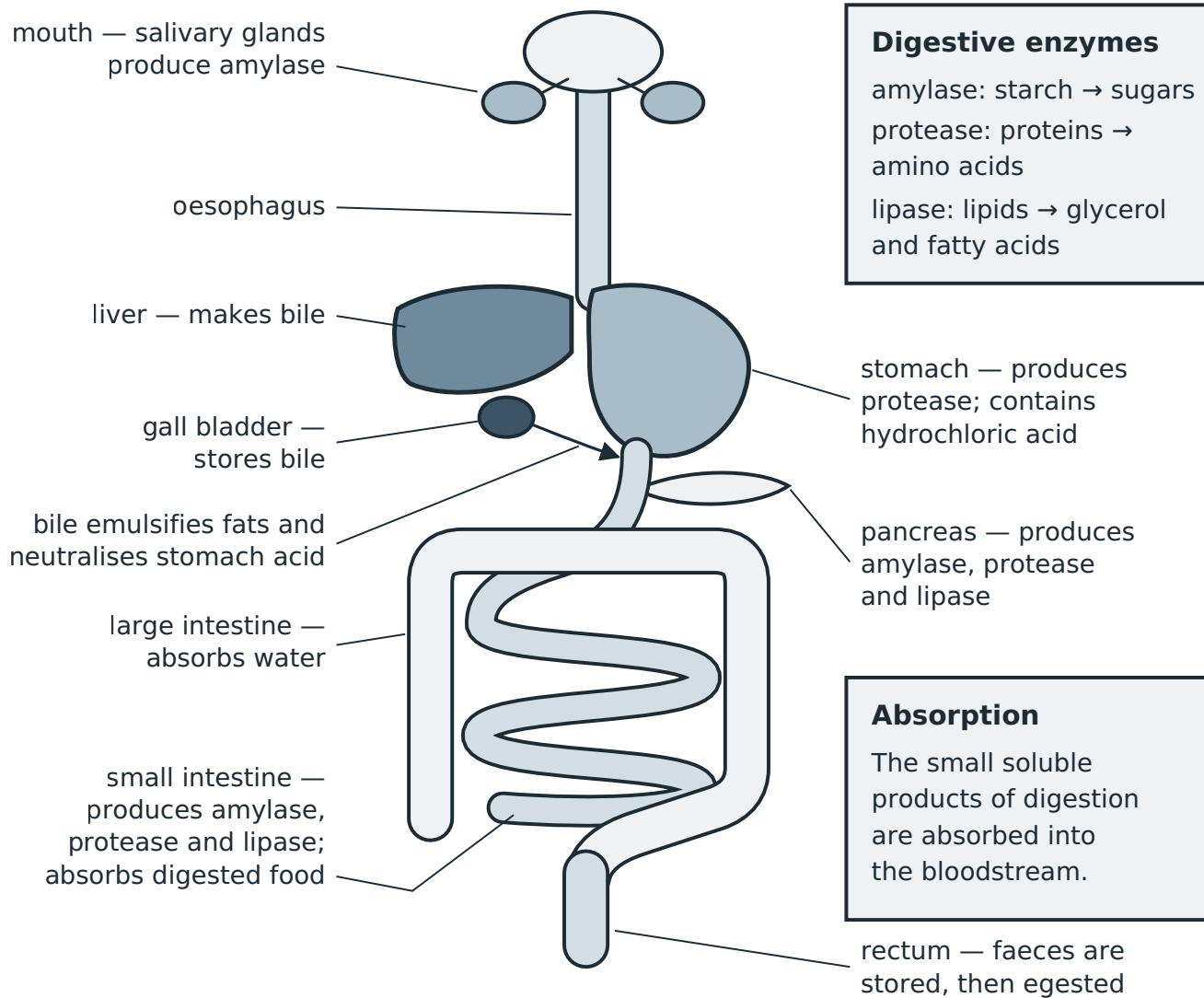
- **Cells** are the basic building blocks of all living organisms.
- A **tissue** is a group of cells with a similar structure and function.
- **Organs** are aggregations of tissues performing specific functions.
- Organs are organised into **organ systems**, which work together to form **organisms**.
- The hierarchy of size and scale runs: cell → tissue → organ → organ system → organism. For example, muscle tissue and glandular tissue make up the **stomach** (an organ), which is part of the **digestive system**, which is part of a human.

2.2 Animal tissues, organs and organ systems

2.2.1 The human digestive system

The **digestive system** is an example of an organ system in which several organs work together to **digest and absorb food**. Digestive enzymes convert food into small soluble molecules that can be absorbed into the bloodstream.

