Seneca

# Y10 Combined Paper 1 Revision

**<u>When</u>** → W/C 22nd/29th June

**<u>You will be assessed on the following subject areas:</u>**

- Biology (B1-2, B3-4, B5-7, B8-9)
- Physics (P1-3, P4-5, P6-7)

Aston Science

# Science Course Overview

| Assessment Details | Your course – Exam Board AQA |
|---|---|
| | Combined Science (AQA Trilogy) – Students study Biology, Chemistry and Physics, with the scores being combined and 2 GCSE's being awarded.<br>The qualifications will be graded on a 17-point scale: 1 – 1 to 5 – 5 (Foundation) or 4-3 to 9-9 (Higher).<br>Separate Science will be awarded 3 GCSEs, one for Biology, Chemistry and Physics.<br>The qualifications will be graded 1-5 (Foundation) or 3-9 (Higher). |
| | There are six 1hr 15-minute papers (1 hr 45-minutes for separates):<br>Two biology, two chemistry and two physics. |

## Trials: W/C 22nd and 29th June

**Combined:** Biology Paper 1 and Physics Paper 1

**Triple:** Biology Paper 1, Chemistry Paper 1 and Physics Paper 1

| Exam | Units | Sub-Units |
|---|---|---|
| **Biology Paper 1** | Cells and organisation | B1 Cell structure and transport |
| | | B2 Cell division |
| | | B3 Organisation and the digestive system |
| | | B4 Organising animals and plants |
| | Disease and bioenergetics | B5 Communicable diseases |
| | | B6 Preventing and treating disease |
| | | B7 non-communicable diseases |
| | | B8 Photosynthesis |
| | | B9 Respiration |
| **Chemistry Paper 1** | Atoms, bonding, and moles | C1 Atomic structure |
| | | C2 The periodic table |
| | | C3 Structure and bonding |
| | | C4 Chemical calculations |
| | Chemical reactions and energy changes | C5 Chemical changes |
| | | C6 Electrolysis |
| | | C7 Energy changes |
| **Physics Paper 1** | Energy and energy resources | P1 Conservation and dissipation of energy |
| | | P2 Energy transfer by heating |
| | | P3 Energy resources |
| | Particles at work | P4 Electric circuits |
| | | P5 Electricity in the home |
| | | P6 Molecules and matter |
| | | P7 Radioactivity |

| | | | | |
|---|---|---|---|---|
| **BBC Bitesize AQA Combined Science** | **BBC Bitesize AQA - Biology** | **BBC Bitesize AQA – Chemistry** | **BBC Bitesize AQA - Physics** | **AQA Exam Paper YouTube videos*** |

*These videos go through all the content for each paper in roughly 30 minutes (per video). Make sure to select the AQA Paper 1 videos, NOT OCR or Edexcel.

## Revision Strategies

As you approach your first set of trial exams, we recognise that you are revising multiple subjects and that time is limited. In Science, progress is built through revising *better* not revising *more*. Below are focussed revision strategies that can be followed using the weekly/bi-weekly "3-2-1" structure.

### What is the "3-2-1" structure?

- Three 20 minutes: learn + questions sessions
- Two 10 minutes: retrieval (no notes) sessions
- One 20 minute: timed exam questions + self-mark + improve session
- Each session should focus on **one small topic or skill.** Focus on **weak** topics, not favourites

### Effective Active Revision Strategies

**Flash Cards**

- Flash cards help your child actively recall key facts and definitions, which strengthens memory and boosts confidence in exams.
- You can quiz your child using their flash cards, turning revision into a quick, focused, and engaging activity at home.

**Exam Questions / Past Papers**

- Practising past papers helps your child become familiar with exam formats and improves their ability to manage time under pressure.
- By reviewing mark schemes and examiner reports, your child can learn exactly what examiners are looking for and how to gain top marks.

**Blurting**

- Blurting involves your child writing down everything they know about a topic from memory, which reveals gaps in their knowledge and strengthens recall.
- Encourage your child to check their notes afterward to see what they missed — this targeted approach makes future revision more effective.

**Feynman Technique**

- With the Feynman Technique, your child explains a topic in simple terms, helping them deeply understand the content rather than just memorising it.
- You can support them by asking them to "teach" you a topic — if they can explain it clearly, they truly understand it.

**2-3-5-7 Method**

- The 2-3-5-7 method spaces revision over increasing intervals (after 2, 3, 5, and 7 days), helping information stick in your child's long-term memory.
- Supporting your child in planning their revision using this method can make their study time more efficient and reduce last-minute cramming stress

*Flash cards can be done using free apps which you can download from the Appstore, as well as on paper!

## Past Papers

The links below will take you directly to past papers for each of the science exams. Make sure to choose the AQA exam board! Mark schemes can also be accessed using these links.

All - https://www.physicsandmathstutor.com/past-papers/gcse-science/

Combined Science - https://www.aqa.org.uk/subjects/science/gcse/science-8464/assessment-resources

Triple Science (Biology) - https://www.aqa.org.uk/subjects/biology/gcse/biology-8461/assessment-resources

Triple Science (Chemistry) – https://www.aqa.org.uk/subjects/chemistry/gcse/chemistry-8462/assessment-resources

Triple Science (Physics) - https://www.aqa.org.uk/subjects/physics/gcse/physics-8463/assessment-resources?f.Resource%20type%7C6=Question%20papers&sort=title&num_ranks=10&start_rank=1

## Checklist of Tasks to complete before the June Trial Exams

- ☐ Create a revision timetable for science
- ☐ Watched the AQA Biology Paper 1 in 25 minutes video (Combined and Triple)
- ☐ Watched the AQA Chemistry Paper 1 in 30 minutes video (Triple)
- ☐ Watched the AQA Physics Paper 1 in 40 minutes video (Combined and Triple)
- ☐ Completed 30 minutes of past paper practice for Biology Paper 1 (Combined and Triple)
- ☐ Completed 30 minutes of past paper practice for Chemistry Paper 1 (Triple)
- ☐ Completed 30 minutes of past paper practice for Physics Paper 1 (Combined and Triple)

# REVISION TIMETABLE – week beginning

| Date → / ↓ Time | **Mon** | **Tues** | **Weds** | **Thurs** | **Fri** |
|---|---|---|---|---|---|
| 3.00-3:30pm | | | | | |
| 3:30-4.00pm | | | | | |
| 4.00-5.00pm | | | | | |
| 5.00-5:30pm | | | | | |
| 5:30-6:30pm | | | | | |
| 6:30-7:30pm | | | | | |
| 7:30-8.00pm | | | | | |
| 8.00-9.00pm | | | | | |

| Date → / ↓ Time | **Sat** | **Sun** |
|---|---|---|
| 9.00-10.00am | | |
| 10.00-11.00am | | |
| 11.00-11:30am | | |
| 11:30-12:30pm | | |
| 12:30-1.00pm | | |
| 1.00-2.00pm | | |
| 2.00-3.00pm | | |
| 3.00-3:30pm | | |
| 3:30-4.00pm | | |
| 4.00-5.00pm | | |
| 5.00-5:30pm | | |
| 5:30-6:30pm | | |
| 6:30-7:30pm | | |
| 7:30-8.00pm | | |
| 8.00-9.00pm | | |

**Focus Subjects to revise this week:**
-
-
-

**Topics that I find most difficult to focus on:**
-
-
-

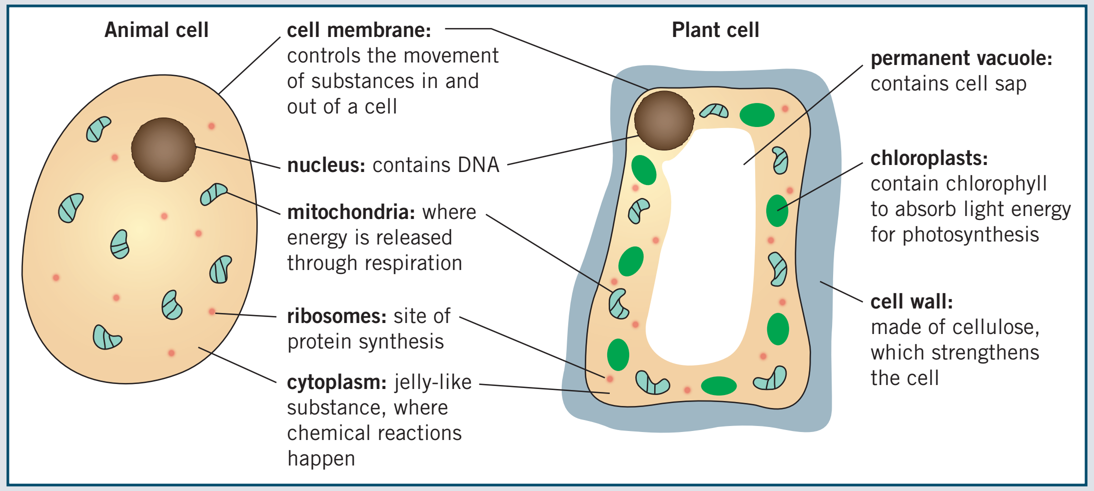
**The teachers who I need to ask for past papers and revision materials from:**
-
-
-

# Chapter 1: Cell biology and transport

## Knowledge organiser

### Eukaryotic cells

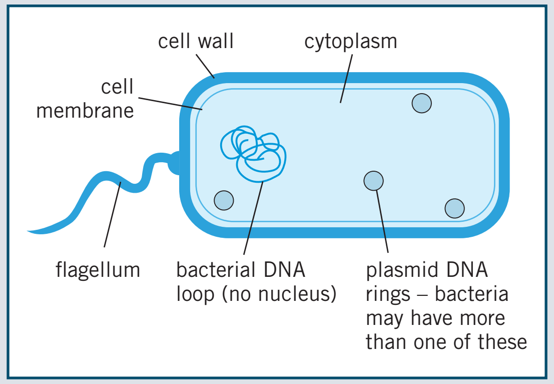
Animal and plant cells are eukaryotic. They have genetic material (DNA) that forms **chromosomes** and is contained in a **nucleus**.




### Prokaryotic cells

Bacteria have the following characteristics:

- single-celled
- no nucleus – have a single loop of DNA
- have small rings of DNA called **plasmids**
- smaller than eukaryotic cells.




### Microscopes

| Light microscope | Electron microscope |
|---|---|
| uses light to form images | uses a beam of electrons to form images |
| living samples can be viewed | samples cannot be living |
| relatively cheap | expensive |
| low magnification | high magnification |
| low resolution | high resolution |

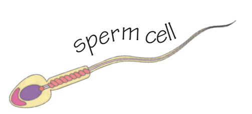
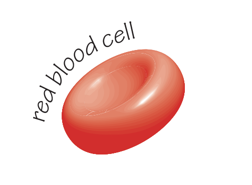
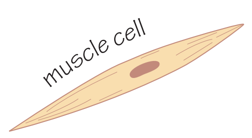
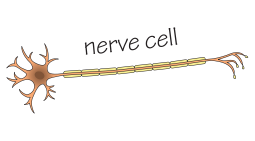
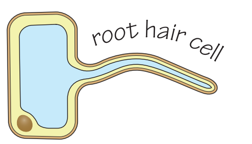
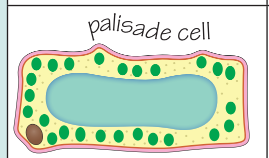
Electron microscopes allow you to see sub-cellular structures, such as ribosomes, that are too small to be seen with a light microscope.

L To calculate the **magnification** of an image:

$$\text{magnification} = \frac{\text{image size}}{\text{actual size}}$$

### Specialised cells

Cells in animals and plants differentiate to form different types of cells. Most animal cells differentiate at an early stage of development, whereas a plant's cells differentiate throughout its lifetime.

| Specialised cell | Function | Adaptations |
|---|---|---|
|   | fertilise an ovum (egg) | • tail to swim to the ovum and fertilise it<br>• lots of mitochondria to release energy from respiration, enabling the sperm to swim to the ovum |
|   | transport oxygen around the body | • no nucleus so more room to carry oxygen<br>• contains a red pigment called haemoglobin that binds to oxygen molecules<br>• flat bi-concave disc shape to increase surface area-to- volume ratio |
|   | contract and relax to allow movement | • contains protein fibres, which can contract to make the cells shorter<br>• contains lots of mitochondria to release energy from respiration, allowing the muscles to contract |
|   | carry electrical impulses around the body | • branched endings, called dendrites, to make connections with other neurones or effectors<br>• myelin sheath insulates the axon to increase the transmission speed of the electrical impulses |
|   | absorb mineral ions and water from the soil | • long projection speeds up the absorption of water and mineral ions by increasing the surface area of the cell<br>• lots of mitochondria to release energy for the active transport of mineral ions from the soil |
|   | enable photosynthesis in the leaf | • lots of chloroplasts containing chlorophyll to absorb light energy<br>• located at the top surface of the leaf where it can absorb the most light energy |

### Comparing diffusion, osmosis, and active transport

| | Diffusion | Osmosis | Active transport |
|---|---|---|---|
| **Definition** | The spreading out of particles, resulting in a net movement from an area of higher **concentration** to an area of lower concentration.<br>Factors which affect the rate of diffusion: difference in concentration, temperature, and surface area of the membrane. | The diffusion of water from a **dilute** solution to a concentrated solution through a **partially permeable membrane**. | The movement of particles from a more dilute solution to a more concentrated solution using energy from respiration. |
| **Movement of particles** | Particles move down the concentration **gradient** – from an area of *high* concentration to an area of *low* concentration. | Water moves from an area of *lower* solute concentration to an area of *higher* solute concentration. | Particles move against the concentration gradient – from an area of *low* concentration to an area of *high* concentration. |
| **Energy required?** | no – passive process | no – passive process | yes – energy released by respiration |
| **Examples** | **Humans**<br>• Nutrients in the small intestine diffuse into the **capillaries** through the **villi**.<br>• Oxygen diffuses from the air in the **alveoli** into the blood in the capillaries. Carbon dioxide diffuses from the blood in the capillaries into the air in the alveoli.<br>• **Urea** diffuses from cells into the blood for excretion in the kidney.<br>**Fish**<br>• Oxygen from water passing over the gills diffuses into the blood in the **gill filaments**.<br>• Carbon dioxide diffuses from the blood in the gill filaments into the water.<br>**Plants**<br>• Carbon dioxide used for photosynthesis diffuses into leaves through the **stomata**.<br>• Oxygen produced during photosynthesis diffuses out of the leaves through the stomata. | **Plants**<br>• Water moves by osmosis from a dilute solution in the soil to a concentrated solution in the **root hair cell**. | **Humans**<br>• Active transport allows sugar molecules to be absorbed from the small intestine when the sugar concentration is higher in the blood than in the small intestine.<br>**Plants**<br>• Active transport is used to absorb mineral ions into the root hair cells from more dilute solutions in the soil. |

**Key terms** Make sure you can write a definition for these key terms.

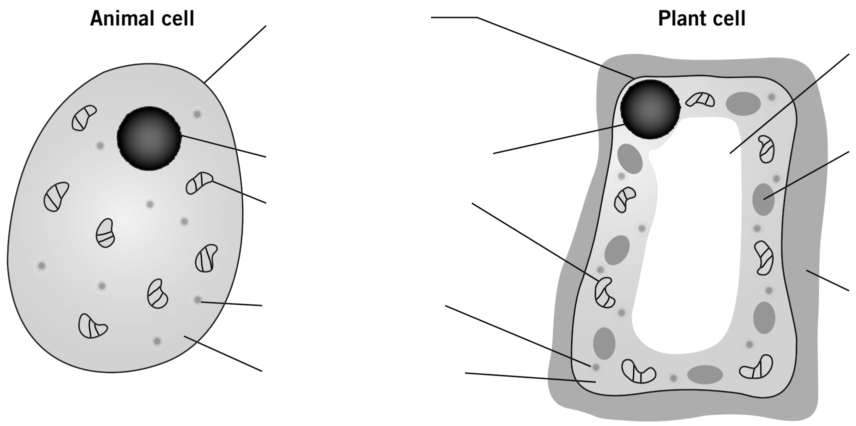
cell membrane cell wall chloroplast chromosome concentration cytoplasm dilute DNA eukaryotic gill filaments gradient magnification mitochondria nucleus partially permeable membrane passive process permanent vacuole plasmid prokaryotic resolution ribosome root hair cell stomata

# Chapter 1: Cell biology and transport

## Knowledge organiser

### Eukaryotic cells

Animal and plant cells are eukaryotic. They have genetic material (DNA) that forms **chromosomes** and is contained in a **nucleus**. Label the diagram.

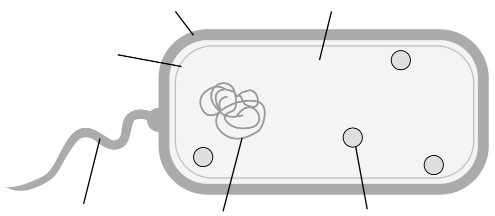



### Prokaryotic cells

Bacteria have the following characteristics:

-
-
-
-

Label the diagram.



### Microscopes

| Light microscope | Electron microscope |
| --- | --- |
| | uses a beam of electrons to form images |
| living samples can be viewed | |
| relatively cheap | |
| | high magnification |
| | high resolution |

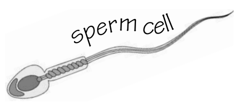
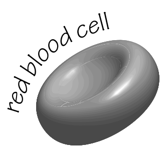
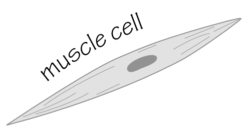
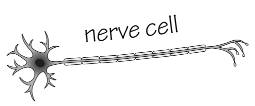
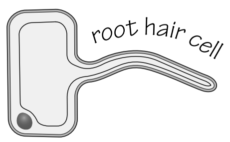
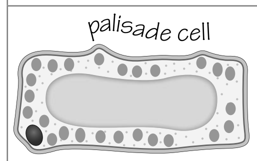
Electron microscopes allow you to see sub-cellular structures, such as ________, that are too small to be seen with a light microscope.

To calculate the **magnification** of an image:

magnification = ________

### Specialised cells

Cells in animals and plants differentiate to form different types of cells. Most animal cells differentiate at an early stage of development, whereas a plant's cells differentiate throughout its lifetime. Complete the table.

| Specialised cell | Function | Adaptations |
| --- | --- | --- |
|   | | • <br> • |
|   | | • <br> • <br> • |
|   | | • <br> • |
|   | | • <br> • |
|   | | • <br> • |
|   | | • <br> • |

### Comparing diffusion, osmosis, and active transport

| | Diffusion | Osmosis | Active transport |
| --- | --- | --- | --- |
| **Definition** | The spreading out of particles, resulting in a net movement from an area of ________ to an area of ________. <br> Factors which affect the rate of diffusion: ________ ________, ________, and ________ ________. | The diffusion of water from a ________ solution to a ________ solution through a ________. | The movement of particles from a more dilute solution to a more concentrated solution using energy from ________. |
| **Movement of particles** | Particles move down the ________ ________ – from an area of *high* concentration to an area of *low* concentration. | Water moves from an area of *lower* ________ concentration to an area of *higher* solute concentration. | Particles move against the concentration gradient – from an area of *low* concentration to an area of *high* concentration. |
| **Energy required?** | ________ | ________ | ________ |
| **Examples** | **Humans** <br> • <br> • <br> • <br> **Fish** <br> • <br> • <br> **Plants** <br> • <br> • | **Plants** <br> • | **Humans** <br> • <br> **Plants** <br> • |

**Key terms**

**Make sure you can write a definition for these key terms.**

cell membrane, cell wall, chloroplast, chromosome, concentration, cytoplasm, dilute, DNA, eukaryotic, gill filaments, gradient, magnification, mitochondria, nucleus, partially permeable membrane, passive process, permanent vacuole, plasmid, prokaryotic, resolution, ribosome, root hair cell, stomata

# Chapter 1: Cell biology and transport

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B1 questions | Answers |
|---|---|---|
| 1 | What are two types of eukaryotic cell? | |
| 2 | What type of cell are bacteria? | |
| 3 | Where is DNA found in animal and plant cells? | |
| 4 | What is the function of the cell membrane? | |
| 5 | What is the function of mitochondria? | |
| 6 | What is the function of chloroplasts? | |
| 7 | What is the function of ribosomes? | |
| 8 | What is the function of the cell wall? | |
| 9 | What is the structure of the main genetic material in a prokaryotic cell? | |
| 10 | How are electron microscopes different to light microscopes? | |
| 11 | What is the function of a red blood cell? | |
| 12 | Give three adaptations of a red blood cell. | |
| 13 | What is the function of a nerve cell? | |
| 14 | Give two adaptations of a nerve cell. | |
| 15 | What is the function of a sperm cell? | |
| 16 | Give two adaptations of a sperm cell. | |
| 17 | What is the function of a palisade cell? | |
| 18 | Give two adaptations of a palisade cell. | |
| 19 | What is the function of a root hair cell? | |
| 20 | Give two adaptations of a root hair cell. | |

| | | |
|---|---|---|
| 21 | What is diffusion? | |
| 22 | Name three factors that affect the rate of diffusion. | |
| 23 | How are villi adapted for exchanging substances? | •<br>•<br>• |
| 24 | How are the lungs adapted for efficient gas exchange? | •<br>•<br>•<br>• |
| 25 | How are fish gills adapted for efficient gas exchange? | •<br>•<br>• |
| 26 | What is osmosis? | |
| 27 | Give one example of osmosis in a plant. | |
| 28 | What is active transport? | |
| 29 | Why is active transport needed in plant roots? | |
| 30 | What is the purpose of active transport in the small intestine? | |

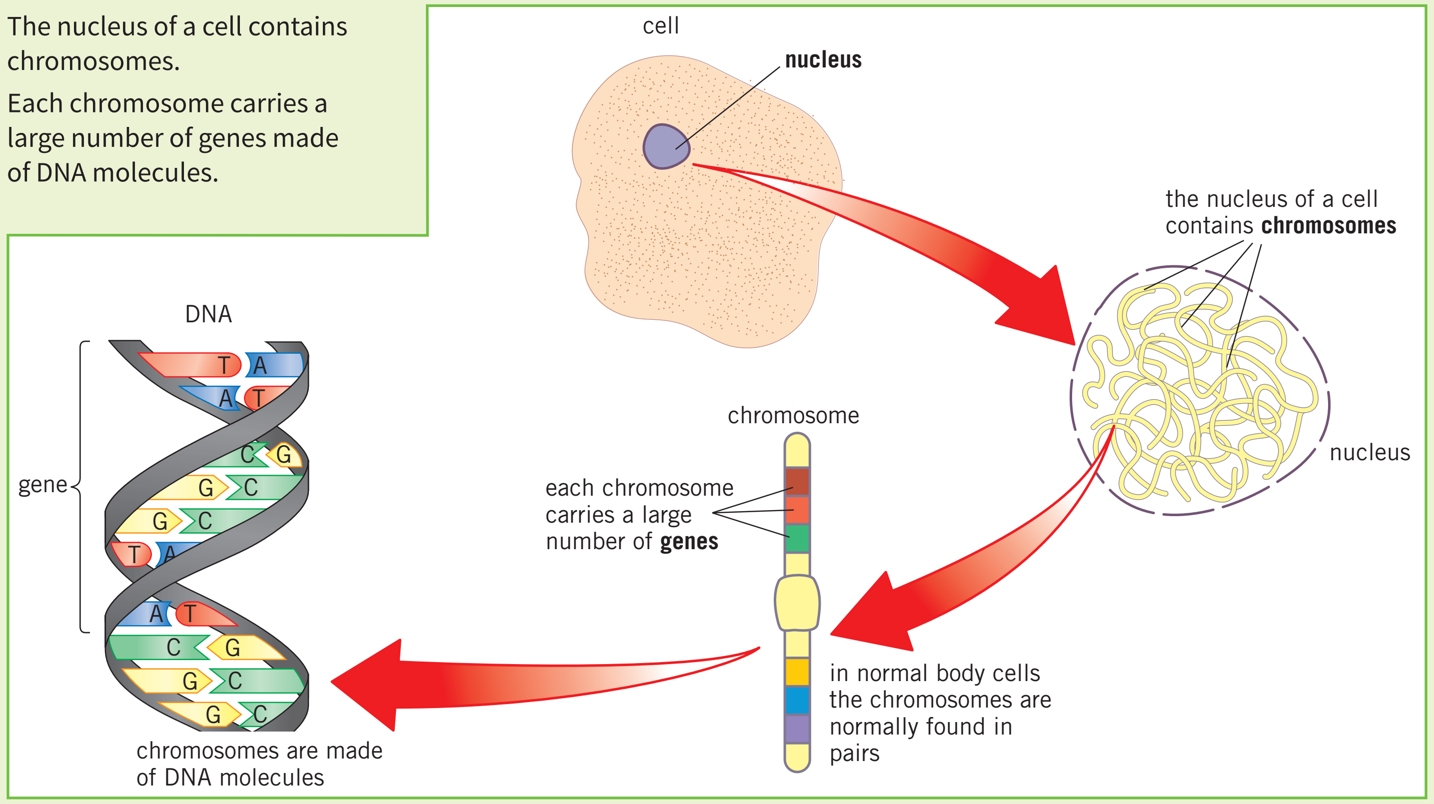
# Chapter 2: Cell division

## Knowledge organiser

### Chromosomes

The nucleus of a cell contains chromosomes.

Each chromosome carries a large number of genes made of DNA molecules.

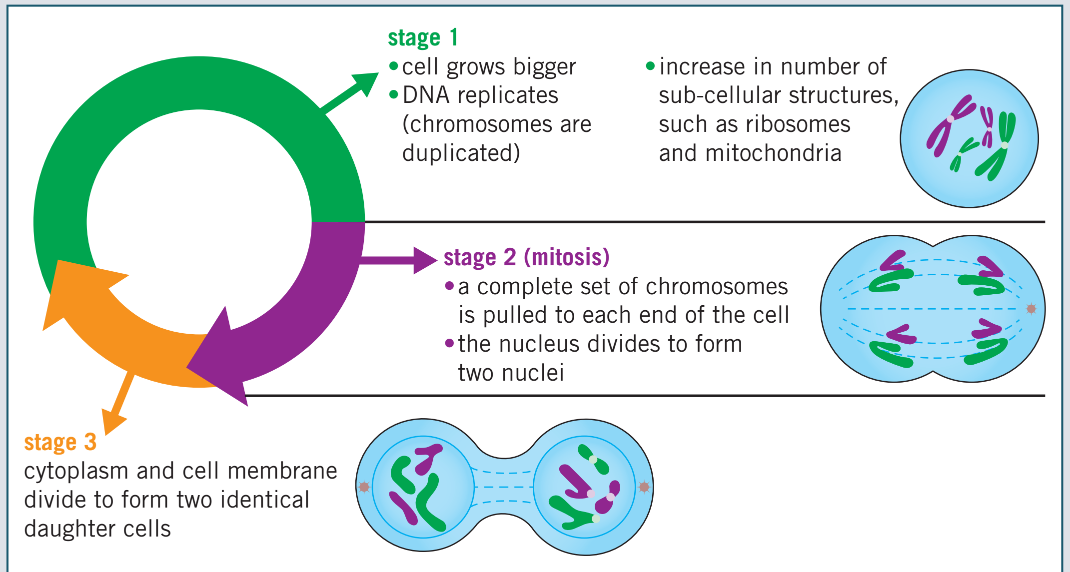



### The cell cycle

Body cells divide to form two identical **daughter cells** by going through a series of stages known as the **cell cycle**.

Cell division by **mitosis** is important for the growth and repair of cells, for example, the replacement of skin cells. Mitosis is also used for asexual reproduction.

There are *three* main stages in the cell cycle:




### Stem cells in medicine

A stem cell is an undifferentiated cell that can develop into one or more types of specialised cell.

There are two types of stem cell in mammals: **adult stem cells** and **embryonic stem cells**.

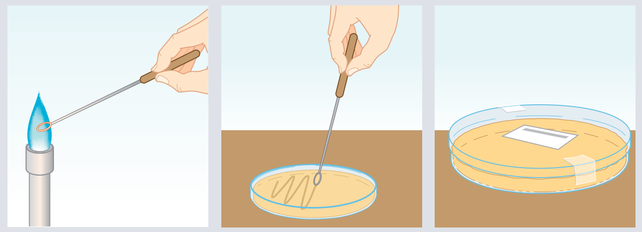
Stem cells can be **cloned** to produce large numbers of identical cells.

| Type of stem cell | Where are they found? | What can they differentiate into? | Advantages | Disadvantages |
|---|---|---|---|---|
| **adult stem cells** | specific parts of the body in adults and children – for example, bone marrow | can only differentiate to form certain types of cells – for example, stem cells in bone marrow can only differentiate into types of blood cell | • fewer ethical issues – adults can consent to have their stem cells removed and used<br>• an already established technique for treating diseases such as leukaemia<br>• relatively safe to use as a treatment and donors recover quickly | • requires a donor, potentially meaning a long wait time to find someone suitable<br>• can only differentiate into certain types of specialised cells, so can be used to treat fewer diseases |
| **embryonic stem cells** | early human embryos (often taken from spare embryos from fertility clinics) | can differentiate into any type of specialised cell in the body – for example, a nerve cell or a muscle cell | • can treat a wide range of diseases as can form any specialised cell<br>• may be possible to grow whole replacement organs<br>• usually no donor needed as they are obtained from spare embryos from fertility clinics | • ethical issues as the embryo is destroyed and each embryo is a potential human life<br>• risk of transferring viral infections to the patient<br>• newer treatment so relatively under-researched – not yet clear if they can cure as many diseases as thought |
| **plant meristem** | meristem regions in the roots and shoots of plants | can differentiate into all cell types – they can be used to create clones of whole plants | • rare species of plants can be cloned to prevent extinction<br>• plants with desirable traits, such as disease resistance, can be cloned to produce large numbers of identical plants<br>• fast and low-cost production of large numbers of plants | • cloned plants are genetically identical, so a whole crop is at risk of being destroyed by a single disease or genetic defect |

### Binary fission

Cell division in bacteria is called binary fission. In optimum temperature and nutrients, bacteria can multiply as often as every 20 minutes. In a lab, bacteria can be grown in sterile conditions on an agar gel plate or in a nutrient broth.

The lid of the petri dish must be sealed but not all the way so that oxygen can still get in. This is so that harmful bacteria that do not need oxygen aren't able to grow.



### Therapeutic cloning

In **therapeutic cloning**

- cells from a patient's own body are used to create a cloned early embryo of themselves
- stem cells from this embryo can be used for medical treatments and growing new organs
- these stem cells have the same genes as the patient, so are less likely to be rejected when transplanted.

### Key terms

**Make sure you can write a definition for these key terms.**

adult stem cell, binary fission, cell cycle, chromosome, clone, daughter cells, embryonic stem cell, gene, meristem, mitosis, nucleus, therapeutic cloning

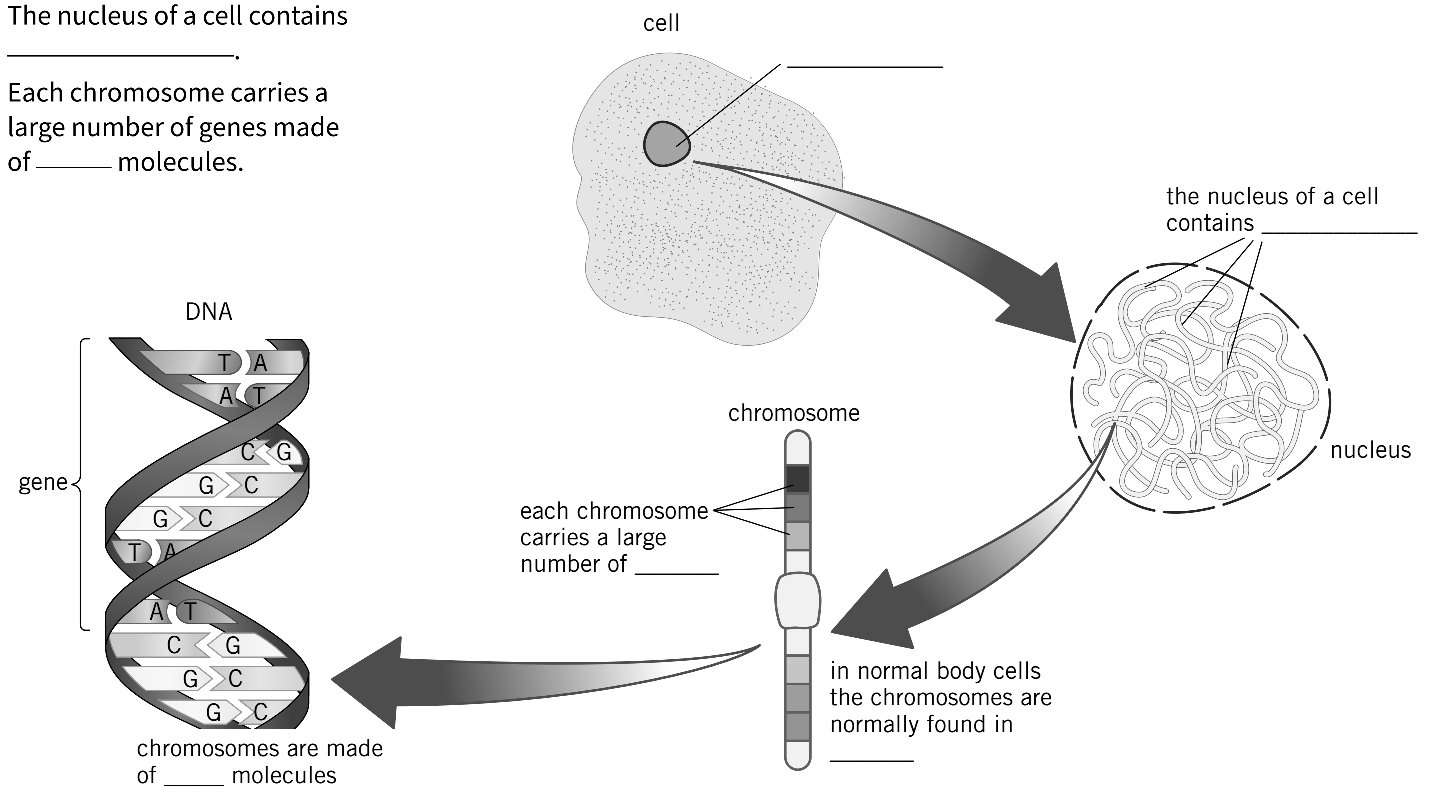
# Chapter 2: Cell division

## Knowledge organiser

### Chromosomes

The nucleus of a cell contains ______________.

Each chromosome carries a large number of genes made of ______ molecules.




### Stem cells in medicine

A stem cell is an undifferentiated cell that can develop into one or more types of ____________ cell.

There are two types of stem cell in ____________: **adult stem cells** and ____________ **stem cells**.

Stem cells can be ____________ to produce large numbers of identical cells. Complete the table.

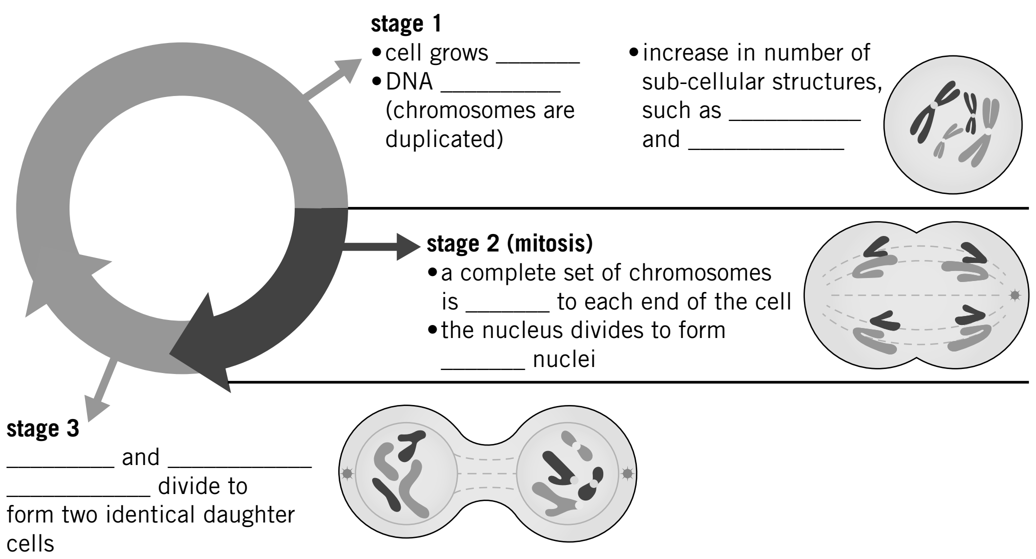
| Type of stem cell | Where are they found? | What can they differentiate into? | Advantages | Disadvantages |
|---|---|---|---|---|
| adult stem cells | | | • <br> • <br> • | • <br> • |
| embryonic stem cells | | | • <br> • <br> • | • <br> • <br> • |
| plant meristem | | | • <br> • <br> • | • |

### The cell cycle

Body cells divide to form ________ identical **daughter cells** by going through a series of stages known as the **cell cycle**.

Cell division by ____________ is important for the growth and ____________ of cells, for example, the replacement of skin cells. Mitosis is also used for ____________ reproduction.

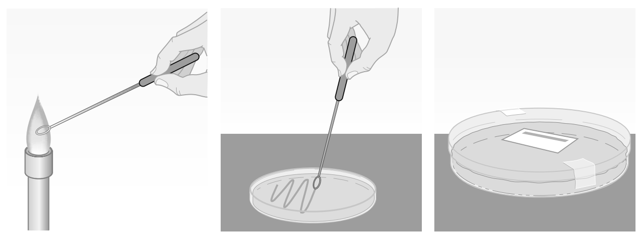
There are *three* main stages in the cell cycle:




### Binary fission

Cell division in ____________ is called binary fission. In optimum ____________ and ____________, bacteria can multiply as often as every 20 minutes. In a lab, bacteria can be grown in ____________ conditions on an agar gel plate or in a nutrient broth.

The lid of the petri dish must be sealed but not all the way so that ____________ can still get in. This is so that harmful ____________ that do not need oxygen aren't able to grow.



### Therapeutic cloning

In **therapeutic cloning**

- cells from a patient's own body are used to create a cloned early ____________ of themselves
- stem cells from this embryo can be used for medical treatments and growing new ____________
- these stem cells have the same genes as the patient, so are less likely to be ____________ when transplanted.

**Key terms**

**Make sure you can write a definition for these key terms.**

*adult stem cell* *binary fission* *cell cycle* *chromosome* *clone* *daughter cells* *embryonic stem cell* *gene* *meristem* *mitosis* *nucleus* *therapeutic cloning*

# Chapter 2: Cell division

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B2 questions | Answers |
|---|---|---|
| 1 | What is a stem cell? | |
| 2 | What are adult stem cells? | |
| 3 | Where can adult stem cells be found? | |
| 4 | What are embryonic stem cells? | |
| 5 | Where are embryonic stem cells found? | |
| 6 | What is therapeutic cloning? | |
| 7 | Give one advantage of using therapeutic cloning. | |
| 8 | Give one advantage of using adult stem cells. | |
| 9 | Give two disadvantages of using adult stem cells. | • |
| 10 | Give two advantages of using embryonic stem cells. | •<br>• |
| 11 | Give two disadvantages of using embryonic stem cells. | •<br>• |
| 12 | What are plant meristems? | |
| 13 | Give two advantages of using plant meristems to clone plants. | •<br>• |
| 14 | Give one disadvantage of using plant meristems to clone plants. | |
| 15 | What is cell division by mitosis? | |
| 16 | What is the purpose of mitosis? | |
| 17 | What happens during the first stage of the cell cycle? | |
| 18 | What happens during mitosis? | |
| 19 | What happens during the third stage of the cell cycle? | |
| 20 | What is the term for cell division in bacteria? | |

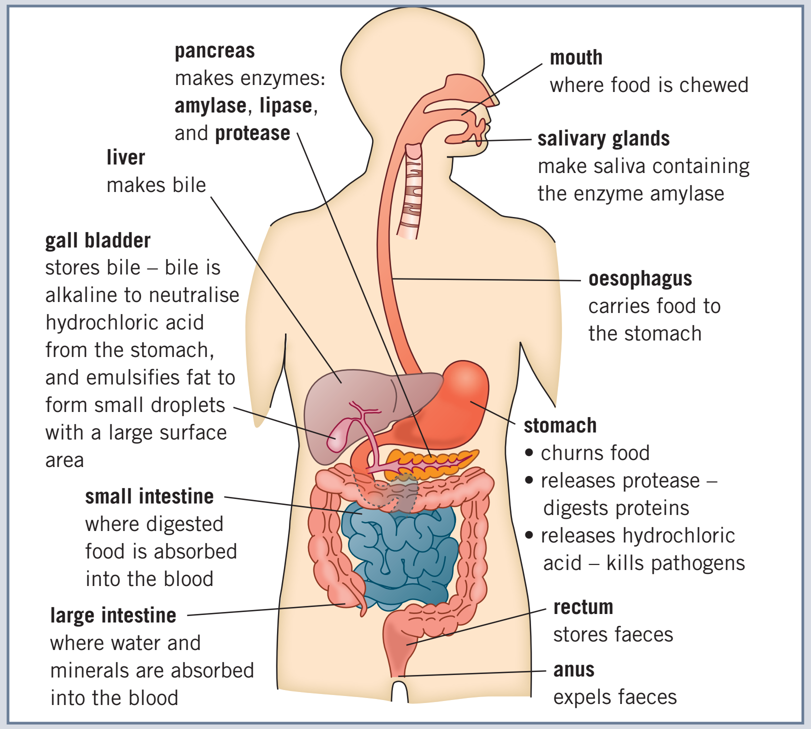
# Chapter 3: Organisation and the digestive system

## Knowledge organiser

There are five **levels of organisation** in living organisms:

- **cells** – basic building blocks
- **tissues** – groups of cells that have similar structures and functions
- **organs** – groups of tissues working together to perform a specific function
- **organ systems** – groups of organs working together
- **organisms** – organ systems work together, forming an organism

## Digestive system



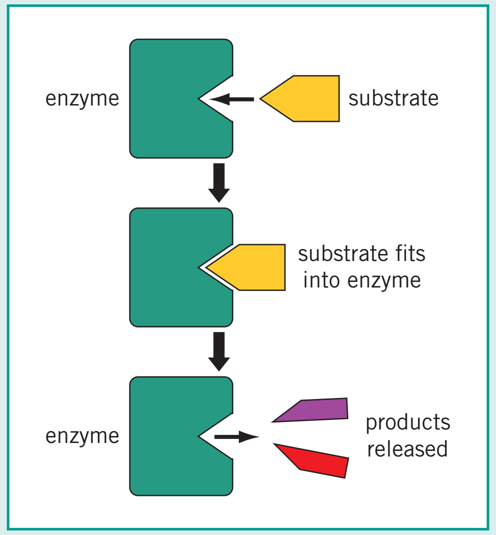

## Digestive enzymes

Digestive enzymes convert food into small, soluble molecules that can then be absorbed into the bloodstream. For example, carbohydrases break down carbohydrates into simple sugars.

| Enzyme | Sites of production | Reaction catalysed |
|---|---|---|
| amylase | salivary glands<br>pancreas<br>small intestine | starch → glucose |
| proteases | stomach<br>pancreas<br>small intestine | proteins → amino acids |
| lipases | pancreas<br>small intestine | lipids → fatty acids and glycerol |

## Enzymes

**Enzymes** are large proteins that **catalyse** (speed up) reactions. Enzymes are not changed in the reactions they catalyse.