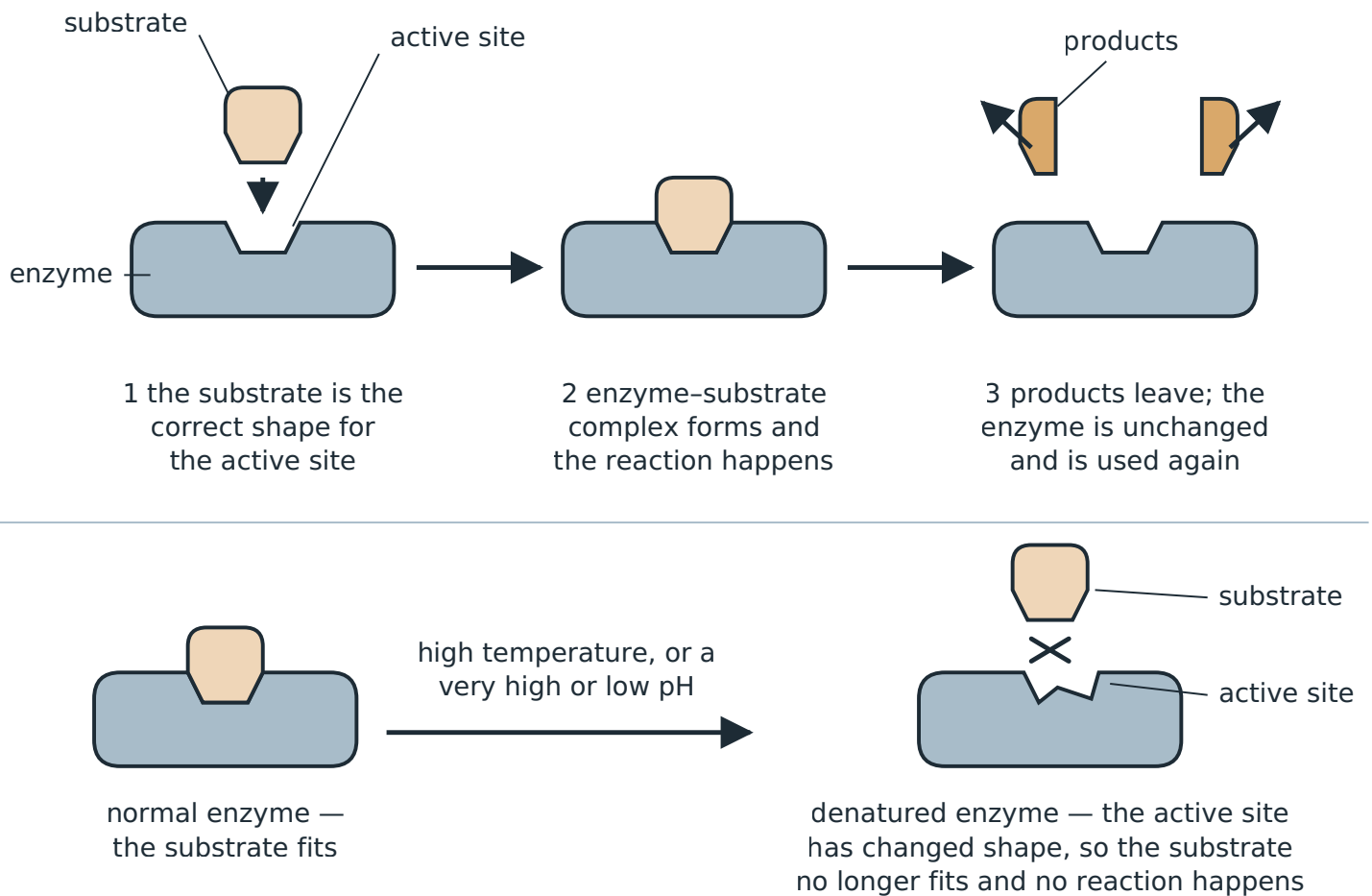
The human digestive system



Enzymes

- Enzymes are large protein molecules that catalyse specific reactions in living organisms due to the shape of their active site.
- Lock and key theory** (a simplified model): the **substrate** fits into the enzyme's **active site** like a key into a lock. Only a substrate with a complementary shape fits, which is why each enzyme is **specific** to one reaction. The products then leave and the enzyme is unchanged and can be reused.

The lock and key model of enzyme action



ANALOGY

An enzyme is a lock and the substrate is its key. One key opens one lock. Heat or the wrong pH bends the lock out of shape — the key no longer fits and the door can never be opened, no matter how hard you push.