### Lock and key theory

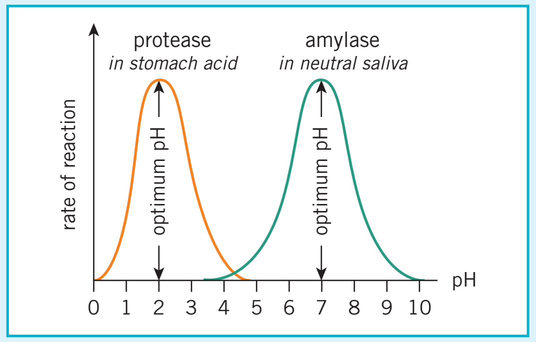
This is a simple model of how enzymes work:

1. The enzyme's **active site** (where the reaction occurs) is a specific shape.
2. The enzyme (the lock) will only catalyse a specific reaction because the **substrate** (the key) fits into its active site.
3. At the active site, enzymes can break molecules down into smaller ones or bind small molecules together to form larger ones.
4. When the products have been released, the enzyme's active site can accept another substrate molecule.

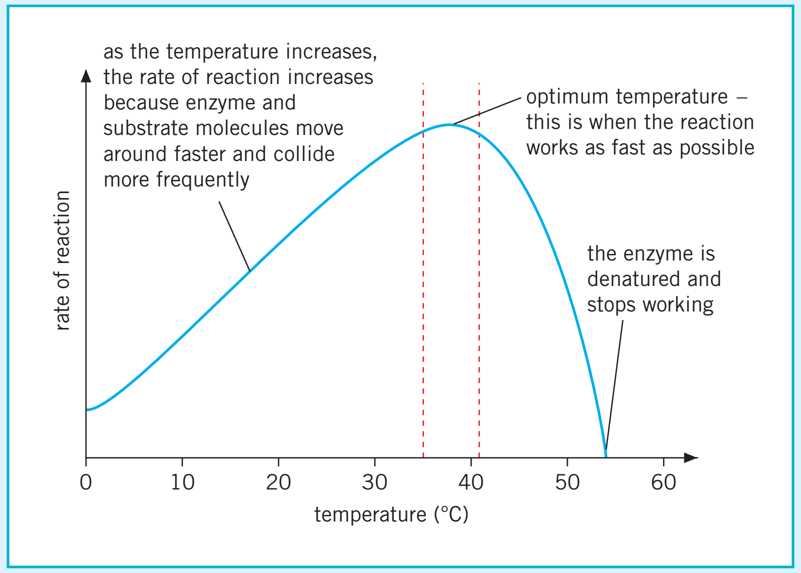
## The effect of pH on enzymes

Different enzymes have different **optimum** pH values.

This allows enzymes to be adapted to work well in environments with different pH values. For example, parts of the digestive system greatly differ in pH.

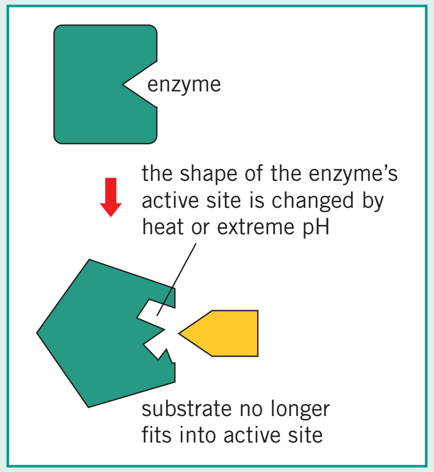



## The effect of temperature on enzymes




## Denaturation

At extremes of pH or at very high temperatures, the shape of an enzyme's active site can change.




The substrate can no longer bind to the active site, so the enzyme cannot catalyse the reaction – the enzyme has been **denatured**.

## Key terms

**Make sure you can write a definition for these key terms.**

active site · amylase · catalyse · denatured · enzyme · lipase · optimum · organ · organ system · pH · protease · substrate · temperature · tissue

# Chapter 3: Organisation and the digestive system

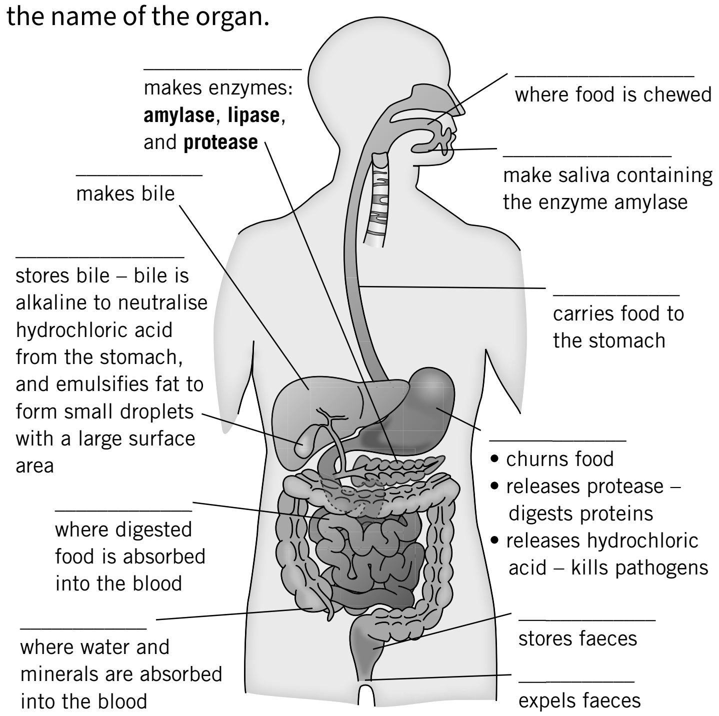
## Knowledge organiser

There are five **levels of organisation** in living organisms. Complete the definitions for each level.

- **cells** ____________
- **tissues** ____________
- **organs** ____________
- **organ systems** ____________
- **organisms** ____________

## Digestive system

Write the name of the organ.



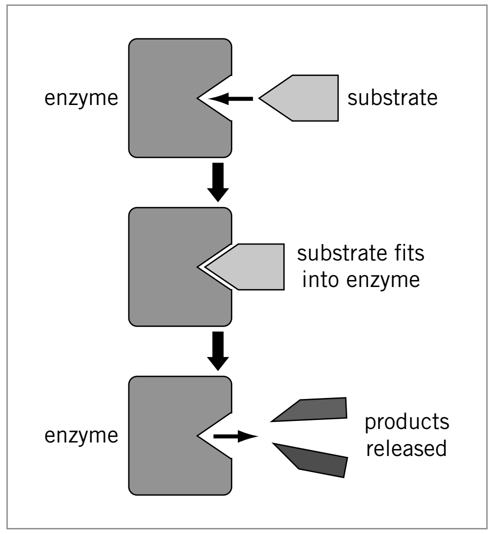

## Digestive enzymes

Digestive enzymes convert food into small, soluble molecules that can then be absorbed into the ____________. For example, carbohydrases break down ____________ into ____________.

| Enzyme | Sites of production | Reaction catalysed |
|---|---|---|
| ____________ | salivary glands<br>pancreas<br>small intestine | starch → glucose |
| proteases | ____________<br>____________<br>____________ | ____________ |
| lipases | ____________<br>____________ | ____________ |

## Enzymes

**Enzymes** are large proteins that ________ (speed up) reactions. Enzymes are not changed in the reactions they catalyse.




### Lock and key theory

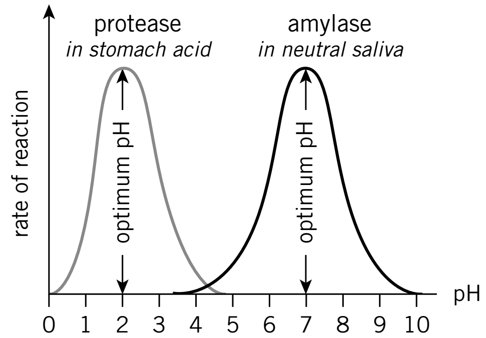
This is a simple model of how enzymes work:

1. The enzyme's ________ ________ (where the reaction occurs) is a specific shape.
2. The ________ (the lock) will only catalyse a specific reaction because the ________ (the key) fits into its active site.
3. At the active site, enzymes can ________ molecules down into smaller ones or bind small molecules together to form ________ ones.
4. When the products have been released, the enzyme's active site can accept another substrate molecule.

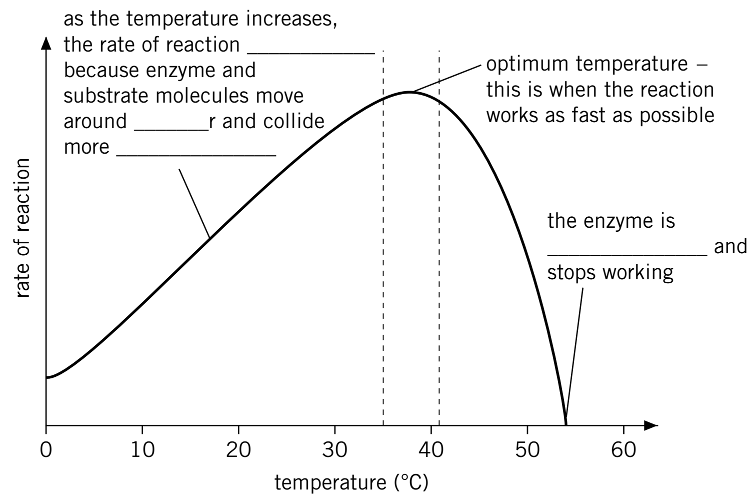
## The effect of pH on enzymes

Different enzymes have different ________ pH values.

This allows enzymes to be adapted to work well in environments with different pH values. For example, parts of the digestive system greatly differ in ________.

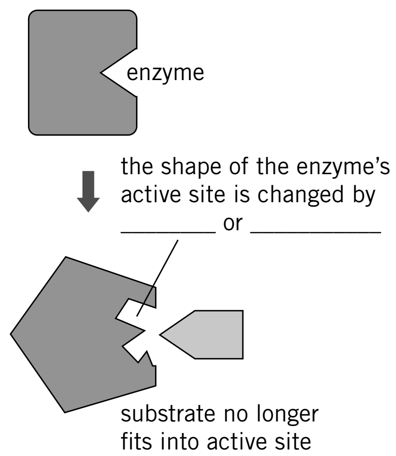



## The effect of temperature on enzymes




## Denaturation

At extremes of pH or at very high temperatures, the shape of an enzyme's active site can change.




The substrate can no longer ________ to the active site, so the enzyme cannot catalyse the reaction – the enzyme has been **denatured**.

**Key terms**

**Make sure you can write a definition for these key terms.**

*active site* *amylase* *catalyse* *denatured* *enzyme* *lipase* *optimum* *organ* *organ system* *pH* *protease* *substrate* *temperature* *tissue*

# Chapter 3: Organisation and digestive system

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

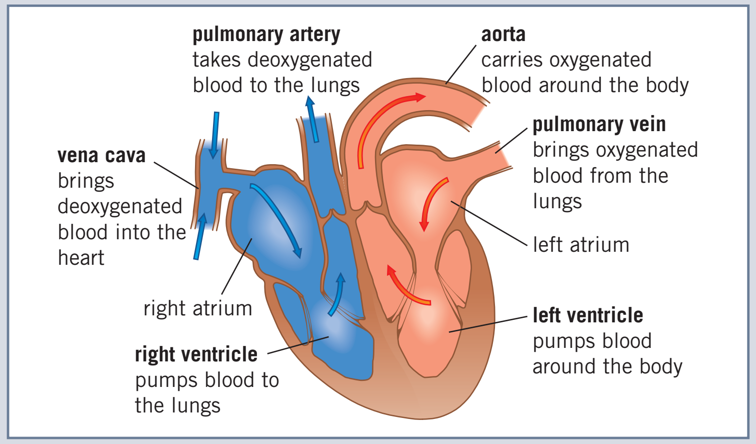
| | B3 questions | Answers |
|---|---|---|
| 1 | Name the five levels of organisation. | |
| 2 | What is a tissue? | |
| 3 | What is an organ? | |
| 4 | What is the function of the liver in digestion? | |
| 5 | What is the function of saliva in digestion? | |
| 6 | Name three enzymes produced in the pancreas. | |
| 7 | What are enzymes? | |
| 8 | Why are enzymes described as specific? | |
| 9 | Describe the function of amylase. | |
| 10 | Where is amylase produced? | |
| 11 | Describe the function of proteases. | |
| 12 | Where are proteases produced? | |
| 13 | Describe the function of lipases. | |
| 14 | Where are lipases produced? | |
| 15 | What are two factors that affect the rate of activity of an enzyme? | |
| 16 | What does denatured mean? | |
| 17 | Describe the effect of temperature on enzyme activity. | |
| 18 | Describe the effect of pH on enzyme activity. | |
| 19 | Why do different digestive enzymes have different optimum pHs? | |
| 20 | What is an organ system? | |

# Chapter 4: Organising animals and plants 1

## Knowledge organiser

### The heart

The heart is the organ that pumps blood around your body. It is made from **cardiac** muscle tissue, which is supplied with oxygen by the **coronary artery**.



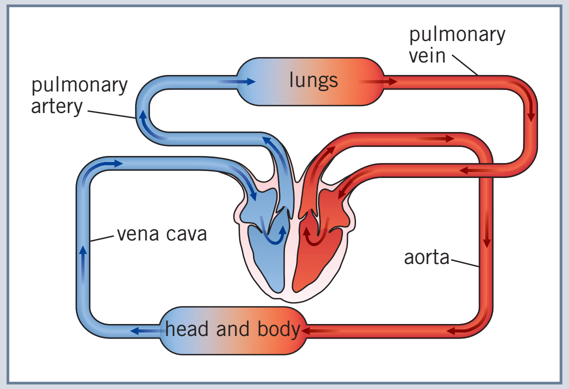

Heart rate is controlled by a group of cells in the right atrium that generate electrical impulses, acting as a pacemaker.

Artificial pacemakers can be used to control irregular heartbeats.

### Double circulatory system

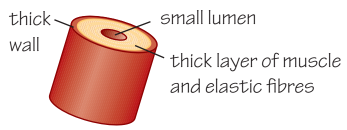
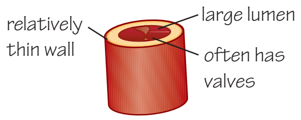
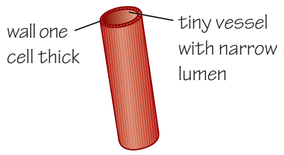
The human circulatory system is described as a **double circulatory system** because blood passes through the heart twice for every circuit around the body:

- the right ventricle pumps blood to the lungs where gas exchange takes place
- the left ventricle pumps blood around the rest of the body.




| | |
|---|---|
| **blood is a tissue made up of four main components** | • red blood cells – bind to oxygen and transport it around the body<br>• plasma – transports substances and blood cells around the body<br>• platelets – form blood clots to create barriers to infections<br>• white blood cells – part of the immune system to defend the body against pathogens |

### Blood vessels

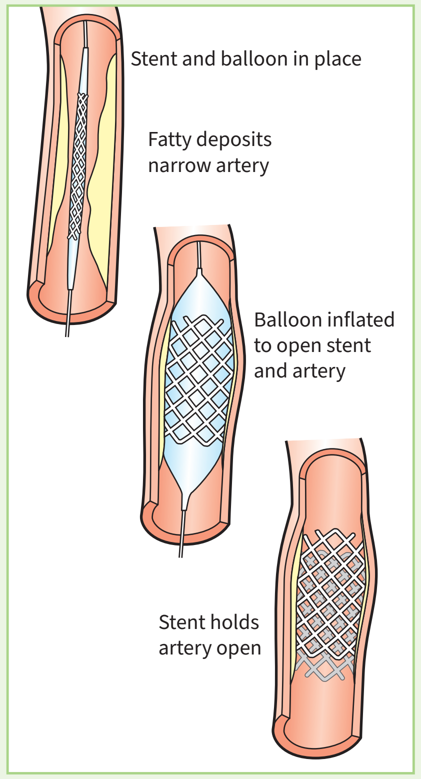
| Vessel | Function | Structure | Diagram |
|---|---|---|---|
| **artery** | carries blood away from the heart (high pressure) | • thick, muscular, and elastic walls<br>• the walls can stretch and withstand high pressure<br>• small lumen |  |
| **vein** | carries blood to the heart (low pressure) | • have valves to stop blood flowing the wrong way<br>• thin walls<br>• large lumen |  |
| **capillary** | • carries blood to tissues and cells<br>• connects arteries and veins | • one cell thick – short diffusion distance for substances to move between the blood and tissues (e.g., oxygen into cells and carbon dioxide out)<br>• very narrow lumen |  |

### Heart issues

**Coronary** heart disease is caused by a build up of fatty material in the coronary arteries, making them narrow, and reducing blood flow. Stents can be used to help keep the coronary arteries open.

Patients with heart failure often have to use artificial hearts before a donor heart becomes available for a heart transplant.

People with faulty heart **valves** may feel symptoms of breathlessness as valves do not fully open, making the heart less efficient. These can be replaced with biological valves (from animals), or mechanical valves (made from titanium and polymers).

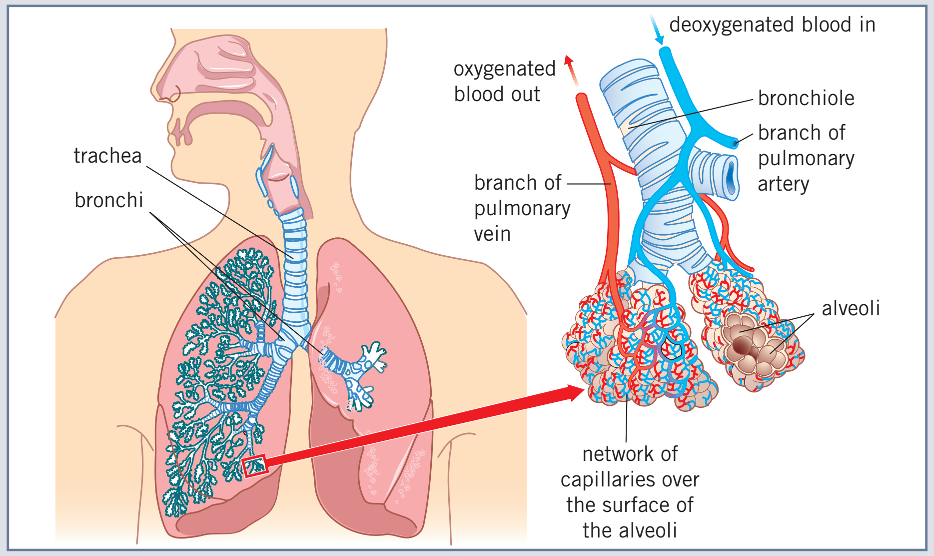



### Lungs

When breathing in, air moves

1. into the body through the mouth and nose
2. down the trachea
3. into the **bronchi**
4. through the **bronchioles**
5. into the **alveoli** (air sacs).

Oxygen then diffuses into the blood in the network of **capillaries** over the surface of the alveoli.



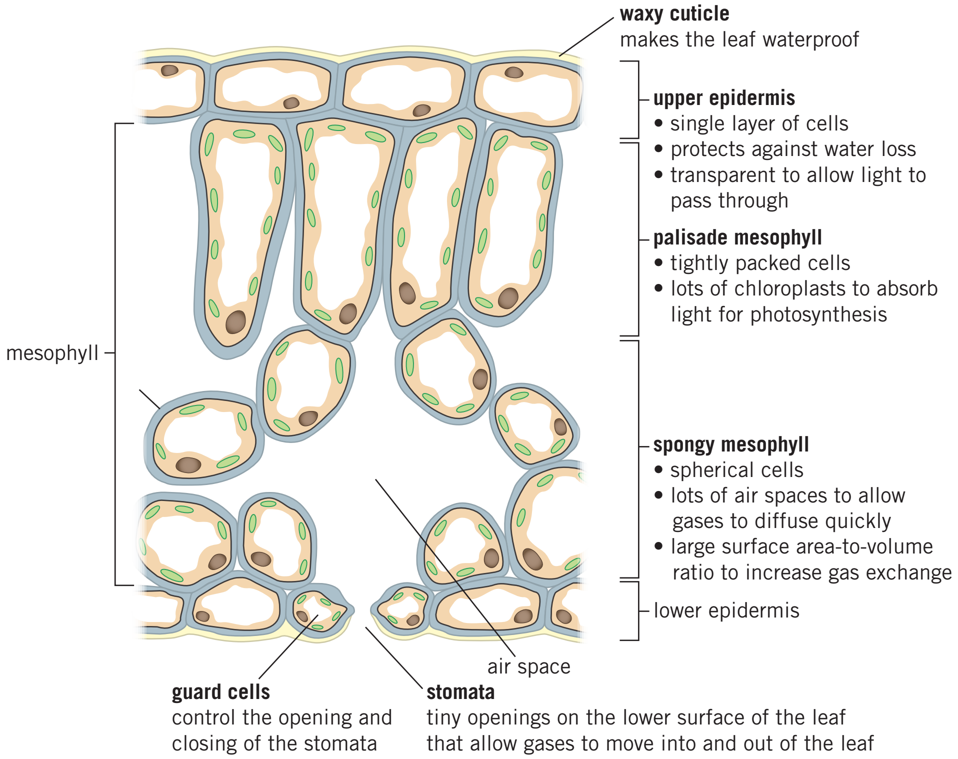

**Key terms**

**Make sure you can write a definition for these key terms.**

alveoli, aorta, artery, atrium, bronchi, bronchiole, capillary, cardiac, coronary, double circulatory system, plasma, platelet, pulmonary, valve, vein, vena cava, ventricle

### Tissues in leaves

Leaves are organs because they contain many tissues that work together to perform photosynthesis.




### Stomata

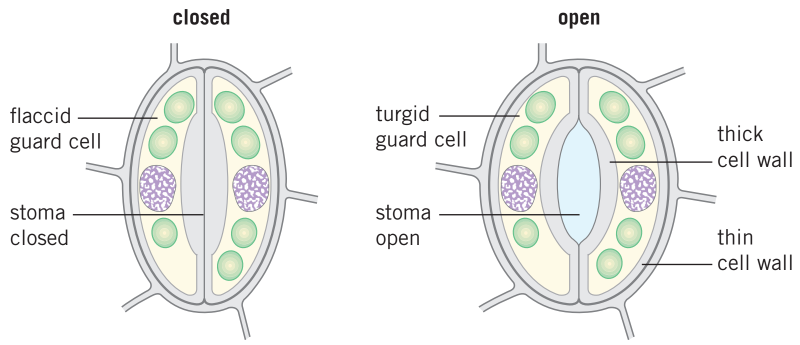
**Stomata** are tiny openings in the undersides of leaves – this placement reduces water loss through evaporation.

They control gas exchange and water loss from leaves by:

- allowing diffusion of carbon dioxide into the plant for photosynthesis
- allowing diffusion of oxygen out of the plant.

**Guard cells** are used to open and close the stomata.

When a plant has plenty of water, the guard cells become turgid. The cell wall on the inner surface is very thick, so it cannot stretch as much as the outer surface. So as the guard cells swell up, they curve away from each other, opening the stoma.




### Transpiration

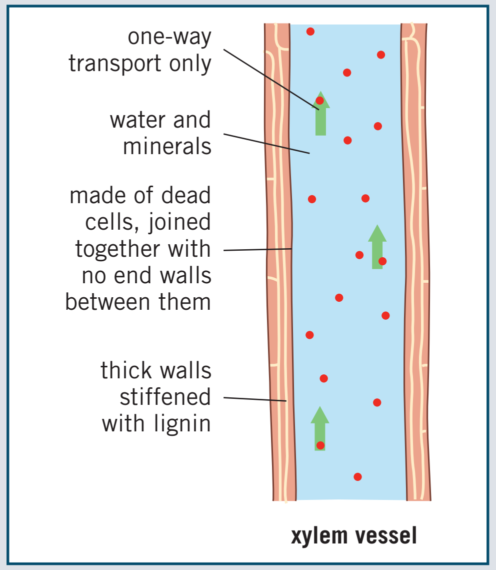
**Description**

Water is lost through the stomata by evaporation. This pulls water up from the roots through the **xylem** and is called transpiration. The constant movement of water up the plant is called the **transpiration stream**.

**Importance**

- provides water to cells to keep them **turgid**
- provides water to cells for photosynthesis
- transports mineral ions to leaves

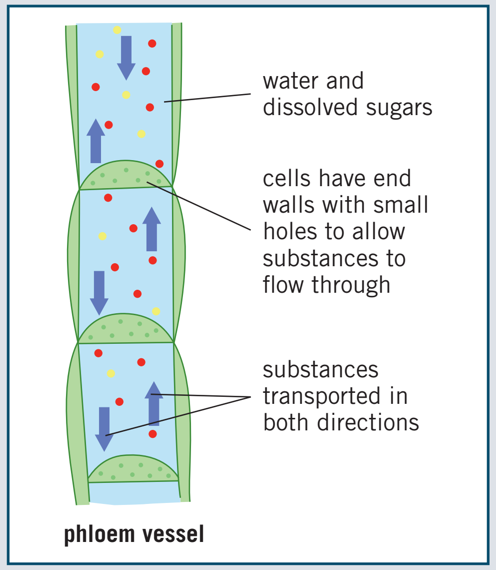
**Specialised tissues**




### Translocation

The movement of dissolved sugars from the leaves to the rest of the plant through the **phloem**.

- moves dissolved sugars made in the leaves during photosynthesis to other parts of the plant
- this allows for respiration, growth, and glucose storage




### Factors affecting the rate of transpiration

| Factor | Effect on transpiration | Because... |
|---|---|---|
| **temperature** | higher temperatures *increase* the rate of transpiration | water evaporates faster in higher temperatures |
| **humidity** | lower humidity *increases* the rate of transpiration | the drier the air, the steeper the concentration gradient of water molecules between the air and leaf |
| **wind speed** | more wind *increases* the rate of transpiration | wind removes the water vapour quickly, maintaining a steeper concentration gradient |
| **light intensity** | higher light intensity *increases* the rate of transpiration | stomata open wider to let more carbon dioxide into the leaf for photosynthesis |

**Key terms**

**Make sure you can write a definition for these key terms.**

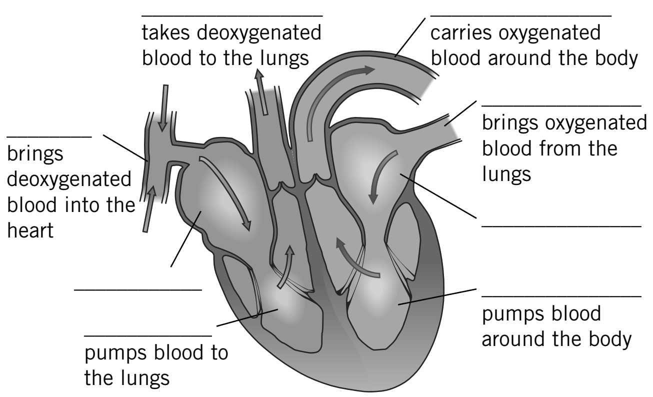
photosynthesis stomata guard cells transpiration translocation
light intensity temperature humidity wind speed phloem xylem

# Chapter 4: Organising animals and plants 1

## Knowledge organiser

### The heart

The heart is the organ that pumps ________ around your body. It is made from ________ muscle tissue, which is supplied with oxygen by the ________ **artery**. Complete the labels on the diagram.



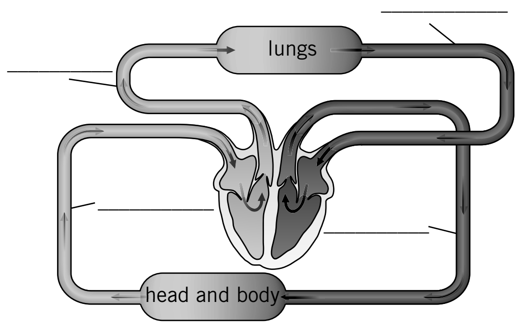

Heart rate is controlled by a group of cells in the ________ that generate ____________, acting as a pacemaker.

Artificial pacemakers can be used to control ______________.

### Double circulatory system

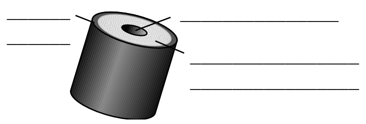
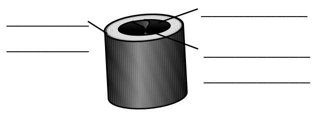
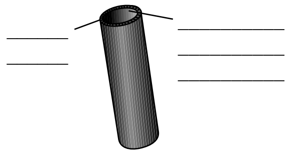
The human circulatory system is described as a ________ ________ ________ because blood passes through the heart ________ for every circuit around the body:

- the right ventricle pumps blood to the ________ where gas exchange takes place
- the ____________ ____________ pumps blood around the rest of the body.




| **blood is a tissue made up of ______ main components** | |
|---|---|
| | • ____________ – bind to oxygen and transport it around the body<br>• ____________ – transports substances and blood cells around the body<br>• ____________ – form blood clots to create barriers to infections<br>• ____________ – part of the immune system to defend the body against pathogens |

### Blood vessels

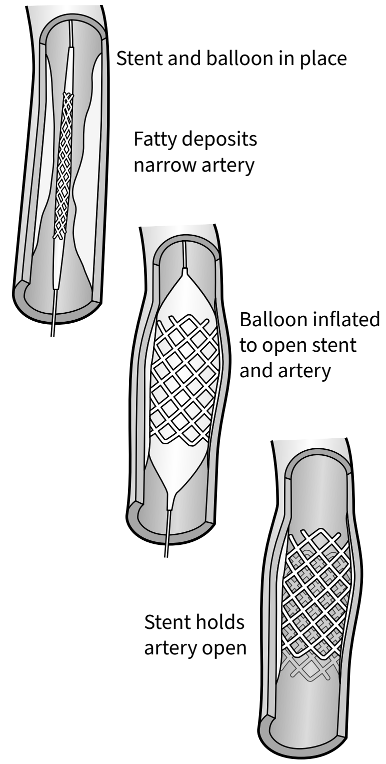
| Vessel | Function | Structure | Diagram |
|---|---|---|---|
| artery | ____________<br>____________ | •<br>•<br>• |  |
| vein | | •<br>•<br>• |  |
| capillary | •<br>• | •<br>• |  |

### Heart issues

**Coronary** heart disease is caused by a build up of fatty material in the ________ arteries, making them ________, and reducing ____________ ____________. ________ can be used to help keep the coronary arteries open.

Patients with heart failure often have to use ____________ ____________ before a donor heart becomes available for a heart transplant.

People with faulty heart **valves** may feel symptoms of breathlessness as valves do not fully ________, making the heart less efficient. These can be replaced with ____________ ____________ (from animals), or ______________ ____________ (made from titanium and polymers).



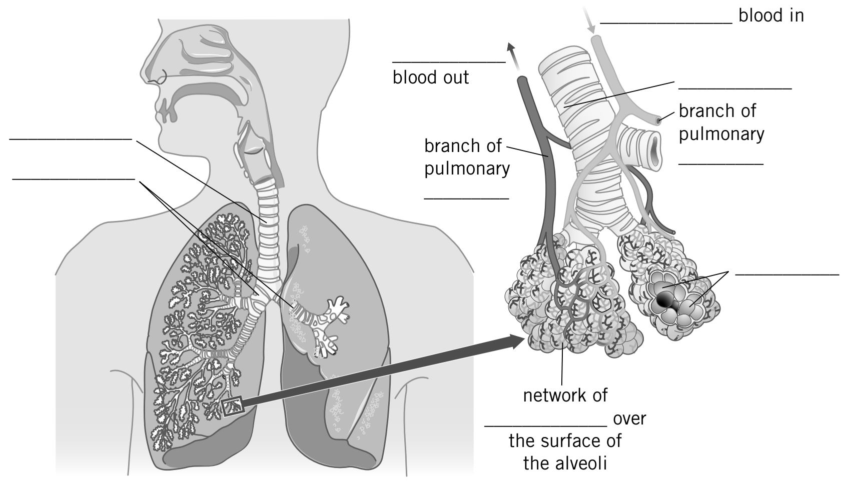

### Lungs

When breathing in, air moves

1. into the body through the mouth and nose
2. down the __________
3. into the __________
4. through the __________
5. into the __________ (air sacs).

Oxygen then diffuses into the blood in the network of __________ over the surface of the alveoli.

Label the diagram.




**Key terms**

**Make sure you can write a definition for these key terms.**

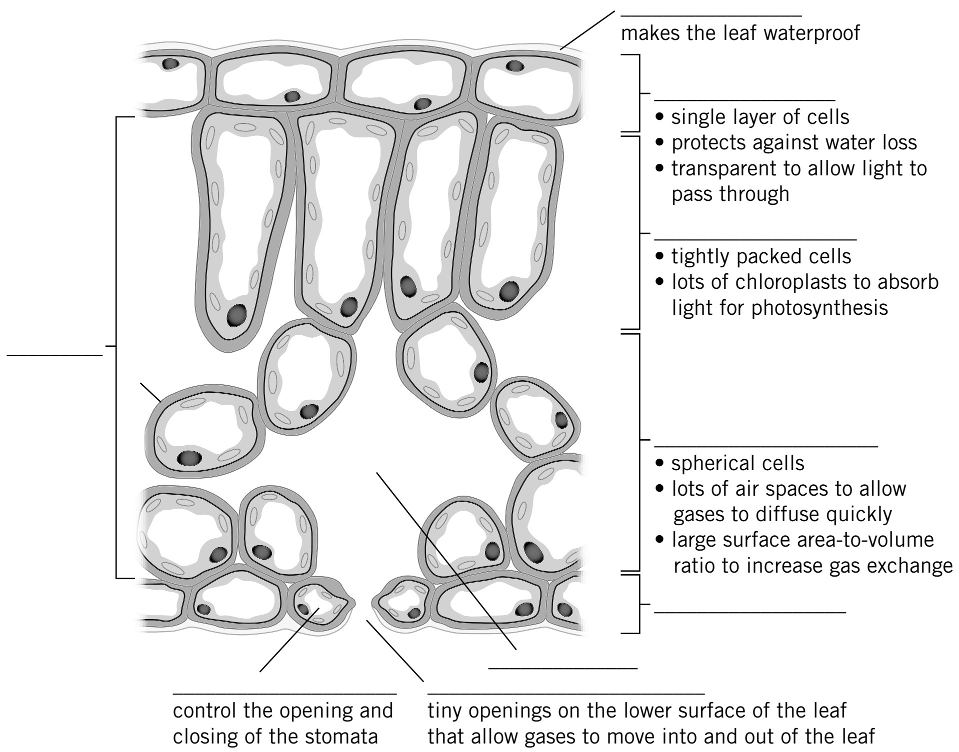
*alveoli aorta artery atrium bronchi bronchiole capillary cardiac coronary double circulatory system plasma platelet pulmonary valve vein vena cava ventricle*

# Chapter 4: Organising animals and plants 2

## Knowledge organiser

### Tissues in leaves

Leaves are ____________ because they contain many tissues that work together to perform ______________.




### Stomata

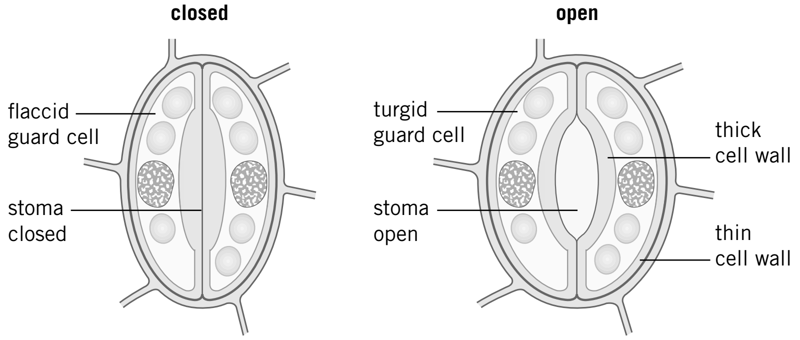
________ are tiny openings in the undersides of leaves – this placement reduces water loss through ________.

They control gas exchange and water loss from leaves by:

- allowing ________ of _______________ into the plant for photosynthesis
- allowing diffusion of ________ out of the plant.

_____________ _____________ are used to open and close the stomata.

When a plant has plenty of water, the guard cells become ________. The cell wall on the inner surface is very ________, so it cannot stretch as much as the outer surface. So as the guard cells ________ up, they curve away from each other, opening the ________.




### Transpiration

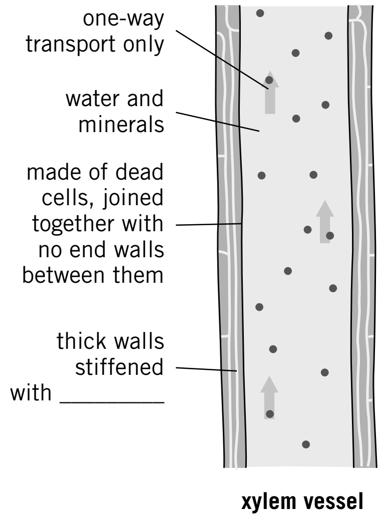
**Description**

Water is lost through the stomata by evaporation. This pulls water up from the roots through the ________ and is called __________. The constant ________ of water up the plant is called the ____________ ____________.

**Importance**

- provides water to cells to keep them ________
- provides ________ to cells for photosynthesis
- transports ____________ to leaves

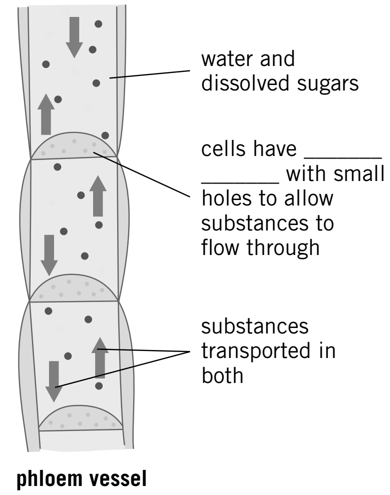
**Specialised tissues**




### Translocation

The movement of dissolved sugars from the leaves to the rest of the plant through the ________.

- moves dissolved sugars made in the leaves during ____________ to other parts of the plant
- this allows for ________, growth, and ________ storage




### Factors affecting the rate of transpiration

| Factor | Effect on transpiration | Because... |
|---|---|---|
| temperature | | |
| humidity | | |
| wind speed | | |
| light intensity | | |

**Key terms**

**Make sure you can write a definition for these key terms.**

*photosynthesis* *stomata* *guard cells* *transpiration* *translocation*
*light intensity* *temperature* *humidity* *wind speed* *phloem* *xylem*

# Chapter 4: Organising animals and plants

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B4 questions | Answers |
|---|---|---|
| 1 | Name the four main components of blood. | |
| 2 | What is the function of platelets? | |
| 3 | Why is the human circulatory system a double circulatory system? | |
| 4 | How does the structure of an artery relate to its function? | |
| 5 | How does the structure of a vein relate to its function? | |
| 6 | How does the structure of a capillary relate to its function? | |
| 7 | List the structures air passes through when breathing in. | |
| 8 | What is the function of the red blood cells? | |
| 9 | What is the function of the white blood cells? | |
| 10 | What is the function of the plasma? | |
| 11 | Why is a leaf an organ? | |
| 12 | How is the upper epidermis adapted for its function? | • <br> • |
| 13 | How is the palisade mesophyll adapted for its function? | |
| 14 | How is the spongy mesophyll adapted for its function? | |
| 15 | What is the function of the guard cells? | |
| 16 | What is the function of the xylem? | |
| 17 | Give three adaptations of the xylem. | • <br> • <br> • |
| 18 | What is the function of the phloem? | |
| 19 | What is the purpose of translocation? | |
| 20 | Define the term transpiration. | |
| 21 | What is the purpose of transpiration? | • <br> • <br> • |
| 22 | Name four factors that affect the rate of transpiration. | |
| 23 | What effect does temperature have on the rate of transpiration? | |
| 24 | What effect does humidity have on the rate of transpiration? | |
| 25 | Why does increased light intensity increase the rate of transpiration? | |
| 26 | What is the function of the stomata? | |
| 27 | Where are most stomata found? | |
| 28 | What is the advantage to the plant of having a high number of stomata at this location? | |

# Chapter 5: Communicable diseases

## Knowledge organiser

### Communicable diseases

**Communicable diseases** can be spread from one organism to another.

**Viruses** live and reproduce rapidly inside an organism's cells. This can damage or destroy the cells.

| Viruses | Spread by | Symptoms |
|---|---|---|
| measles | inhalation of droplets produced by infected people when sneezing and coughing | • fever<br>• red skin rash<br>• complications can be fatal – young children are vaccinated to immunise them against measles |
| HIV (human immunodeficiency virus) | • sexual contact<br>• exchange of body fluids (e.g., blood when drug users share needles) | • flu-like symptoms at first<br>• virus attacks the body's immune cells, which can lead to AIDS – where the immune system is so damaged that it cannot fight off infections or cancers |
| TMV (tobacco mosaic virus – plants) | • direct contact of plants with infected plant material<br>• animal and plant vectors<br>• soil: the pathogen can remain in soil for decades | • mosaic pattern of discolouration on the leaves – where chlorophyll is destroyed<br>• reduces plant's ability to photosynthesise, affecting growth |

**Bacteria** reproduce rapidly inside organisms and may produce **toxins** that damage tissues and cause illness.

| Bacteria | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| *Salmonella* | bacteria in or on food that is being ingested | *Salmonella* bacteria and the toxins they produce cause<br>• fever<br>• abdominal cramps<br>• vomiting<br>• diarrhoea | poultry are vaccinated against *Salmonella* bacteria to control spread |
| gonorrhoea | direct sexual contact – gonorrhoea is a **sexually transmitted disease** (STD) | • thick yellow or green discharge from the vagina or penis<br>• pain when urinating | • treatment with antibiotics (many antibiotic-resistant strains have appeared)<br>• barrier methods of contraception, such as condoms |

| Fungi | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| rose black spot | water and wind | • purple or black spots on leaves, which turn yellow and drop early<br>• reduces plant's ability to photosynthesise, affecting growth | • **fungicides**<br>• affected leaves removed and destroyed |

| Protists | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| malaria | mosquitos feed on the blood of infected people and spread the protist pathogen when they feed on another person – organisms that spread disease by carrying pathogens between people are called **vectors** | • recurrent episodes of fever<br>• can be fatal | • prevent mosquito vectors breeding<br>• mosquito nets to prevent bites<br>• anti-malarial medicine |

### Detection and identification of plant diseases

#### Signs that a plant is diseased

- stunted growth
- spots on leaves
- areas of rot or decay
- growths
- malformed stems or leaves
- discolouration
- pest infestation

#### Ways of identifying plant diseases

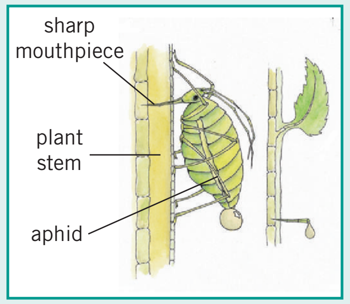
- gardening manuals and websites
- laboratory testing of infected plants
- testing kits containing monoclonal antibodies (Chapter 9 *Monoclonal antibodies*)

### Plant diseases and insects

Plant diseases can also be directly caused by insects.