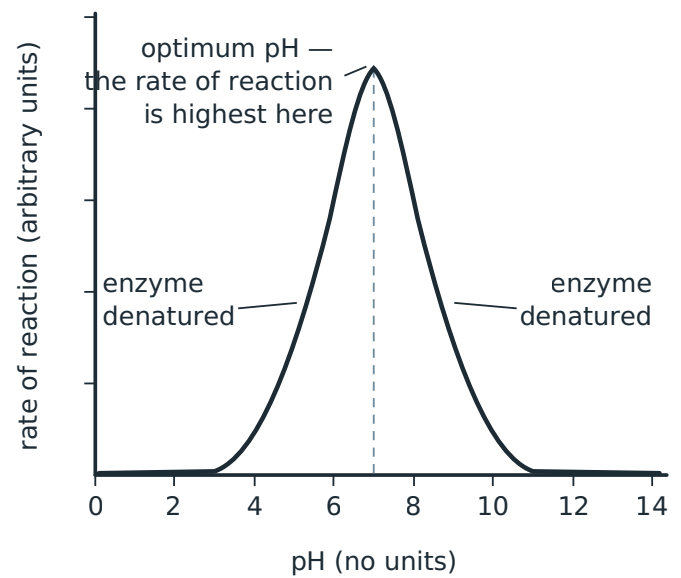
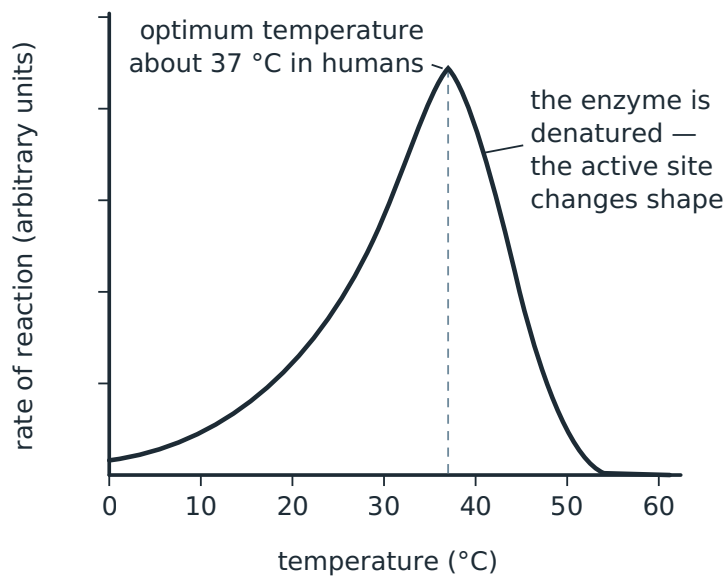
Effect of temperature

- As temperature increases, the rate of reaction increases: enzyme and substrate molecules have more kinetic energy so there are **more successful collisions** per second.
- Above the **optimum temperature** the rate falls sharply. The bonds holding the enzyme's shape break, the **active site changes shape**, the substrate no longer fits and the enzyme is **denatured**. Denaturing is permanent.

Effect of pH

- Each enzyme has an **optimum pH**. Either side of it the rate falls, and at extreme pH the active site changes shape and the enzyme is denatured.
- Stomach protease works best in **acidic** conditions (about pH 2, because the stomach produces hydrochloric acid); amylase in the small intestine works best in **slightly alkaline** conditions (about pH 7–8).

The effect of temperature and of pH on the rate of an enzyme-controlled reaction



WATCH OUT

An enzyme is not "killed" at high temperature — it was never alive. Say **denatured**, and explain it as a change to the shape of the **active site**.

Digestive enzymes

Enzyme	Sites of production	Substrate	Products
Amylase (a carbohydrase)	salivary glands, pancreas, small intestine	starch	simple sugars
Protease	stomach, pancreas, small intestine	proteins	amino acids
Lipase	pancreas, small intestine	lipids (fats)	glycerol and fatty acids

Word equations are enough; no chemical symbol equations are required. For example: **starch + water → simple sugars** (catalysed by amylase).

Uses of the products — the products of digestion are used to **build new carbohydrates, lipids and proteins**. Some **glucose is used in respiration**.

Bile

- Bile is made in the **liver** and stored in the **gall bladder**.
- It is **alkaline**, so it **neutralises hydrochloric acid from the stomach**, giving lipase the alkaline conditions it needs.
- It also emulsifies fat to form small droplets, which increases the surface area.
- Together, the alkaline conditions and large surface area increase the rate of fat breakdown by lipase. Bile is not an enzyme — it causes a physical change, not a chemical one.

2.2.2 The heart and blood vessels

The **heart** is an organ that pumps blood around the body in a **double circulatory system**. The **right ventricle** pumps blood to the **lungs**, where gas exchange takes place. The **left ventricle** pumps blood around the **rest of the body**. The left ventricle has a thicker muscular wall because it must generate a higher pressure.