**Aphids** are insects that suck sap from the stems of plants. This results in

- reduced rate of growth
- wilting
- discolouration of leaves.




Ladybirds can be used to control aphid infestations as ladybird larvae eat aphids.

### Plant defences

#### Physical barriers

- cellulose cell walls – provide a barrier to infection
- tough waxy cuticle on leaves
- bark on trees – a layer of dead cells that can fall off

#### Chemical barriers

- many plants produce antibacterial chemicals
- poison production stops animals eating plants

#### Mechanical adaptations

- thorns and hairs stop animals eating plants
- leaves that droop or curl when touched to scare herbivores or dislodge insects
- some plants **mimic** the appearance of unhealthy or poisonous plants to deter insects or herbivores

### Controlling the spread of communicable disease

There are a number of ways to help prevent the spread of communicable diseases from one organism to another.

#### Hygiene

Hand washing, disinfecting surfaces and machinery, keeping raw meat separate, covering mouth when coughing/sneezing, etc.

#### Isolation

Isolation of infected individuals – people, animals, and plants can be isolated to stop the spread of disease.

#### Controlling vectors

If a vector spreads a disease destroying or controlling the population of the vector can limit the spread of disease.

#### Vaccination

Vaccination can protect large numbers of individuals against diseases.

### Key terms

**Make sure you can write a definition for these key terms.**

aphid, bacterium, communicable disease, fungicide, fungus, isolation, mimic, pathogen, protist, sexually transmitted disease (STD), toxin, vaccination, vector, virus

# Chapter 5: Communicable diseases

## Knowledge organiser

### Communicable diseases

**Communicable diseases** can be spread from one ____________ to another.

**Viruses** live and ________ rapidly inside an organism's cells. This can damage or destroy the cells.

**Viruses**

| | Spread by | Symptoms |
|---|---|---|
| measles | inhalation of ____________ produced by infected people when sneezing and coughing | • <br> • |
| HIV (human immunodeficiency virus) | • <br> • | • <br> • |
| TMV (tobacco mosaic virus – plants) | • <br> • <br> • | • <br> • |

**Bacteria** reproduce rapidly inside organisms and may produce that damage tissues and cause illness.

**Bacteria**

| | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| *Salmonella* | | *Salmonella* bacteria and the toxins they produce cause: <br> • <br> • <br> • <br> • | |
| gonorrhoea | | • <br> • | • <br> • |

**Fungi**

| | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| rose black spot | | • <br> • | • <br> • |

**Protists**

| | Spread by | Symptoms | Prevention and treatment |
|---|---|---|---|
| malaria | mosquitos feed on the blood of infected people and spread the protist pathogen when they feed on another person – organisms that spread disease by carrying pathogens between people are called ________________ | • <br> • | • <br> • <br> • |

### Detection and identification of plant diseases

**Signs that a plant is diseased**

- 
- 
- 
- 
- 
- 
- 

**Ways of identifying plant diseases**

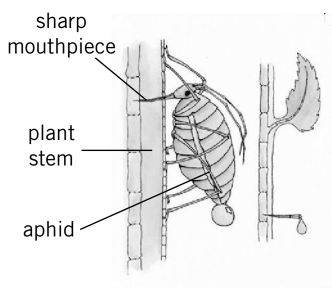
- 
- 
- 

### Plant diseases and insects

Plant diseases can also be directly caused by insects.

________ are insects that suck ______ from the stems of plants. This results in

- 
- 
- 




Ladybirds can be used to control aphid infestations as ladybird ______ eat aphids.

### Plant defences

**Physical barriers**

- 
- 
- 

**Chemical barriers**

- 
- 

**Mechanical adaptations**

- 
- 
- 

### Controlling the spread of communicable disease

Give reasons why some factors can help prevent the spread of communicable diseases from one organism to another.

| Hygiene | Isolation | Controlling ________ | Vaccination |
|---|---|---|---|
| ____________________ | ____________________ | ____________________ | ____________________ |
| ____________________ | ____________________ | ____________________ | ____________________ |
| ____________________ | ____________________ | ____________________ | ____________________ |
| ____________________ | ____________________ | ____________________ | ____________________ |
| ____________________ | ____________________ | ____________________ | ____________________ |

**Key terms**

**Make sure you can write a definition for these key terms.**

aphid  bacterium  communicable disease  fungicide  fungus  isolation  mimic  pathogen  protist  sexually transmitted disease (STD)  toxin  vaccination  vector  virus

# Chapter 5: Communicable diseases

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B5 questions | Answers |
|---|---|---|
| 1 | What is a communicable disease? | |
| 2 | What is a pathogen? | |
| 3 | Name four types of pathogen. | |
| 4 | How can pathogens spread? | |
| 5 | How do bacteria make you ill? | |
| 6 | How do viruses make you ill? | |
| 7 | Name three examples of viral diseases. | |
| 8 | Name two examples of bacterial diseases. | |
| 9 | Name four methods of controlling the spread of communicable disease. | |
| 10 | Describe an example of a protist disease. | |
| 11 | Describe an example of a fungal disease in plants. | |
| 12 | How can the cause of a plant disease be identified? | |
| 13 | What are three mechanical defences that protect plants? | |
| 14 | Give three physical defences of plants. | |
| 15 | How can aphids be controlled by gardeners? | |
| 16 | How can plant diseases be detected? | |

# Chapter 6: Preventing and treating disease

## Knowledge organiser

### Non-specific defences

Non-specific defences of the human body against all pathogens include:

**Skin**

- physical barrier to infection
- produces antimicrobial secretions
- microorganisms that normally live on the skin prevent pathogens growing

**Nose**

Cilia and **mucus** trap particles in the air, preventing them from entering the lungs.

Trachea and bronchi produce mucus, which is moved away from the lungs to the back of the throat by cilia, where it is expelled.

**Stomach**

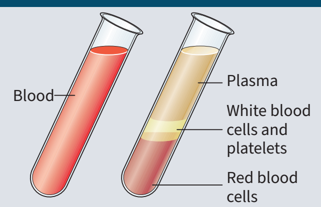
Produces strong acid (pH 2) that destroys pathogens in mucus, food, and drinks.

### White blood cells

If a pathogen enters the body, the immune system tries to destroy the pathogen.

The function of **white blood cells** is to fight pathogens.

There are two main types of white blood cell – lymphocytes and phagocytes.




### Lymphocytes

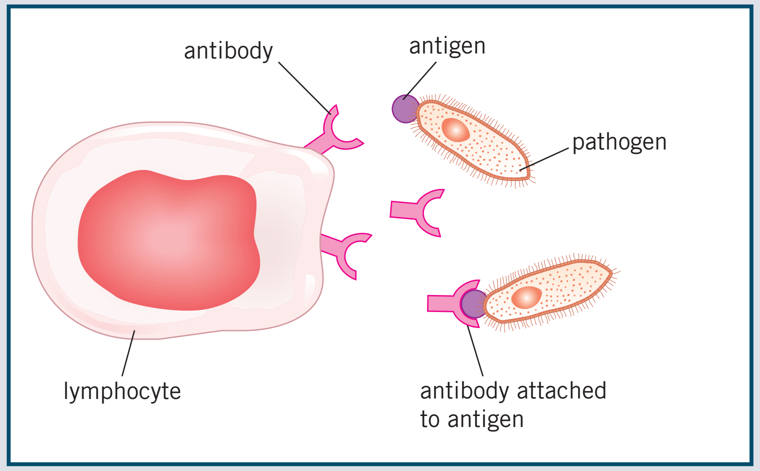
Lymphocytes fight pathogens in two ways:

**Antitoxins**

Lymphocytes produce **antitoxins** that bind to the toxins produced by some pathogens (usually bacteria). This *neutralises* the toxins.

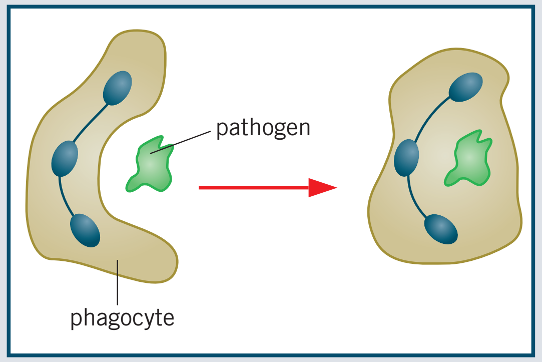
**Antibodies**

Lymphocytes produce **antibodies** that target and help to destroy specific pathogens by binding to **antigens** (proteins) on the pathogens' surfaces.




### Phagocytes

1. Phagocytes are attracted to areas of infection.
2. The phagocyte surrounds the pathogen and engulfs it.
3. Enzymes that digest and destroy the pathogen are released.




### Monoclonal antibodies (HT only)

**Monoclonal antibodies** are produced by mouse lymphocytes which are combined with a tumour cell to make a hybridoma cell. These can divide to make an antibody which can later be cloned and used to treat diseases such as cancer or used in pregnancy tests.

### Key terms

Make sure you can write a definition for these key terms.

antibiotic · antibody · antigen · antitoxin · dose · double-blind trial · efficacy · Herd immunity · monoclonal antibodies · mucus · peer review · placebo · toxicity · vaccination · white blood cell

### Treating diseases

**Antibiotics**

- **Antibiotics** are medicines that can kill *bacteria* in the body.
- Specific bacteria need to be treated by specific antibiotics.
- Antibiotics have greatly reduced deaths from infectious bacterial diseases, but antibiotic-resistant strains of bacteria are emerging.

**Treating viral diseases**

- Antibiotics *do not* affect viruses.
- Drugs that kill viruses often damage the body's tissues.
- Painkillers treat the symptoms of viral diseases but do not kill pathogens.

### Discovering and developing new drugs

Drugs were traditionally extracted from plants and microorganisms, for example

- the heart drug digitalis comes from foxglove plants
- the painkiller aspirin originates from willow trees
- penicillin was discovered by Alexander Fleming from *Penicillium* mould.

Most modern drugs are now synthesised by chemists in laboratories.

New drugs are extensively tested and trialled for

- **toxicity** – is it harmful?
- **efficacy** – does it work?
- **dose** – what amount is safe and effective to give?

### Stages of clinical trials

**Pre-clinical trials**

Drug is tested in cells, tissues, and live animals.

**Clinical trials**

1. Healthy volunteers receive very low doses to test whether the drug is safe and effective.
2. If safe, larger numbers of healthy volunteers and patients receive the drug to find the optimum dose.

**Peer review**

Before being published, the results of clinical trials will be tested and checked by independent researchers. This is called **peer review**.

**Double-blind trials**

Some clinical trials give some of their patients a **placebo** drug – one that is known to have no effect.

**Double-blind trials** are when neither the patients nor the doctors know who has been given the real drug and who has been given the placebo. This reduces biases in the trial.

### Vaccinations

**Vaccinations** involve injecting small quantities of dead or inactive forms of a pathogen into the body. This stimulates lymphocytes to produce the correct antibodies for that pathogen. If the same pathogen re-enters the body, the correct antibodies can be produced quickly to prevent infection. If a large proportion of the population is vaccinated against a disease, it is less likely to spread. This is called **herd immunity**.

# Chapter 6: Preventing and treating disease

## Knowledge organiser

### Non-specific defences

Non-specific defences of the human body against all pathogens include the skin, nose, and stomach. Give examples of how these can prevent disease.

**Skin**
- 
- 
- 

**Nose**
- 
- 

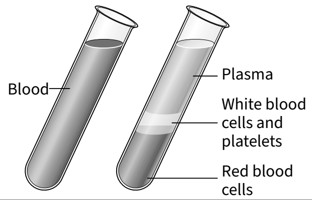
**Stomach**
- 

### White blood cells

If a pathogen enters the body, the __________ system tries to destroy the pathogen.

The function of **white blood cells** is to fight __________.

There are two main types of white blood cell – ______________ and ______________.




### Lymphocytes

Lymphocytes fight pathogens in two ways:

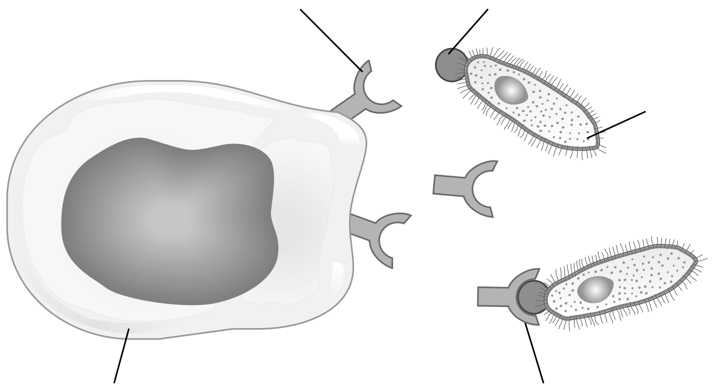
#### Antitoxins

Lymphocytes produce **antitoxins** that bind to the __________ produced by some pathogens (usually bacteria). This __________ the toxins.

#### Antibodies

Lymphocytes produce **antibodies** that target and help to destroy specific __________ by binding to __________ (proteins) on the pathogens' surfaces.

**Label the diagram.**

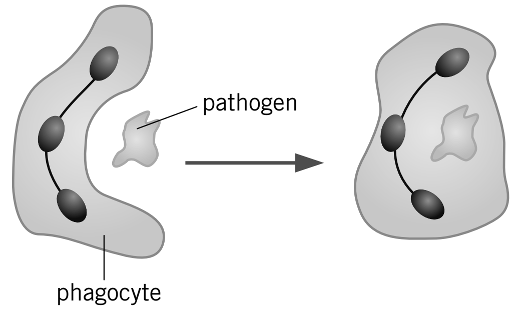


### Phagocytes

1 Phagocytes are attracted to areas of __________.

2 The phagocyte surrounds the pathogen and __________ it.

3 __________ that digest and destroy the pathogen are released.




### Monoclonal antibodies (HT only)

**Monoclonal antibodies** are produced by mouse lymphocytes which are combined with a tumour cell to make a __________ __________. These can divide to make an __________ which can later be cloned and used to treat diseases such as _________ or used in pregnancy tests.

**Key terms**

**Make sure you can write a definition for these key terms.**

antibiotic, antibody, antigen, antitoxin, dose, double-blind trial, efficacy, Herd immunity, monoclonal antibodies, mucus, peer review, placebo, toxicity, vaccination, white blood cell

### Treating diseases

#### Antibiotics

- **Antibiotics** are medicines that can kill __________ in the body.
- Specific bacteria need to be treated by specific __________.
- Antibiotics have greatly __________ deaths from infectious bacterial diseases, but ________________ - ________________ strains of bacteria are emerging.

#### Treating viral diseases

- Antibiotics do not affect __________.
- Drugs that kill viruses often damage the body's __________.
- __________ treat the symptoms of viral diseases but do not kill pathogens.

### Discovering and developing new drugs

Drugs were traditionally extracted from __________ and __________, for example

- the heart drug digitalis comes from foxglove plants
- the painkiller __________ originates from willow trees
- __________ was discovered by Alexander Fleming from *Penicillium* mould.

Most modern drugs are now synthesised by chemists in __________.

New drugs are extensively tested and trialled for

- __________ – is it harmful?
- __________ – does it work?
- __________ – what amount is safe and effective to give?

### Stages of clinical trials

**______________ trials**

Drug is tested in cells, tissues, and live animals.

**Clinical trials**

1 __________ volunteers receive very low doses to test whether the drug is __________ and __________.

2 If safe, larger numbers of healthy volunteers and patients receive the drug to find the __________ dose.

**__________ review**

Before being published, the results of clinical trials will be tested and checked by independent researchers. This is called __________ **review**.

#### Double-blind trials

Some clinical trials give some of their patients a __________ drug – one that is known to have no effect.

**Double-blind trials** are ________________________________________________ ________________________. This reduces __________ in the trial.

### Vaccinations

**Vaccinations** involve injecting small quantities of __________ or __________ forms of a pathogen into the body. This stimulates __________ to produce the correct antibodies for that pathogen. If the same pathogen re-enters the body, the correct __________ can be produced quickly to prevent __________.

If a large proportion of the population is vaccinated against a disease, it is less likely to spread. This is called ____________ ____________.

# Chapter 6: Preventing and treating disease

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B6 questions | Answers |
|---|---|---|
| 1 | What non-specific systems does the body use to prevent pathogens getting into it? | •<br>•<br>• |
| 2 | What three functions do white blood cells have? | |
| 3 | What happens during phagocytosis? | |
| 4 | What are antigens? | |
| 5 | Why are antibodies a specific defence? | |
| 6 | What is the function of an antitoxin? | |
| 7 | What does a vaccine contain? | |
| 8 | How does vaccination protect against a specific pathogen? | |
| 9 | What is herd immunity? | |
| 10 | What is an antibiotic? | |
| 11 | What do painkillers do? | |
| 12 | What properties of new drugs are clinical trials designed to test? | |
| 13 | What happens in the pre-clinical stage of a drug trial? | |
| 14 | What is a placebo? | |
| 15 | What is a double-blind trial? | |
| 16 | What is a monoclonal antibody? | |
| 17 | Give two examples in which monoclonal antibodies can be used for. | |

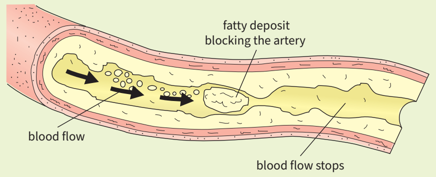
# Chapter 7: Non-communicable diseases

## Knowledge organiser

### Coronary heart disease

**Coronary heart disease** (CHD) occurs when the coronary arteries become narrowed by the build-up of layers of fatty material within them.

This reduces the flow of blood, resulting in less oxygen for the heart muscle, which can lead to heart attacks.




### Health issues

**Health** is the state of physical and mental well-being.

The following factors can affect health:

- communicable and non-communicable diseases
- diet
- stress
- exercise
- life situations.

Different types of disease may interact, for example:

- defects in the immune system make an individual more likely to suffer from infectious diseases
- viral infection can trigger cancers
- immune reactions initially caused by a pathogen can trigger allergies, for example skin rashes and asthma
- severe physical ill health can lead to depression and other mental illnesses.

### Treating cardiovascular diseases

| Treatment | Description | Advantages | Disadvantages |
|---|---|---|---|
| **stent** | inserted into blocked coronary arteries to keep them open | • widens the artery – allows more blood to flow, so more oxygen is supplied to the heart<br>• less serious surgery | • can involve major surgery – risk of infection, blood loss, blood clots, and damage to blood vessels<br>• risks from anaesthetic used during surgery |
| **statins** | drugs that reduce blood **cholesterol** levels, slowing down the deposit of fatty material in the arteries | • effective<br>• no need for surgery<br>• can prevent CHD from developing | • possible side effects such as muscle pain, headaches, and sickness<br>• cannot cure CHD, so patient will have to take tablets for many years |
| **replace faulty heart valves** | heart valves that leak or do not open fully, preventing control of blood flow through the heart, can be replaced with biological or mechanical valves | • allows control of blood flow through the heart<br>• long-term cure for faulty heart valves | • can involve major surgery – risk of infection, blood loss, blood clots, and damage to blood vessels<br>• risks from anaesthetic used during surgery |
| **transplants** | if the heart fails a donor heart, or heart and lungs, can be transplanted<br>**artificial hearts** can be used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest during recovery | • long-term cure for the most serious heart conditions<br>• treats problems that cannot be treated in other ways | • transplant may be rejected if there is not a match between donor and patient<br>• lengthy process<br>• major surgery – risk of infection, blood loss, blood clots, and damage to blood vessels<br>• risks from anaesthetic used during surgery |

### Risk factors and non-communicable diseases

A **risk factor** is any aspect of your lifestyle or substance in your body that can increase the risk of a disease developing.

Some risk factors cause specific diseases. Other diseases are caused by factors interacting.

| Risk factor | Disease | Effects of risk factor |
|---|---|---|
| diet (obesity) and amount of exercise | Type 2 diabetes | body does not respond properly to the production of insulin, so blood glucose levels cannot be controlled |
| | cardiovascular diseases | increased blood cholesterol can lead to CHD |
| alcohol | impaired liver function | long-term alcohol use causes liver cirrhosis (scarring), meaning the liver cannot remove toxins from the body or produce sufficient bile |
| | impaired brain function | damages the brain and can cause anxiety and depression |
| | affected development of unborn babies | alcohol can pass through the placenta, risking miscarriages, premature births, and birth defects |
| smoking | lung disease and cancers | cigarettes contain carcinogens, which can cause cancers |
| | affected development of unborn babies | chemicals can pass through the placenta, risking premature births and birth defects |
| carcinogens, such as ionising radiation, and genetic risk factors | cancers | for example, tar in cigarettes and ultraviolet rays from the Sun can cause cancers |
| | | some genetic factors make an individual more likely to develop certain cancers |

### Cancer

Cancer is the result of changes in cells that lead to uncontrolled growth and division by mitosis.

Rapid division of abnormal cells can form a **tumour**.

**Malignant** tumours are cancerous tumours that invade neighbouring tissues and spread to other parts of the body in the blood, forming secondary tumours.

**Benign** tumours are non-cancerous tumours that do not spread in the body.

### Treatment

Treatment of non-communicable diseases linked to lifestyle risk factors – such as poor diet, drinking alcohol, and smoking – can be very costly, both to individuals and to the Government.

A high incidence of these lifestyle risk factors can cause high rates of non-communicable diseases in a population.

### Key terms

**Make sure you can write a definition for these key terms.**

artificial heart, benign, carcinogen, cholesterol, coronary heart disease, health, malignant, risk factor, statin, stent, transplant, tumour

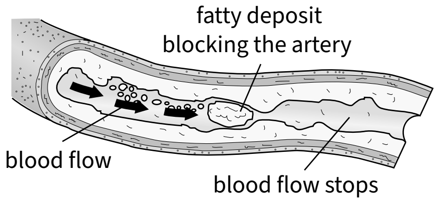
# Chapter 7: Non-communicable diseases

## Knowledge organiser

### Coronary heart disease

**Coronary heart disease** (CHD) occurs when the coronary arteries become ______ by the build-up of layers of ______ material within them.

This reduces the flow of ______, resulting in less ______ for the heart muscle, which can lead to ______ ______.




### Health issues

**Health** is the state of physical and mental well-being.

The following factors can affect health:

- 
- 
- 
- 
- 

Different types of disease may interact, for example:

- ______ in the immune system make an individual more likely to suffer from infectious diseases
- ______ infection can trigger cancers
- immune reactions initially caused by a ______ can trigger allergies, for example skin rashes and asthma
- severe physical ill health can lead to ______ and other mental illnesses.

### Risk factors and non-communicable diseases

A **risk factor** is any aspect of your lifestyle or substance in your body that can ______ the risk of a disease developing.

Some risk factors cause specific diseases. Other diseases are caused by factors interacting.

| Risk factor | Disease | Effects of risk factor |
|---|---|---|
| *diet (obesity) and amount of exercise* | • | |
| | • | |
| *alcohol* | • | |
| | • | |
| | • | |
| *smoking* | • | |
| | • | |
| *carcinogens, such as ionising radiation, and genetic risk factors* | • | |
| | | |

### Treating cardiovascular diseases

| Treatment | Description | Advantages | Disadvantages |
|---|---|---|---|
| **stent** | inserted into ______ coronary arteries to keep them open | • <br> • | • <br> • |
| **statins** | drugs that reduce blood ______ levels, slowing down the deposit of ______ material in the arteries | • <br> • <br> • | • <br> • <br> • |
| **replace faulty heart valves** | heart valves that ______ or do not open fully, preventing control of blood flow through the heart, can be replaced with ______ or ______ valves | • <br> • | • <br> • |
| **transplants** | if the heart ______ a donor heart, or heart and lungs, can be transplanted <br> ______ ______ can be used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest during recovery | • <br> • | • <br> • <br> • <br> • |

### Cancer

Cancer is the result of changes in cells that lead to ______ growth and division by ______.

Rapid division of abnormal cells can form a ______.

______ tumours are cancerous tumours that invade neighbouring tissues and spread to other parts of the body in the blood, forming ______ tumours.

______ tumours are non-cancerous tumours that do not spread in the body.

### Treatment

Treatment of non-communicable diseases can be very costly to both individuals and the Government. They are often caused by lifestyle risk factors including:

- 
- 
- 

A high incidence of these lifestyle risk factors can cause high rates of non-communicable diseases in a ______.

**Key terms**

**Make sure you can write a definition for these key terms.**

*artificial heart* *benign* *carcinogen* *cholesterol* *coronary heart disease* *health* *malignant* *risk factor* *statin* *stent* *transplant* *tumour*

# Chapter 7: Non-communicable diseases

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B7 questions | Answers |
|---|---|---|
| 1 | What is coronary heart disease? | |
| 2 | What is a stent? | |
| 3 | What are statins? | |
| 4 | What is a faulty heart valve? | |
| 5 | How can a faulty heart valve be treated? | |
| 6 | When do heart transplants take place? | |
| 7 | What are artificial hearts used for? | |
| 8 | Define health. | |
| 9 | What factors can affect health? | |
| 10 | What is a risk factor? | |
| 11 | Give five risk factors. | |
| 12 | What is cancer? | |
| 13 | What are malignant tumours? | |
| 14 | What are benign tumours? | |
| 15 | What two types of risk factor affect the development of cancers? | |
| 16 | What is a carcinogen? | |

# Chapter 8: Photosynthesis

## Knowledge organiser

### Photosynthetic reaction

**Photosynthesis** is a chemical reaction in which energy is transferred from the environment as light from the Sun to the leaves of a plant. This is an **endothermic** reaction.

**Chlorophyll**, the green pigment in **chloroplasts** in the leaves, absorbs the light energy. Leaves are well-adapted to increase the rate of photosynthesis when needed.

L **carbon dioxide** + water $\xrightarrow{\text{light}}$ **glucose** + oxygen

$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$

### Rate of photosynthesis

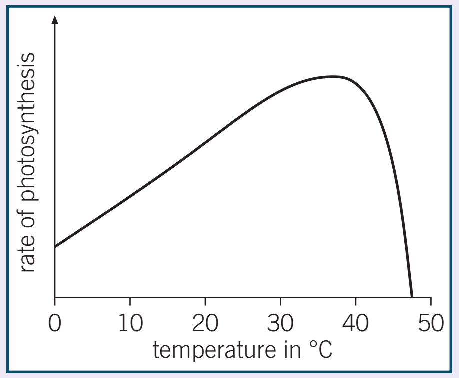
A **limiting factor** is anything that limits the rate of a reaction when it is in short supply.

The limiting factors for photosynthesis are

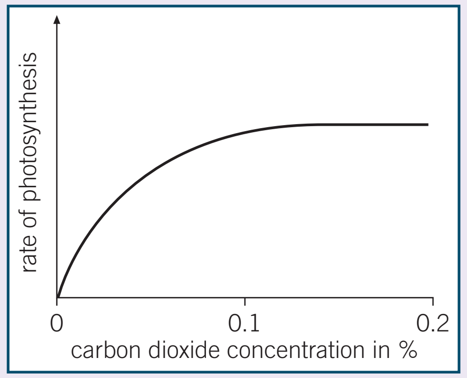
- temperature
- light intensity
- carbon dioxide concentration
- amount of chlorophyll.

Less chlorophyll in the leaves reduces the rate of photosynthesis. More chlorophyll may be produced by plants in well-lit areas to increase the photosynthesis rate.

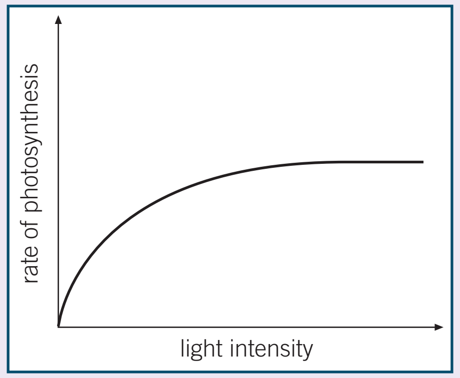
### Limiting factors and photosynthesis rate (HT only)




- At low temperatures the rate of photosynthesis is low because the reactant molecules have less kinetic energy.
- Photosynthesis is an enzyme-controlled reaction, so at high temperatures the enzymes are denatured and the rate quickly decreases.




- Carbon dioxide is used up in photosynthesis, so increasing carbon dioxide concentration increases the rate of photosynthesis.
- At a certain point, another factor becomes limiting.
- Carbon dioxide is often the limiting factor for photosynthesis.

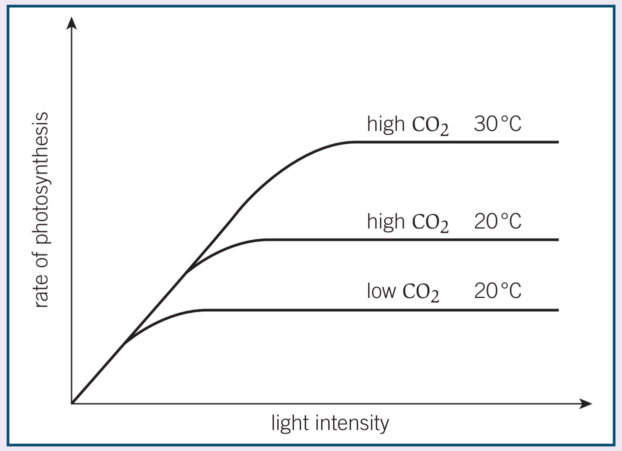



- Light energy is needed for photosynthesis, so increasing light intensity increases the rate of photosynthesis.
- At a certain point, another factor becomes limiting.
- Photosynthesis will stop if there is little or no light.

### Interaction of limiting factors (HT only)

Limiting factors often interact, and any one may be limiting photosynthesis.

For example, on the graph the lowest curve has both carbon dioxide and temperature limiting photosynthesis. Temperature is limiting for the middle curve, and the highest curve shows photosynthesis rate increases when both temperature and carbon dioxide are increased until another factor becomes limiting.




### Inverse square law (HT only)

As the distance of a light source from a plant increases, the light intensity decreases – this is called an inverse relationship. This relationship is not linear, as light intensity varies in inverse proportion to the square of the distance:

L $$\text{light intensity} \propto \frac{1}{\text{distance}^2}$$

For example, if you double the distance between a light source and a plant, light intensity falls by three-quarters.

### Greenhouse economics

Commercial greenhouses control limiting factors to get the highest possible rates of photosynthesis so they can grow plants as quickly as possible or produce the highest yields, whilst still making a profit.

### Uses of glucose

**Uses of glucose produced in photosynthesis**

- convert into insoluble starch for storage (in leaves, tubers, and bulbs)
- for respiration to produce energy
- produce fat or oil (lipids) for storage
- produce cellulose to strengthen cell walls
- produce amino acids for protein synthesis – plants also need nitrate ions from the soil for this

### Key terms

**Make sure you can write a definition for these key terms.**

carbon dioxide | chlorophyll | chloroplast | concentration | endothermic | glucose | greenhouse gases | light intensity | inverse square law | limiting factor | photosynthesis | protein synthesis

# Chapter 8: Photosynthesis

## Knowledge organiser

### Photosynthetic reaction

**Photosynthesis** is a chemical reaction in which energy is transferred from the environment as ______ from the Sun to the ______ of a plant. This is an ______ reaction.

**Chlorophyll**, the green pigment in ______ in the leaves, ______ the light energy. Leaves are well-adapted to ______ the rate of photosynthesis when needed.

L ______ + ______ → ______ + ______

__$CO_2$ + __$H_2O$ → $C_6H_{12}O_6$ + __$O_2$

### Rate of photosynthesis

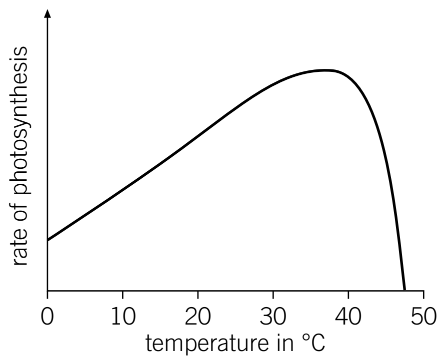
A ______ ______ is anything that limits the rate of a reaction when it is in short supply.

The limiting factors for photosynthesis are

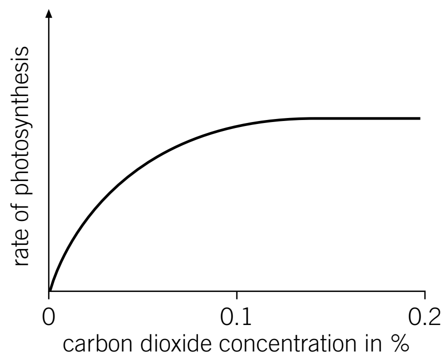
-
-
-
-

Less chlorophyll in the leaves ______ the rate of photosynthesis. More chlorophyll may be produced by plants in well-lit areas to ______ the photosynthesis rate.

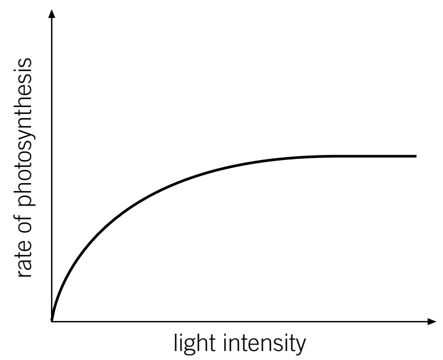
### Limiting factors and photosynthesis rate (HT only)




- At low temperatures the rate of photosynthesis is ______ because the reactant molecules have less ______ energy.
- Photosynthesis is an enzyme-controlled reaction, so at high temperatures the enzymes are ______ and the rate quickly ______.




- ______ ______ is used up in photosynthesis, so increasing carbon dioxide concentration ______ the rate of photosynthesis.
- At a certain point, another factor becomes ______.
- Carbon dioxide is often the limiting factor for photosynthesis.

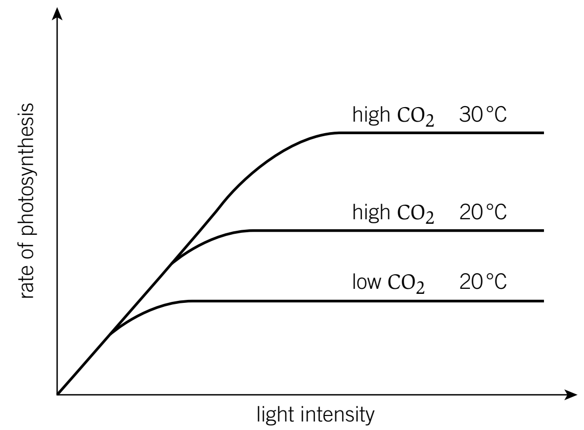



- Light energy is needed for photosynthesis, so increasing ______ ______ increases the rate of photosynthesis.
- At a certain point, another factor becomes limiting.
- Photosynthesis will ______ if there is little or no light.

### Interaction of limiting factors (HT only)

Limiting factors often interact, and any one may be limiting photosynthesis.

For example, on the graph the ______ curve has both carbon dioxide and temperature limiting photosynthesis. ______ is limiting for the middle curve, and the highest curve shows photosynthesis rate increases when both ______ and ______ ______ are increased until another factor becomes limiting.




### Inverse square law (HT only)

As the distance of a light source from a plant ______, the light intensity ______ – this is called an inverse relationship. This relationship is not ______, as light intensity varies in inverse proportion to the square of the distance:

L ______ ∝ ______

For example, if you ______ the distance between a light source and a plant, light intensity falls by three-quarters.

### Greenhouse economics

Commercial greenhouses ______ limiting factors to get the highest possible rates of ______ so they can grow plants as quickly as possible or produce the highest ______, whilst still making a profit.

### Uses of glucose

**Uses of glucose produced in photosynthesis**

- convert into ______ starch for storage (in leaves, tubers, and bulbs)
- produce fat or oil (______) for ______
- produce ______ ______ for ______ ______ – plants also need ______ ions from the soil for this
- produce ______ to strengthen ______ ______
- for ______ to produce ______

**Key terms**

Make sure you can write a definition for these key terms.

*carbon dioxide* *chlorophyll* *chloroplast* *concentration* *endothermic* *glucose* *greenhouse gases* *light intensity* *inverse square law* *limiting factor* *photosynthesis* *protein synthesis*

# Chapter 8: Photosynthesis

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B8 questions | Answers |
|---|---|---|
| 1 | Where does photosynthesis occur? | |
| 2 | What is the name of the green pigment in the leaves? | |
| 3 | What type of reaction is photosynthesis? | |
| 4 | What type of energy is used in photosynthesis? | |
| 5 | Give the word equation for photosynthesis. | |
| 6 | Give the balanced symbol equation for photosynthesis. | |
| 7 | Define the term limiting factor. | |
| 8 | Give the limiting factors of photosynthesis. | •<br>•<br>•<br>• |
| 9 | Describe how light intensity affects the rate of photosynthesis. | |
| 10 | Describe how carbon dioxide concentration affects the rate of photosynthesis. | |
| 11 | Describe how temperature affects the rate of photosynthesis. | |
| 12 | Give the equation for the inverse square law for light intensity. | |
| 13 | Why are limiting factors important in the economics of growing plants in greenhouses? | |
| 14 | How do plants use the glucose produced in photosynthesis? | •<br>•<br>•<br>•<br>• |

# Chapter 9: Respiration

## Knowledge organiser

### Cellular respiration

Cellular **respiration** is an **exothermic** reaction that occurs continuously in the **mitochondria** of living cells to supply the cells with energy.

The energy released during respiration is needed for all living processes, including

- chemical reactions to build larger molecules, for example, making proteins from amino acids
- muscle contraction for movement
- keeping warm.

Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen).

| Type of respiration | Oxygen required? | Relative amount of energy transferred |
|---|---|---|
| **aerobic** | ✓ | complete **oxidation** of glucose – large amount of energy is released |
| **anaerobic** | ✗ | incomplete oxidation of glucose – much less energy is released per glucose molecule than in aerobic respiration |

### Aerobic respiration

glucose + oxygen → carbon dioxide + water

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

### Anaerobic respiration in muscles

glucose → lactic acid

$$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$$

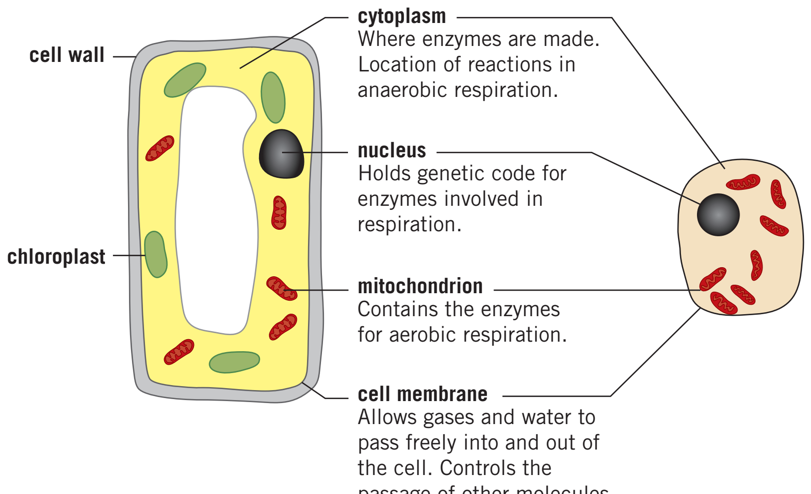
### Fermentation

Anaerobic respiration in plant and yeast cells is represented by the equation

glucose → ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called **fermentation**.

The products of fermentation are important in the manufacturing of bread and alcoholic drinks.




Typical plant cell

Typical animal cell

### Key terms

Make sure you can write a definition for these key terms.

aerobic, amino acids, anaerobic, carbohydrates, cellulose, exothermic, fermentation, fatty acid, glycerol, glycogen, lactic acid, lipids, metabolism, mitochondria, oxidation, oxygen debt, proteins, respiration, starch

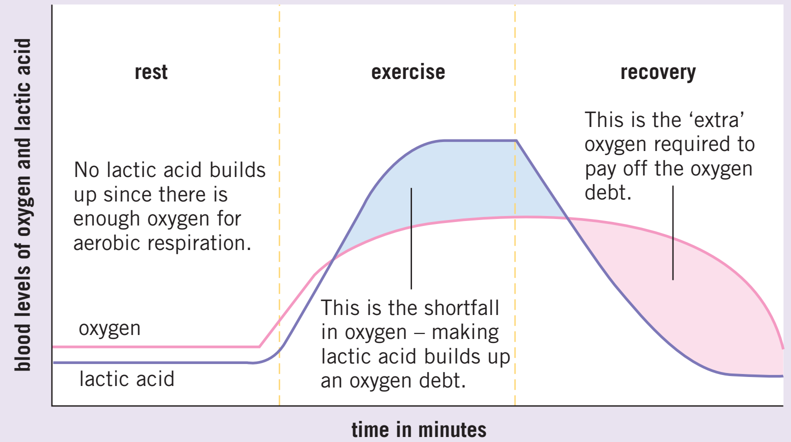
### Response to exercise

During exercise the human body reacts to the increased demand for energy.

To supply the muscles with more oxygenated blood, heart rate, breathing rate, and breath volume all increase.

If insufficient oxygen is supplied, anaerobic respiration takes place instead, leading to the build-up of **lactic acid**.

During long periods of vigorous exercise, muscles become fatigued and stop contracting efficiently.




### Oxygen debt (HT only)

After exercise, the lactic acid accumulated during anaerobic respiration needs to be removed. **Oxygen debt** is the amount of oxygen needed to react with the lactic acid to remove it from cells.

### Removal of lactic acid

lactic acid in the muscles

↓

transported to the liver in the blood

↓

lactic acid is converted back to glucose

### Metabolism

**Metabolism** is the sum of all the reactions in a cell or the body.

The energy released by respiration in cells is used for the continual enzyme-controlled processes of metabolism that produce new molecules.

Metabolic processes include the synthesis and breakdown of:

**Carbohydrates**

- synthesis of larger carbohydrates from sugars (starch, glycogen, and cellulose)
- breakdown of glucose in respiration to release energy

**Lipids**

- synthesis of lipids from one molecule of glycerol and three molecules of fatty acid

**Proteins**

- synthesis of amino acids from glucose and nitrate ions
- amino acids used to form proteins
- excess proteins broken down to form urea for excretion

# Chapter 9: Respiration

## Knowledge organiser

### Cellular respiration

Cellular **respiration** is an ____________ reaction that occurs continuously in the ________________ of living cells to supply the cells with energy.