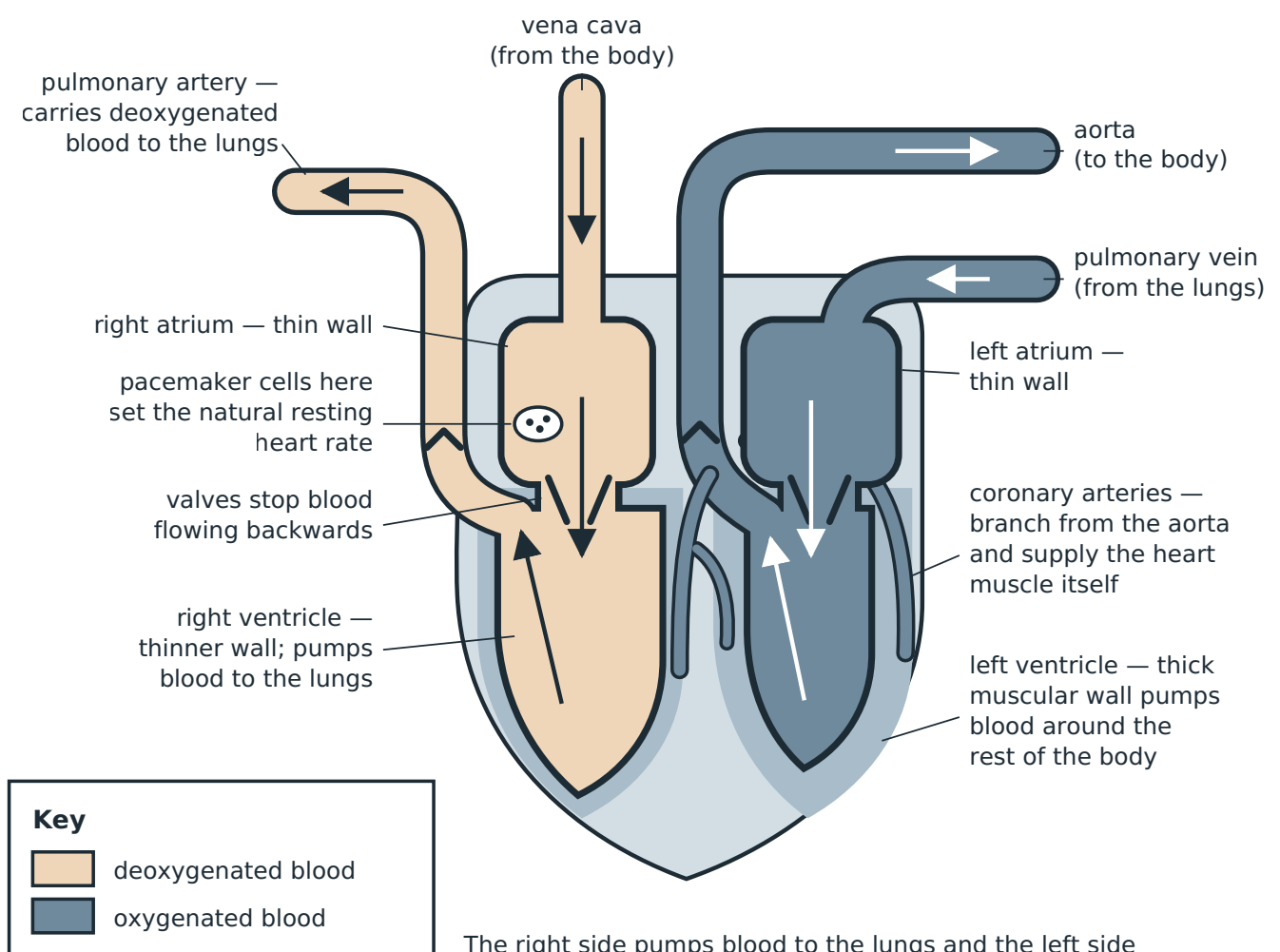
ANALOGY

The double circulatory system is like a delivery van that returns to the depot between every two drops. Blood goes heart → lungs → heart → body → heart. The short lung trip is at low pressure so the delicate alveoli are not damaged; returning to the pump means the blood leaves for the body at high pressure and travels fast.

Blood vessels associated with the heart (only these are required):

- **Vena cava** — brings deoxygenated blood from the body into the right atrium.
- **Pulmonary artery** — carries deoxygenated blood from the right ventricle to the lungs.
- **Pulmonary vein** — brings oxygenated blood from the lungs to the left atrium.
- **Aorta** — carries oxygenated blood from the left ventricle to the body.
- **Coronary arteries** — branch off the aorta and supply the heart muscle itself with oxygenated blood.

The heart and its associated blood vessels



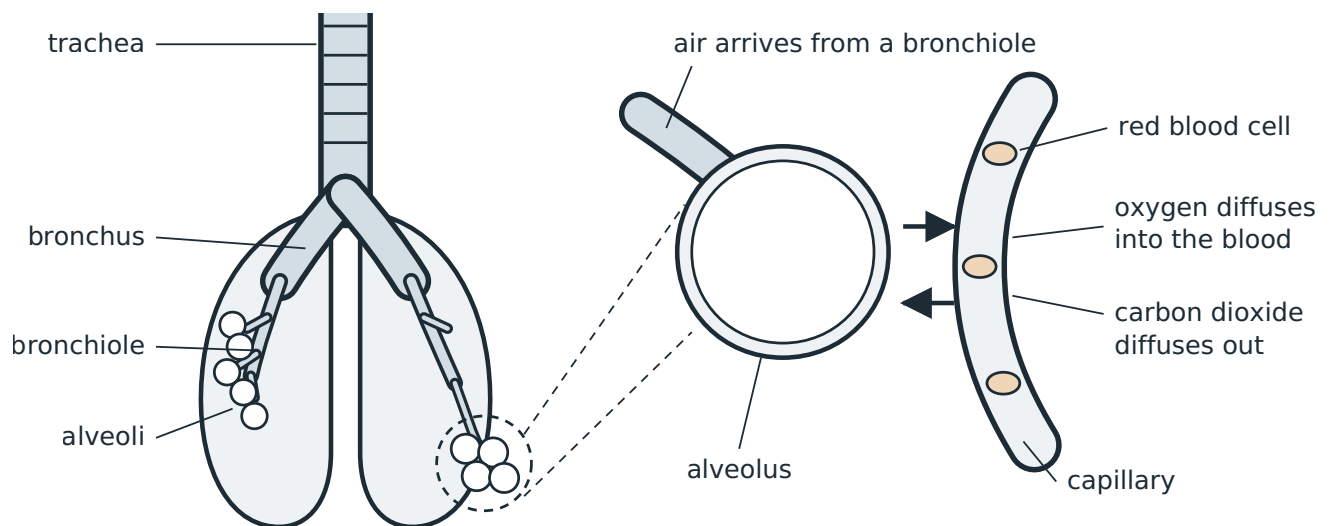
The right side pumps blood to the lungs and the left side pumps it to the rest of the body — a double circulatory system. The left ventricle wall is thickest because it has to push blood the furthest.

The names of the heart valves are **not required**, but you should know that valves keep blood flowing in one direction only.

Pacemaker — the natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. **Artificial pacemakers** are electrical devices used to **correct irregularities in the heart rate**.

The lungs — knowledge is restricted to the trachea, bronchi, alveoli and the capillary network surrounding the alveoli. Air travels down the trachea, which divides into two **bronchi**, one to each lung; these branch into smaller tubes ending in millions of air sacs called **alveoli**. Adaptations for gas exchange: a very **large surface area**; walls only **one cell thick** for a short diffusion path; a rich **capillary network** maintaining a steep concentration gradient; and **ventilation** by breathing. Oxygen diffuses from the alveoli into the blood, and carbon dioxide diffuses from the blood into the alveoli.

The lungs, alveoli and gas exchange



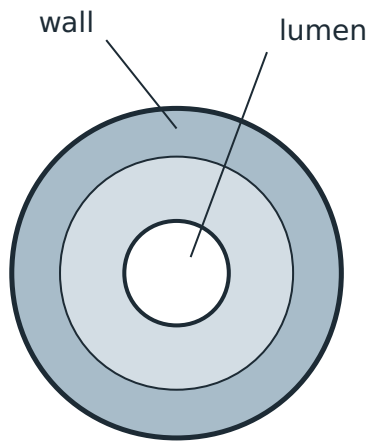
Adaptations of an efficient gas exchange surface

- large surface area — millions of alveoli give a very large area
- thin walls — the alveolus wall and the capillary wall are each one cell thick, so the diffusion path is short
- rich blood supply — a dense capillary network keeps the concentration gradient steep
- well ventilated — breathing keeps replacing the air in the alveoli

Blood vessels

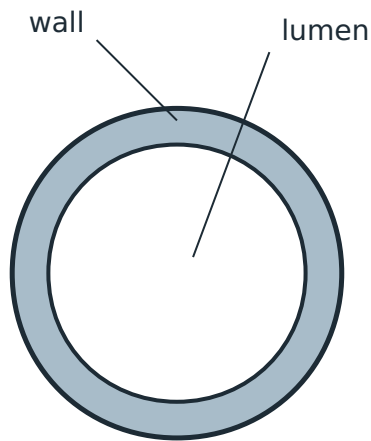
	Artery	Vein	Capillary
Direction	carries blood away from the heart	carries blood back to the heart	links arteries to veins in the tissues
Wall	thick, muscular and elastic	thin	one cell thick
Lumen	narrow	wide	very narrow (one red blood cell wide)
Valves	none	valves to stop backflow	none
Related to function	withstands and maintains high pressure ; elastic walls recoil to keep blood moving	low pressure, so a wide lumen reduces resistance and valves prevent backflow	thin wall gives a short diffusion path for exchange of substances with cells

Artery, vein and capillary compared



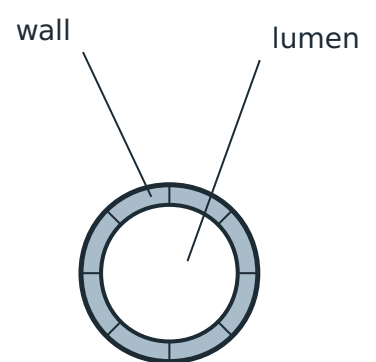
Artery

thick wall of muscle and elastic fibres
narrow lumen
no valves
carries blood away from the heart at high pressure



Vein

thin wall — little muscle or elastic tissue
large lumen
valves present
carries blood back to the heart at low pressure



Capillary

wall only one cell thick
very narrow lumen
no valves
walls are permeable
lets substances diffuse into and out of cells

Longitudinal section of a vein



(the three cross-sections are not drawn to the same scale)

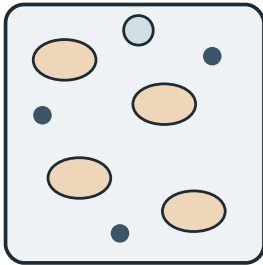
2.2.3 Blood

Blood is a tissue consisting of **plasma**, in which the red blood cells, white blood cells and platelets are suspended.