The energy released during respiration is needed for all living processes, including

- 
- 
- 

Respiration in cells can take place ____________ (using oxygen) or ____________ (without oxygen).

| Type of respiration | Oxygen required? | Relative amount of energy transferred |
|---|---|---|
| **aerobic** | ________ | complete ____________ of glucose – large amount of ________ is released |
| **anaerobic** | ________ | ____________ oxidation of glucose – much ________ energy is released per glucose molecule than in aerobic respiration |

### Aerobic respiration

______ + ______ → __________ + ______

$C_6H_{12}O_6$ + _$O_2$ → _$CO_2$ + _$H_2O$

### Anaerobic respiration in muscles

______ → ________

$C_6H_{12}O_6$ → _$C_3H_6O_3$

### Fermentation

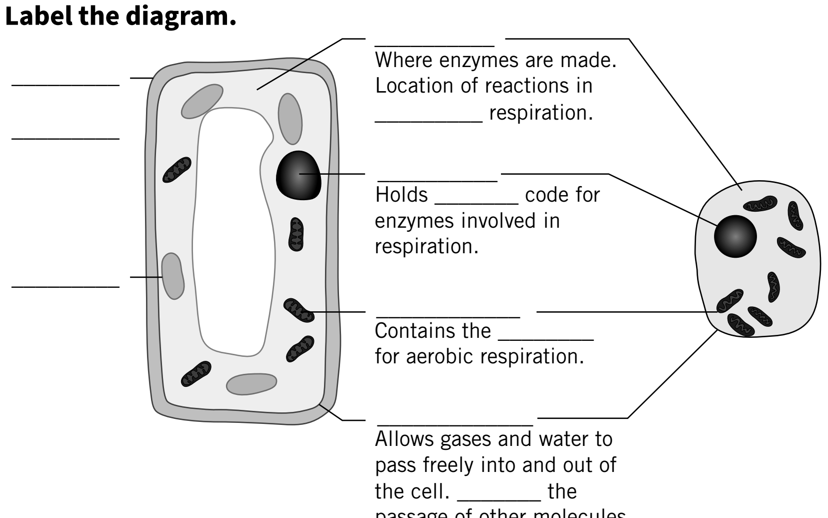
Anaerobic respiration in plant and ________ cells is represented by the equation

________ → ________ + ____________ ____________

Anaerobic respiration in yeast cells is called ____________.

The products of fermentation are important in the manufacturing of ________ and ________________.

**Label the diagram.**




Typical plant cell

Typical animal cell

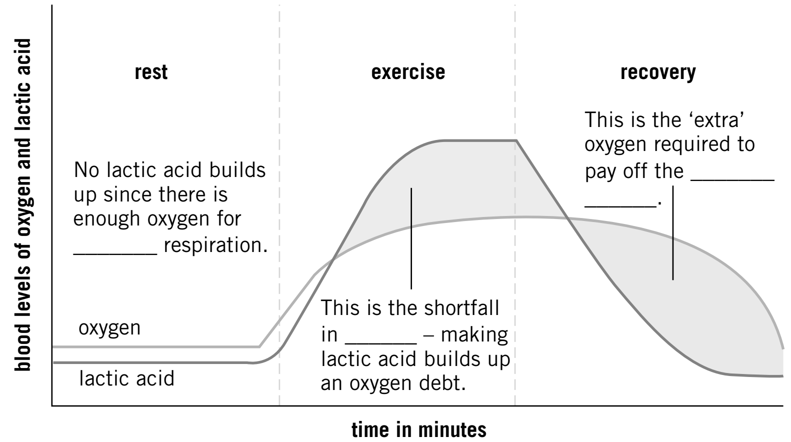
### Response to exercise

During exercise the human body ______ to the increased demand for energy.

To supply the muscles with more __________ blood, ______ rate, ______ rate, and breath ________ all increase.

If insufficient oxygen is supplied, ____________ respiration takes place instead, leading to the build-up of ____________ ____________.

During long periods of vigorous exercise, ________ become fatigued and stop contracting efficiently.




### Oxygen debt (HT only)

After exercise, the lactic acid accumulated during anaerobic respiration needs to be __________.

**Oxygen debt** is the amount of oxygen needed to react with the lactic acid to remove it from ______.

### Removal of lactic acid

lactic acid in the ______

↓

transported to the ______ in the blood

↓

lactic acid is converted back to ______

### Metabolism

**Metabolism** is the ________ of all the reactions in a cell or the body.

The energy released by __________ in cells is used for the continual enzyme-controlled processes of __________ that produce new molecules.

Metabolic processes include the synthesis and breakdown of:

**Carbohydrates**

- synthesis of larger ___________ from _________ (starch, glycogen, and cellulose)
- breakdown of glucose in respiration to release energy

**Lipids**

- synthesis of _________ from one molecule of _________ and three molecules of ____________ ____________

**Proteins**

- synthesis of ____________ ____________ from ____________ and __________ ions
- amino acids used to form __________
- excess proteins broken down to form ________ for excretion

### Key terms

**Make sure you can write a definition for these key terms.**

*aerobic* *amino acids* *anaerobic* *carbohydrates* *cellulose* *exothermic* *fermentation* *fatty acid* *glycerol* *glycogen* *lactic acid* *lipids* *metabolism* *mitochondria* *oxidation* *oxygen debt* *proteins* *respiration* *starch*

# Chapter 9: Respiration

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | B9 questions | Answers |
|---|---|---|
| 1 | Define the term cellular respiration. | |
| 2 | What do organisms need energy for? | • <br> • <br> • |
| 3 | What is the difference between aerobic and anaerobic respiration? | |
| 4 | Write the word equation for aerobic respiration. | |
| 5 | Write the word equation for anaerobic respiration in muscles. | |
| 6 | Write the balanced symbol equation for aerobic respiration. | |
| 7 | Why does aerobic respiration release more energy per glucose molecule than anaerobic respiration? | |
| 8 | What is anaerobic respiration in yeast cells called? | |
| 9 | Write the word equation for anaerobic respiration in plant and yeast cells. | |
| 10 | How does the body supply the muscles with more oxygenated blood during exercise? | |
| 11 | What substance builds up in the muscles during anaerobic respiration? | |
| 12 | What happens to muscles during long periods of activity? | |
| 13 | What is oxygen debt? | |
| 14 | How is lactic acid removed from the body? | |
| 15 | What is metabolism? | |

# Chapter 1: Conservation and dissipation of energy

## Knowledge organiser

## Systems

A **system** is an object or group of objects.

Whenever anything changes in a system, energy is transferred between its stores or to the surroundings.

A **closed system** is one where no energy can escape to or enter from the surroundings. The total energy in a closed system never changes.

## Energy stores

| | |
|---|---|
| **kinetic** | energy an object has because it is moving |
| **gravitational potential** | energy an object has because of its height above the ground |
| **elastic potential** | energy an elastic object has when it is stretched or compressed |
| **thermal (or internal)** | energy an object has because of its temperature (the total kinetic and potential energy of the particles in the object) |
| **chemical** | energy that can be transferred by chemical reactions involving foods, fuels, and the chemicals in batteries |
| **nuclear** | energy stored in the nucleus of an atom |
| **magnetic** | energy a magnetic object has when it is near a magnet or in a magnetic field |
| **electrostatic** | energy a charged object has when near another charged object |

## Energy transfers

Energy can be transferred to and from different stores by:

**Heating**
Energy is transferred from one object to another object with a lower temperature.

**Waves**
Waves (e.g., light and sound) can transfer energy.

**Electricity**
An electric current transfers energy.

**Forces (mechanical work)**
Energy is transferred when a force moves or changes the shape of an object.

## Examples of energy transfers

When you stretch a rubber band, energy from your chemical store is mechanically transferred to the rubber band's elastic potential store.

When a block is dropped from a height, energy is mechanically transferred (by the force of gravity) from the block's gravitational potential store to its kinetic store.

When this block hits the ground, energy from its kinetic energy store is transferred mechanically and by sound waves to the thermal energy store of the surroundings.

The electric current in a kettle transfers energy to the heating element's thermal energy store. Energy is then transferred by heating from the heating element's thermal energy store to the thermal energy store of the water.

When an object slows down due to friction, energy is mechanically transferred from the object's kinetic store to its thermal store, the thermal store of the object it is rubbing against, and to the surroundings.

## Work done

When an object is moved by a force **work** is done on the object. The force transfers energy to the object. The amount of energy transferred is equal to the work done. You can calculate the work done (and the energy transferred) using the equation:

(L) work done (J) = force (N) x distance moved along the line of action of the force (m)

## Calculating the energy in an energy store

An object's gravitational potential energy store depends on its height above the ground, the gravitational field strength, and its mass.

gravitational potential energy (J) = mass (kg) × gravitational field strength (N/kg) × height (m)

(L) $E_p = m\,g\,h$

An object's kinetic energy store depends only on its mass and speed.

kinetic energy (J) = 0.5 × mass (kg) × (speed)$^2$ (m/s)

(L) $E_k = \frac{1}{2} m\,v^2$

The elastic potential energy store of a stretched spring can be calculated using:

elastic potential energy (J) = 0.5 × spring constant (N/m) × (extension)$^2$ (m)

$E_e = \frac{1}{2} k\,e^2$ (assuming the limit of proportionality has not been exceeded)

**Power** is how much work is done (or how much energy is transferred) per second. The unit of power is the watt (W).

1 watt = 1 joule of energy transferred per second

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time (s)}}$$

(L) $P = \frac{E}{t}$

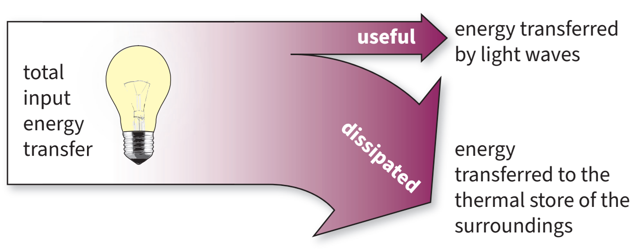
or

$$\text{power (W)} = \frac{\text{work done (J)}}{\text{time (s)}}$$

$P = \frac{W}{t}$

## Useful and dissipated energy

Energy cannot be created or destroyed – it can only be transferred usefully, stored, or dissipated (wasted).




Energy is never entirely transferred usefully – some energy is always dissipated, meaning it is transferred to less useful stores.

All energy eventually ends up transferred to the thermal energy store of the surroundings.

In machines, work done against the force of friction usually causes energy to be wasted because energy is transferred to the thermal store of the machine and its surroundings.

**Lubrication** is a way of reducing unwanted energy transfer due to friction.

**Streamlining** is a way of reducing energy wasted due to air resistance or drag in water.

Use of thermal insulation is a way of reducing energy wasted due to heat dissipated to the surroundings.

**Efficiency** is a measure of how much energy is transferred usefully. You must know the equation to calculate efficiency as a *decimal*:

$$\text{efficiency} = \frac{\text{useful output energy transfer (J)}}{\text{total input energy transfer (J)}}$$

(L) *or*

$$\text{efficiency} = \frac{\text{useful power output (W)}}{\text{total power input (W)}}$$

To give efficiency as a *percentage*, just multiply the result from the above calculation by 100 and add the % sign to the answer.

## Key terms

Make sure you can write a definition for these key terms.

chemical, closed system, dissipated, efficiency, elastic potential, electrostatic, gravitational potential, kinetic, lubrication, magnetic, nuclear, power, streamlining, system, thermal, work done

# Chapter 1: Conservation and dissipation of energy

## Knowledge organiser

### Systems

A **system** is an ______ or group of objects.

Whenever anything changes in a system, ______ is transferred between its stores or to the surroundings.

A ______ ______ is one where no energy can escape to or enter from the surroundings. The total energy in a closed system ______ changes.

### Energy stores

| | |
|---|---|
| **kinetic** | energy an object has because it is ______ |
| ______ ______ | energy an object has because of its height above the ground |
| **elastic potential** | energy an elastic object has when it is stretched or ______ |
| **thermal (or internal)** | energy an object has because of its ______ (the total kinetic and potential energy of the particles in the object) |
| ______ | energy that can be transferred by chemical reactions involving foods, fuels, and the chemicals in batteries |
| ______ | energy stored in the nucleus of an atom |
| **magnetic** | energy a magnetic object has when it is near a magnet or in a magnetic ______ |
| ______ | energy a charged object has when near another charged object |

### Energy transfers

Energy can be transferred to and from different stores by:

**Heating**
Energy is transferred from one object to another object with a ______ temperature.

**Waves**
Waves (e.g., ______ and ______) can transfer energy.

**Electricity**
An electric ______ transfers energy.

**Forces (mechanical work)**
Energy is transferred when a force moves or changes the ______ of an object.

### Examples of energy transfers

When you stretch a rubber band, energy from your chemical store is ______ transferred to the rubber band's ______ ______ store.

When a block is dropped from a height, energy is mechanically transferred (by the force of gravity) from the block's ______ ______ store to its ______ store.

When this block hits the ground, energy from its ______ ______ store is transferred mechanically and by ______ waves to the ______ energy store of the surroundings.

The electric current in a ______ transfers energy to the heating element's thermal energy store. Energy is then transferred by heating from the heating element's thermal energy store to the thermal energy store of the water.

When an object slows down due to ______, energy is mechanically transferred from the object's kinetic store to its thermal store, the thermal store of the object it is ______ against, and to the surroundings.

### Work done

When an object is moved by a ______ **work** is done on the object. The force transfers energy to the ______. The amount of energy transferred is ______ to the work done. You can calculate the work done (and the energy transferred) using the equation:

work done (J) = ______ (N) x ______ (m)

### Calculating the energy in an energy store

An object's gravitational potential energy store depends on its height above the ground, the gravitational field strength, and its mass.

gravitational potential energy (J) = ______ (kg) × ______ ______ (N/kg) × ______ (m)

$$E_p = m\,g\,h$$

An object's kinetic energy store depends only on its mass and speed.

kinetic energy (J) = ______ × ______ (kg) × (______)$^2$ (m/s)

$$E_k = \frac{1}{2} m\,v^2$$

The elastic potential energy store of a stretched spring can be calculated using:

elastic potential energy (J) = ______ × ______ ______ (N/m) × (______)$^2$ (m)

$$E_e = \frac{1}{2} k\,e^2$$ (assuming the limit of proportionality has not been exceeded)

**Power** is how much work is done (or how much energy is transferred) per second. The unit of power is the watt (W).

1 watt = 1 joule of energy transferred per second

power (W) = ______ (J) / ______ (s)

$$P = \frac{E}{t}$$

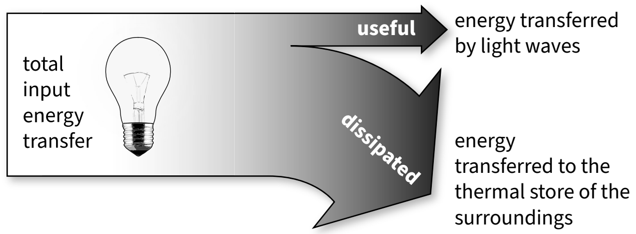
or

power (W) = ______ (J) / ______ (s)

$$P = \frac{W}{t}$$

### Useful and dissipated energy

Energy cannot be ______ or destroyed – it can only be transferred usefully, stored, or dissipated (wasted).




Energy is never entirely ______ usefully – some energy is always dissipated, meaning it is transferred to less ______ stores.

All energy eventually ends up transferred to the ______ energy store of the surroundings.

In machines, work done against the force of ______ usually causes energy to be wasted because energy is transferred to the thermal store of the machine and its ______.

______ is a way of reducing unwanted energy transfer due to friction.

______ is a way of reducing energy wasted due to air resistance or drag in water.

Use of thermal ______ is a way of reducing energy wasted due to heat dissipated to the surroundings.

______ is a measure of how much energy is transferred usefully. You must know the equation to calculate efficiency as a *decimal*:

efficiency = ______ (J) / ______ (J)

*or*

efficiency = ______ (W) / ______ (W)

To give efficiency as a *percentage*, just multiply the result from the above calculation by ______ and add the % sign to the answer.

### Key terms

**Make sure you can write a definition for these key terms.**

chemical, closed system, dissipated, efficiency, elastic potential, electrostatic, gravitational potential, kinetic, lubrication, magnetic, nuclear, power, streamlining, system, thermal, work done

# Chapter 1: Conservation and dissipation of energy

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P1 questions | Answers |
|---|---|---|
| 1 | Name the five energy stores | |
| 2 | Name the four ways in which energy can be transferred. | |
| 3 | What is a system? | |
| 4 | What is a closed system? | |
| 5 | What is work done? | |
| 6 | What is the unit for energy? | |
| 7 | What is one joule of work? | |
| 8 | Describe the energy transfer when a moving car slows down. | |
| 9 | Describe the energy transfer when an electric kettle is used to heat water. | |
| 10 | Describe the energy transfer when a ball is fired using an elastic band. | |
| 11 | Describe the energy transfer when a battery powered toy car is used. | |
| 12 | Describe the energy transfer when a falling apple hits the ground. | |
| 13 | Name the unit that represents one joule transferred per second. | |
| 14 | A motor is 30% efficient. What does that mean? | |

# Chapter 2: Energy transfer by heating

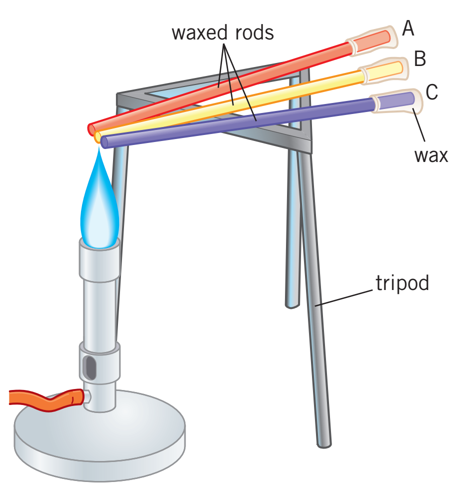
## Knowledge organiser

### Thermal conductivity

The **thermal conductivity** of a material tells you how quickly energy is transmitted through it by thermal conduction.

You can test the thermal conductivity of rods made of different metals using this experimental set-up. Each rod must have the same diameter and length, and the same temperature difference between its ends.

One end of each rod is covered in wax and the other ends are heated equally. The faster the wax melts, the higher the thermal conductivity of the metal.




### Insulating buildings

Heating bills can be expensive so it is important to reduce the rate of heat loss from buildings.

Some factors that affect the rate of heat loss from a building include:

**1** the thickness of its walls and roof

**2** the thermal conductivity of its walls and roof.

*lower thermal conductivity = lower rate of heat loss*

The thermal conductivity of the walls and roof can be reduced by using **thermal insulators**.

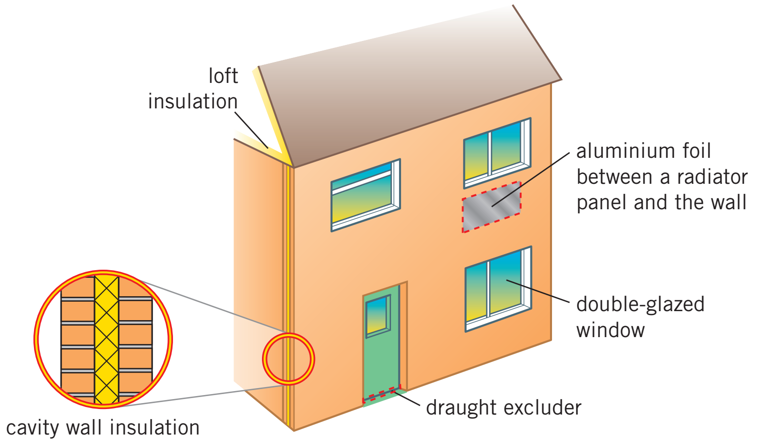
A thermal insulator is a material which has a low thermal conductivity. The rate of energy transfer through an insulator is low.

The energy transfer per second through a material depends on:

**1** the material's thermal conductivity

**2** the temperature difference between the two sides of the material

**3** the thickness of the material.




### Specific heat capacity

When a substance is heated or cooled the temperature change depends on:

- the substance's mass
- the type of material
- how much energy is transferred to it.

Every type of material has a **specific heat capacity** – the amount of energy needed to raise the temperature of 1 kg of the substance by 1 °C.

The energy transferred to the thermal store of a substance can be calculated from the substance's mass, specific heat capacity, and temperature change:

*change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg°C) × temperature change (°C)*

$$\Delta E = m\ c\ \Delta\theta$$

This equation will be given to you on the equation sheet, but you need to be able to select and apply it to the correct questions.

**Key terms**

**Make sure you can write a definition for these key terms.**

absorb | black body | electromagnetic spectrum | emit | greenhouse gas | infrared radiation | specific heat capacity | thermal conductivity | thermal insulator

# Chapter 2: Energy transfer by heating

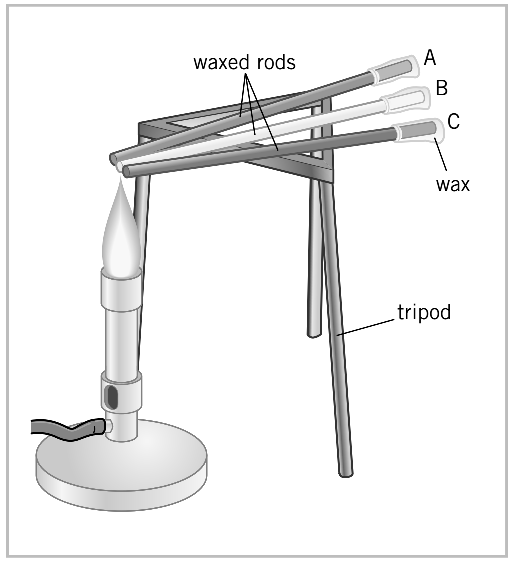
## Knowledge organiser

### Thermal conductivity

The **thermal conductivity** of a material tells you how ______________________________ ______________________________.

You can test the thermal conductivity of rods made of different metals using this experimental set-up. Each rod must have the same ________ and ________, and the same temperature difference between its ends.

One end of each rod is covered in ________ and the other ends are heated equally. The faster the wax melts, the ______________ ______________________.




### Insulating buildings

Heating bills can be expensive so it is important to reduce the rate of ____________ loss from buildings.

Some factors that affect the rate of heat loss from a building include:

1.
2.