Component	Structure	Function
Plasma	straw-coloured liquid	transports carbon dioxide, urea, the soluble products of digestion, hormones and heat
Red blood cells	biconcave disc (large surface area), no nucleus (more room), packed with haemoglobin	carry oxygen from the lungs to respiring tissues (haemoglobin + oxygen → oxyhaemoglobin)
White blood cells	have a nucleus; some engulf microorganisms (phagocytes), some make antibodies or antitoxins (lymphocytes)	defend the body against pathogens
Platelets	small fragments of cells, no nucleus	help the blood to clot at a wound, sealing it and preventing entry of microorganisms

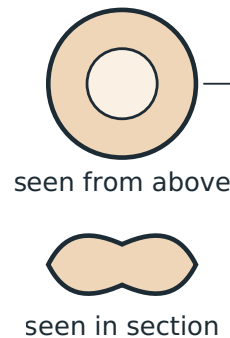
The components of blood

Plasma



- straw-coloured liquid
- transports carbon dioxide, urea and hormones
- transports the soluble products of digestion
- the blood cells and platelets are carried suspended in it

Red blood cell



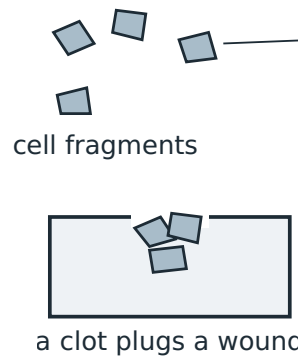
- no nucleus, so there is more room for haemoglobin
- biconcave disc shape gives a large surface area for diffusion
- haemoglobin joins with oxygen in the lungs and carries it to the cells

White blood cell



- has a nucleus
- some engulf and digest pathogens
- some make antibodies
- some make antitoxins
- they defend the body

Platelets



- small fragments of cells, with no nucleus
- help the blood to clot at a wound
- clotting stops blood loss and stops pathogens getting in

You should be able to recognise blood cells in a photograph or diagram and explain how they are adapted. You should also be able to evaluate risks related to the use of blood products, such as transmission of infection from donated blood versus the benefit of a life-saving transfusion.

2.2.4 Coronary heart disease: a non-communicable disease

- In **coronary heart disease**, layers of fatty material build up inside the coronary arteries, narrowing them. This **reduces the flow of blood** through the coronary arteries, resulting in a lack of oxygen for the heart muscle, which can cause chest pain or a heart attack.
- **Stents** are used to keep the coronary arteries open.
Advantages: effective for a long time; recovery is quick.
Disadvantages: risk of complications during surgery; blood clots can form near the stent.
- **Statins** are widely used to **reduce blood cholesterol levels**, which slows down the rate of fatty material deposit.
Advantages: reduce the risk of heart attack and stroke.
Disadvantages: must be taken long term (regularly, for life); side effects such as headaches, liver problems or muscle pain; they are not fast-acting.
- **Faulty valves** — heart valves may become faulty, preventing the valve from **opening fully** (restricting blood flow so less blood is pumped and the person becomes breathless), or the valve might **develop a leak** so blood flows in the wrong direction. Faulty valves can be replaced using **biological or mechanical valves**. Biological valves may wear out and need replacing; mechanical valves last longer but the patient must take **anti-clotting drugs** for life.
- **Heart failure** — a donor heart, or heart and lungs, can be transplanted. Problems: donors are scarce, and the body may **reject** the organ so immunosuppressant drugs are needed.
- **Artificial hearts** are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery. They are less likely to be rejected because they are not living tissue, but surgery risks bleeding and infection, and blood clots may form.
- Exam skill: **evaluate** these treatments — give advantages, disadvantages and a justified conclusion.

2.2.7 Cancer

- **Cancer** is the result of changes in cells that lead to uncontrolled growth and division.
- **Benign tumours** are growths of abnormal cells which are contained in one area, usually within a membrane. They do not invade other parts of the body.
- **Malignant tumour cells are cancers**. They invade neighbouring tissues and spread to different parts of the body in the blood, where they form secondary tumours.
- Scientists have identified **lifestyle risk factors** for various types of cancer (for example smoking and lung cancer, UV exposure and skin cancer, alcohol and liver cancer). There are also **genetic risk factors** for some cancers.

2.2.5 Health issues

- **Health** is the state of physical and mental well-being.
- Diseases, both communicable and non-communicable, are major causes of ill health. Other factors including **diet, stress and life situations** may have a profound effect on both **physical and mental health**.
- Different types of disease may interact:
- **Defects in the immune system** mean that an individual is more likely to suffer from infectious diseases.
- Viruses living in cells can be the trigger for cancers.
- Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma.
- Severe physical ill health can lead to depression and other mental illness.
- Maths skills: translate disease incidence information between **graphical and numerical forms**; construct and interpret **frequency tables, bar charts and histograms**; use a **scatter diagram to identify a correlation** between two variables; and understand the **principles of sampling** as applied to scientific and epidemiological data (the sample must be large enough and randomly chosen to be representative of the population).

2.2.6 The effect of lifestyle on some non-communicable diseases

- **Risk factors** are linked to an increased rate of a disease. They can be **aspects of a person's lifestyle** or substances in the person's body or environment.
- A causal mechanism has been proven for some risk factors, but not in others. A correlation alone does not prove cause.
- Required examples:
- the effects of **diet, smoking and exercise** on **cardiovascular disease**
- **obesity as a risk factor for Type 2 diabetes**
- the effect of **alcohol** on the **liver and brain function**
- the effect of **smoking** on **lung disease and lung cancer**
- the effects of **smoking and alcohol** on **unborn babies**
- **carcinogens, including ionising radiation**, as risk factors in **cancer**.
- Many diseases are caused by the interaction of a number of factors.
- **Costs** — you should be able to discuss the **human and financial cost** of non-communicable diseases to an individual (shorter life, poor quality of life, loss of earnings), a local community, a nation (NHS treatment costs, lost working days) or globally, and explain how lifestyle factors change the incidence of these diseases at local, national and global levels.

2.3 Plant tissues, organs and systems

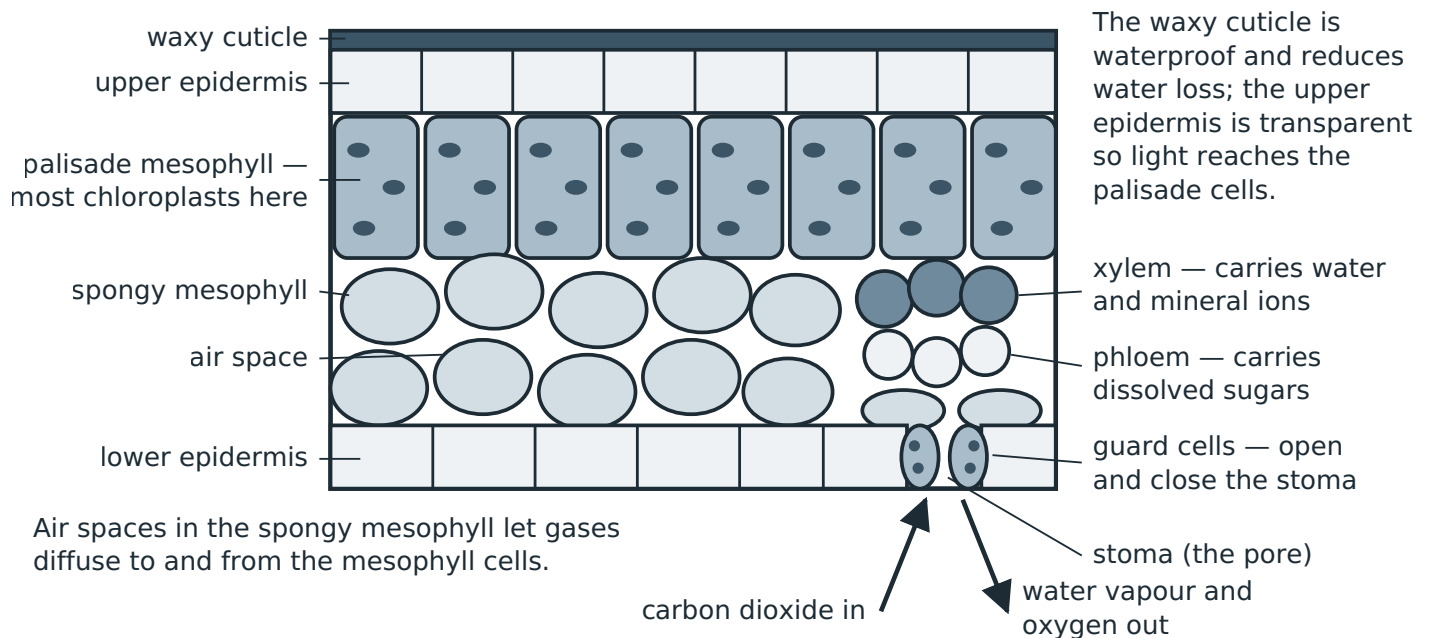
2.3.1 Plant tissues

Plant tissues include:

- **Epidermal tissue** — covers the whole plant; the upper epidermis is transparent to let light through and is covered by a waxy cuticle that reduces water loss.
- **Palisade mesophyll** — tightly packed cells full of **chloroplasts** near the top of the leaf; the main site of photosynthesis.
- **Spongy mesophyll** — loosely packed cells with **air spaces** between them, giving a large surface area for the **diffusion of gases**.
- **Xylem and phloem** — the transport tissues (see 2.3.2).
- **Meristem tissue** — found at the **growing tips of shoots and roots**; can differentiate into any type of plant cell.

The leaf is a plant organ. Knowledge is limited to the epidermis, palisade and spongy mesophyll, xylem and phloem, and guard cells surrounding stomata. Light passes through the transparent upper epidermis to the palisade layer; carbon dioxide diffuses in through the **stomata** and through the air spaces of the spongy mesophyll; the xylem and phloem in the leaf veins supply water and carry sugars away.

Cross-section of a leaf



2.3.2 Plant organ system

The roots, stem and leaves form a plant organ system for transport of substances around the plant.

Tissue	Structure	Function
Root hair cell	long, thin projection giving a very large surface area; many mitochondria	efficient uptake of water by osmosis and mineral ions by active transport
Xylem	hollow tubes of dead cells with no end walls, strengthened by lignin	transports water and mineral ions from the roots to the stems and leaves in the transpiration stream ; one direction only, upwards
Phloem	tubes of elongated cells ; cell sap moves from one cell to the next through pores in the end walls	translocation — transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage; moves in both directions

Detailed structure of phloem tissue and the mechanism of transport are **not required**.

Stomata and guard cells — the role of stomata and guard cells is to control gas exchange and water loss. Stomata are pores mostly on the lower surface of the leaf, each surrounded by two **guard cells**. When the plant has plenty of water the guard cells become turgid and the stoma opens, letting carbon dioxide in for photosynthesis and water vapour out. When water is short the guard cells become flaccid and the stoma closes, reducing water loss but also stopping gas exchange.

Transpiration — water evaporates from the surfaces of the mesophyll cells and diffuses out as **water vapour through the stomata**. This loss pulls a continuous column of water up the xylem from the roots: the transpiration stream.

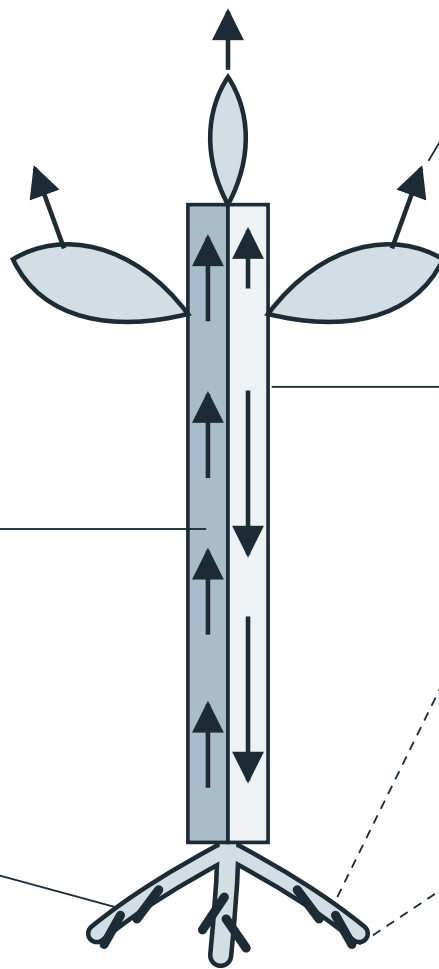
Transpiration in the xylem and translocation in the phloem

Rate of transpiration increases when:

- the temperature increases
- air movement increases
- light intensity increases
- humidity decreases

xylem — carries water and mineral ions from the roots up to the leaves; this flow is the transpiration stream

roots — covered in root hair cells that absorb from the soil

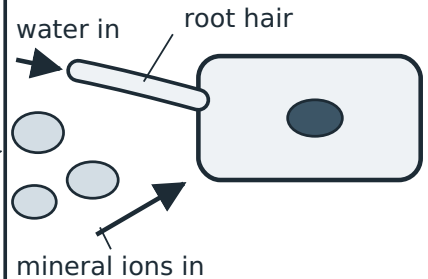


water evaporates from the leaf and diffuses out through the stomata

phloem — carries dissolved sugars from the leaves to the rest of the plant; this is called translocation

Root hair cell

adapted for uptake of water by osmosis and mineral ions by active transport



Factors affecting the rate of transpiration

Factor	Effect on rate	Why
Temperature (increase)	increases	water molecules have more energy so evaporate and diffuse faster
Humidity (increase)	decreases	more water vapour outside the leaf means a smaller concentration gradient for diffusion out of the stomata
Air movement (increase)	increases	wind blows away water vapour from around the stomata, keeping the concentration gradient steep
Light intensity (increase)	increases	stomata open in the light for photosynthesis, so more water vapour escapes

Measuring transpiration — a **potometer** measures the rate of water uptake, which is used as a measure of the rate of transpiration.

NOTE

You should also be able to investigate the distribution of stomata and guard cells (for example by counting stomata in several fields of view on the upper and lower epidermis and finding a **mean**), and understand the principles of **sampling** — take enough readings from randomly chosen areas so the sample is representative.