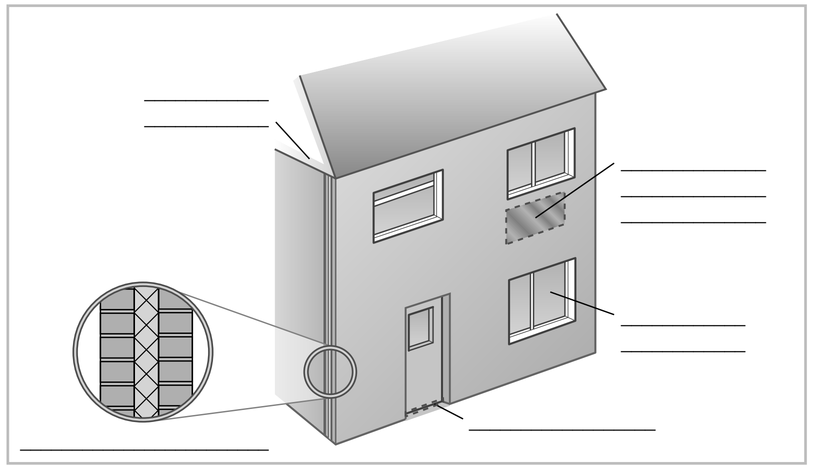
*lower thermal conductivity =*

The thermal conductivity of the walls and roof can be reduced by using __________ __________.

A thermal insulator is a material which has a ________ thermal conductivity. The rate of energy transfer through an insulator is _____.

The energy transfer per second through a material depends on:

1.
2.
3.



### Specific heat capacity

When a substance is heated or cooled the temperature change depends on:

-
-
-

Every type of material has a **specific heat capacity** – ______________________________ ______________________________

The energy transferred to the ____________ _________ of a substance can be calculated from the substance's mass, specific heat capacity, and temperature change:

*change in thermal energy (J) = mass (kg) × specific heat capacity (J/kg°C) × temperature change (°C)*

$$\Delta E = m\ c\ \Delta\theta$$

This equation will be given to you on the equation sheet, but you need to be able to select and apply it to the correct questions.

**Key terms**

**Make sure you can write a definition for these key terms.**

*absorb* | *black body* | *electromagnetic spectrum* | *emit* | *greenhouse gas* | *infrared radiation* | *specific heat capacity* | *thermal conductivity* | *thermal insulator*

# Chapter 2: Energy transfer by heating

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P2 questions | Answers |
|---|---|---|
| 1 | What does a material's thermal conductivity tell you? | |
| 2 | Which materials have low thermal conductivity? | |
| 3 | Give three factors that determine the rate of thermal energy transfer through a material. | |
| 4 | What factors affect the rate of heat loss from a building? | |
| 5 | Define specific heat capacity. | |

# Chapter 3: Energy resources

## Knowledge organiser

### Energy resources

The main ways in which we use the Earth's energy resources are:

- generating electricity
- heating
- transport.

Most of our energy currently comes from **fossil fuels** – coal, oil, and natural gas.

### Reliability and environmental impact

Some energy resources are more reliable than others. **Reliable** energy resources are ones that are available all the time (or at predictable times) and in sufficient quantities.

Both **renewable** and **non-renewable** energy resources have some kind of **environmental impact** when we use them.

### Non-renewable energy resources

- not replaced as quickly as they are used
- will eventually run out

For example, fossil fuels and nuclear fission.

### Renewable energy resources

- can be replaced at the same rate as they are used
- will not run out

For example, solar, tidal, wave, wind, geothermal, biofuel, and hydroelectric energies.

### Non-renewable energy resources

| Resource | Main uses | Source | Advantages | Disadvantages |
|---|---|---|---|---|
| coal | generating electricity | extracted from underground | • enough available to meet current energy demands<br>• reliable – supply can be controlled to meet demand<br>• relatively cheap to extract and use | • will eventually run out<br>• release carbon dioxide when burned – one of the main causes of climate change<br>• release other polluting gases, such as sulfur dioxide (from coal and oil) which causes acid rain<br>• oil spills in the oceans kill marine life |
| oil | generating electricity<br>transport<br>heating | | | |
| natural gas | generating electricity<br>heating | | | |
| nuclear fission | generating electricity | mining naturally occurring elements, such as uranium and plutonium | • no polluting gases or greenhouse gases produced<br>• enough available to meet current energy demands<br>• large amount of energy transferred from a very small mass of fuel<br>• reliable – supply can be controlled to meet demand | produces nuclear waste, which is:<br>• dangerous<br>• difficult and expensive to dispose of<br>• stored for centuries before it is safe to dispose of.<br>nuclear power plants are expensive to:<br>• build and run<br>• decommission (shut down). |

### Renewable energy resources

| Resource | Main uses | Source | Advantages | Disadvantages |
|---|---|---|---|---|
| solar energy | generating electricity | sunlight transfers energy to solar cells | can be used in remote places<br>very cheap to run once installed<br>no pollution/greenhouse gases produced | supply depends on weather<br>expensive to buy and install<br>cannot supply large scale demand |
| | heating | sunlight transfers energy to solar heating panels | | |
| hydroelectric energy | generating electricity | water flowing downhill turns generators | low running cost<br>no fuel costs<br>reliable and supply can be controlled to meet demand | expensive to build hydroelectric dams<br>flood a large area behind the dam, destroying habitats and resulting in greenhouse gas production from rotting vegetation |
| tidal energy | generating electricity | turbines on tidal barrages turned by water as the tide comes in and out | predictable supply as there are always tides<br>can produce large amounts of electricity<br>no fuel costs<br>no pollution/greenhouse gases produced | tidal barrages:<br>– change marine habitats and can harm animals<br>– restrict access and can be dangerous for boats<br>– are expensive to build and maintain<br>cannot control supply<br>supply varies depending on time of month |
| wave energy | generating electricity | floating generators powered by waves moving up and down | low running cost<br>no fuel costs<br>no pollution/greenhouse gases produced | floating generators:<br>– change marine habitats and can harm animals<br>– restrict access and can be dangerous for boats<br>– are expensive to build, install, and maintain<br>dependent on weather<br>cannot supply large scale demand |
| wind energy | generating electricity | turbines turned by the wind | low running cost<br>no fuel costs<br>no pollution/greenhouse gases produced | supply depends on weather<br>large amounts of land needed to generate enough electricity for large scale demand<br>can produce noise pollution for nearby residents |
| geothermal energy | generating electricity<br>heating | radioactive substances deep within the Earth transfer heat energy to the surface | low running cost<br>no fuel costs<br>no pollution/greenhouse gases produced | expensive to set up<br>only possible in a few suitable locations around the world |
| biofuels | generating electricity<br>transport | fuel produced from living or recently living organisms, for example, plants and animal waste | can be **carbon neutral** – the amount of carbon dioxide released when the fuel is burnt is equal to the amount of carbon dioxide absorbed when the fuel is grown<br>reliable and supply can be controlled to meet demand | expensive to produce biofuels<br>growing biofuels requires a lot of land and water that could be used for food production<br>can lead to deforestation – forests are cleared for growing biofuel crops |

### Key terms

Make sure you can write a definition for these key terms.

biofuel carbon neutral environmental impact fossil fuel geothermal hydroelectric non-renewable reliability renewable

# Chapter 3: Energy resources

## Knowledge organiser

### Energy resources

The main ways in which we use the Earth's energy resources are:

- 
- 
- 

Most of our energy currently comes from **fossil fuels** – ________, ________, and ________ ________.

### Reliability and environmental impact

Some energy resources are more reliable than others. **Reliable** energy resources are ______________________________________________ ______________________________________________.

Both __________ and __________ energy resources have some kind of **environmental impact** when we use them. Name the issues below.

### Non-renewable energy resources

- 
- 

For example, __________ and ____________________.

### Renewable energy resources

- 
- 

For example, __________ __________ __________ and ____________________.

| Non-renewable energy resources | | | | |
|---|---|---|---|---|
| **Resource** | **Main uses** | **Source** | **Advantages** | **Disadvantages** |
| coal | • | | • • • | • • • • |
| oil | • • • | | | |
| natural gas | • • | | | |
| nuclear fission | • | | • • • • | produces nuclear waste, which is: • • • nuclear power plants are expensive to: • • |

| Renewable energy resources | | | | |
|---|---|---|---|---|
| **Resource** | **Main uses** | **Source** | **Advantages** | **Disadvantages** |
| solar energy | • • | | • • • | • • • |
| hydroelectric energy | • | | • • • | • • |
| tidal energy | • | | • • • | tidal barrages: • • • • • |
| wave energy | • | | • • • | floating generators: • • • • • |
| wind energy | • | | • • • | • • • |
| geothermal energy | • • | | • • • | • • |
| biofuels | • • | | • • | • • • |

**Key terms**

**Make sure you can write a definition for these key terms.**

*biofuel* *carbon neutral* *environmental impact* *fossil fuel* *geothermal* *hydroelectric* *non-renewable* *reliability* *renewable*

# Chapter 3: Energy resources

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P3 questions | Answers |
|---|---|---|
| 1 | What is a non-renewable energy resource? | |
| 2 | What is a renewable energy resource? | |
| 3 | What are the main renewable and non-renewable resources available on Earth? | |
| 4 | What are the main advantages of using coal as an energy resource? | |
| 5 | What are the main disadvantages of using coal as an energy resource? | |
| 6 | What are the main advantages of using nuclear fuel as an energy resource? | |
| 7 | What are the main disadvantages of using nuclear fuel as an energy resource? | |
| 8 | What are the main advantages of using solar energy? | |
| 9 | What are the main disadvantages of using solar energy? | |
| 10 | What are the main advantages of using tidal power? | |
| 11 | What are the main disadvantages of using tidal power? | |
| 12 | What are the main advantages of using wave turbines? | |
| 13 | What are the main disadvantages of using wave turbines? | |
| 14 | What are the main disadvantages of using wind turbines? | |
| 15 | What are the advantages and the disadvantages of using geothermal energy? | |
| 16 | What are the main advantages and disadvantages of using biofuels? | |
| 17 | What are the main advantages and disadvantages of using hydroelectric power? | |

# Chapter 4: Electric circuits

## Knowledge organiser

## Charge

An atom has no **charge** because it has equal numbers of positive protons and negative electrons.

When electrons are removed from an atom it becomes *positively* charged. When electrons are added to an atom it becomes *negatively* charged.

## Static charge

Insulating materials can become charged when they are rubbed with another insulating material. This is because electrons are transferred from one material to the other. Materials that gain electrons become negatively charged and those that lose electrons become positively charged.

Positive charges do not usually transfer between materials.

Electric charge is measured in coulombs C.

## Sparks

If two objects have a very strong electric field between them, electrons in the air molecules will be strongly attracted towards the positively charged object. If the electric field is strong enough, electrons will be pulled away from the air molecules and cause a flow of electrons between the two objects – this is a **spark**.

## Drawing electric fields

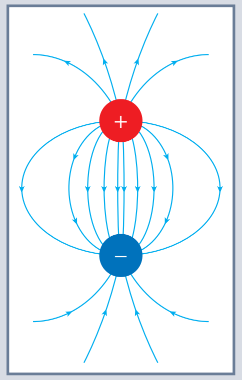
A charged object creates an **electric field** around itself.

If a charged object is placed in the electric field of another charged object it experiences **electrostatic force**. This means that the two charged objects exert a non-contact force on each other:

- like charges repel each other
- opposing charges attract each other.

The electric field, and the force between two charged objects, gets stronger as the distance between the objects decreases.

## Drawing electric fields




Electric fields can be represented using a diagram with field lines. These show the direction of the force that a small positive charge would experience when placed in the electric field.

When drawing electric fields, make sure:

- field lines meet the surface of charged objects at 90°
- arrows always point away from positive charges and towards negative charges.

## Resistance

When electrons move through a circuit, they collide with the ions and atoms of the wires and components in the circuit. This causes **resistance** to the flow of charge.

The unit of resistance is the ohm (Ω).

A long wire has more resistance than a short wire because electrons collide with more ions as they pass through a longer wire.

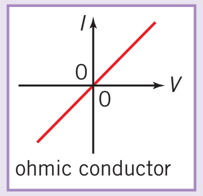
The resistance of an electrical component can be found by measuring the current and potential difference:

potential difference (V) = current (A) × resistance (Ω)

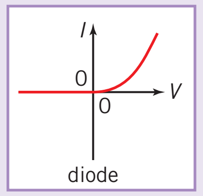
$V = IR$

## Current-potential difference graphs

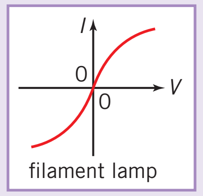
A graph of current through a component against the p.d. across it ($I$–$V$ graph), is known as the component characteristic.




Current is directly proportional to the p.d. in an ohmic conductor at a constant temperature. The resistance is constant.




The current through a diode only flows in one direction – called the forward direction. There needs to be a minimum voltage before any current will flow.

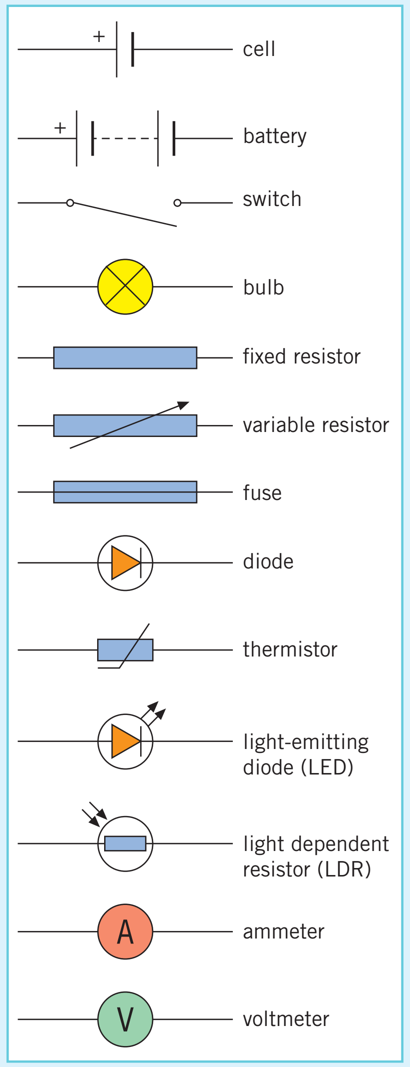



As more current flows through the filament, its temperature increases. The atoms in the wire vibrate more, and collide more often with electrons flowing through it, so resistance increases as temperature increases. The resistance of a thermistor decreases and temperature increases. The resistance of a light dependent resistor (LDR) decreases as light intensity increases.

The resistance of an ohmic conductor can be found by calculating the gradient at that point and taking the inverse:

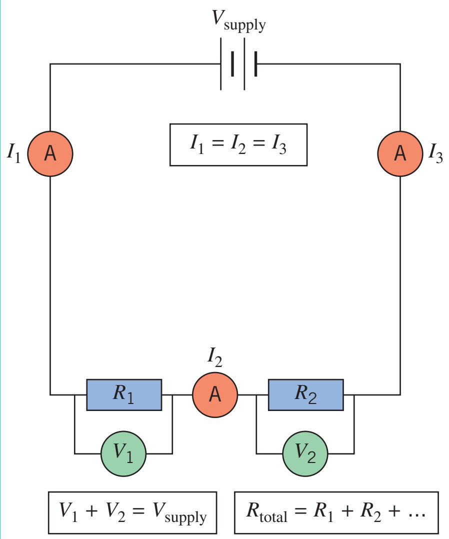
$$\text{resistance} = \frac{1}{\text{gradient}}.$$

## Circuit components




## Series circuits

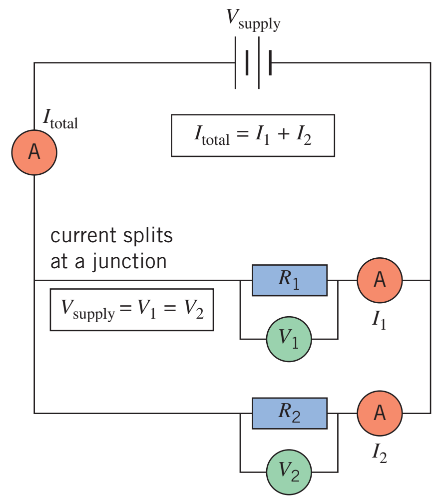
In a series circuit, the components are connected one after the other in a single loop. If one component in a series circuit stops working the whole circuit will stop working.




Components with a higher resistance will transfer a larger share of the total p.d. because $V = IR$ (and current is the same through all components).

## Parallel circuits

A parallel circuit is made up of two or more loops through which current can flow. If one branch of a parallel circuit stops working, the other branches will not be affected.




The total resistance of two or more components in parallel is always less than the smallest resistance of any branch. This is because adding a loop to the circuit provides another route for the current to flow, so more current can flow in total even though the p.d. has not changed. Adding more resistors in parallel decreases the total resistance of a circuit.

## Electric current

**Electric current** is when **charge** flows. The charge in an electric circuit is carried by electrons.

The unit of current is the ampere (amp, A).

1 ampere = 1 coulomb of charge flow per second

Charge (C) = current (A) x time (s)

In circuit diagrams, current flows from the positive terminal of a cell or battery to the negative terminal. This is known as conventional current.

In a single closed loop, the current has the same value at any point in the circuit.

Metals are good conductors of electricity because they contain delocalised electrons, which are free to flow through the structure.

## Potential difference

**Potential difference** (p.d.) is a measure of how much energy is transferred between two points in a circuit. The unit of potential difference is the volt (V).

- The p.d. across a component is the work done on it by each coulomb of charge that passes through it.
- The p.d. across a power supply or battery is the energy transferred to each coulomb of charge that passes through it.

For electrical charge to flow through a circuit there must be a source of potential difference.

Potential difference (V) = energy transferred (J)/ charge (C)

## Key terms

**Make sure you can write a definition for these key terms.**

ampere
charge
coulomb
current
electric field
electrostatic force
LDR
parallel
potential difference
resistance
series
static
thermistor

# Chapter 4: Electric circuits

## Knowledge organiser

### Charge

An ______ has no **charge** because it has equal numbers of positive protons and negative electrons.

When electrons are removed from an atom it becomes ______ charged. When electrons are added to an atom it becomes ______ charged.

### Static charge

Insulating materials can become charged when they are ______ with another insulating material. This is because electrons are ______ from one material to the other. Materials that ______ ______ become negatively charged and those that ______ ______ become positively charged.

______ charges do not usually transfer between materials.

Electric charge is measured in ______.

### Sparks

If two objects have a very ______ electric field between them, electrons in the ______ molecules will be strongly attracted towards the ______ ______ object. If the electric field is strong enough, electrons will be ______ away from the air molecules and cause a flow of electrons between the two objects – this is a **spark**.

### Drawing electric fields

A ______ object creates an **electric field** around itself.

If a charged object is placed in the electric field of another charged object it experiences ______ ______. This means that the two charged objects exert a ______ force on each other:

- like charges ______ each other
- opposing charges ______ each other.

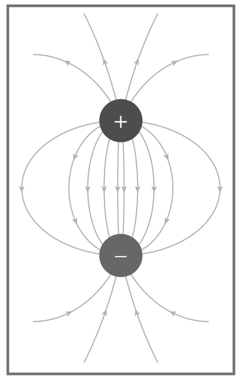
The electric field, and the force between two charged objects, gets ______ as the distance between the objects decreases.

### Drawing electric fields

Electric fields can be represented using a diagram with ______ ______. These show the ______ of the force that a small positive charge would experience when placed in the electric field.

When drawing electric fields, make sure:

- field lines meet the surface of charged objects at ______
- arrows always point ______ from positive charges and ______ negative charges.




### Resistance

When electrons move through a circuit, they ______ with the ions and atoms of the wires and components in the circuit. This causes ______ to the flow of charge.

The unit of resistance is the ______.

A ______ wire has more resistance than a ______ wire because electrons collide with more ions as they pass through a longer wire.

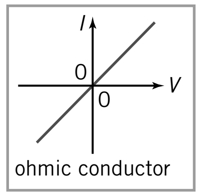
The resistance of an electrical component can be found by measuring the ______ and potential difference:

potential difference (V) = ______ (A) × ______ (Ω)

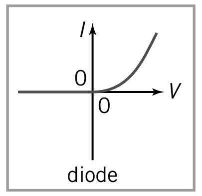
$V = IR$

### Current–potential difference graphs

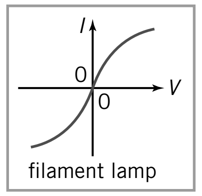
A graph of current through a component against the p.d. across it ($I$–$V$ graph), is known as the ______ characteristic.




Current is ______ ______ to the p.d. in an ohmic conductor at a ______ temperature. The ______ is constant.




The current through a diode only flows in one direction – called the ______ ______. There needs to be a minimum ______ before any current will flow.




As more current flows through the filament, its temperature ______. The atoms in the wire ______ more, and collide more often with ______ flowing through it, so resistance increases as temperature ______. The resistance of a ______ decreases and temperature increases. The resistance of a light dependent resistor (LDR) ______ as light intensity increases.

The resistance of an ohmic conductor can be found by calculating the gradient at that point and taking the ______:

$$\text{resistance} = \frac{1}{\text{gradient}}.$$

### Electric current

**Electric current** is when ______ flows. The charge in an electric circuit is carried by electrons.

The unit of current is the ______.

*1 ampere = 1 coulomb of charge flow per second*

*Charge (C) = current (A) x time (s)*

In circuit diagrams, current flows from the ______ terminal of a cell or battery to the ______ terminal. This is known as ______.

In a single closed loop, the current has the same value at any point in the circuit.

Metals are good ______ of electricity because they contain ______ electrons, which are free to ______ through the structure.

### Potential difference

**Potential difference** (p.d.) is ______ ______. The unit of potential difference is the ______.

- The p.d. across a component is the ______ on it by each coulomb of charge that passes through it.
- The p.d. across a power supply or battery is the ______ to each coulomb of charge that passes through it.

For electrical charge to flow through a circuit there must be a source of potential difference.

*Potential difference (V) = energy transferred (J)/ charge (C)*

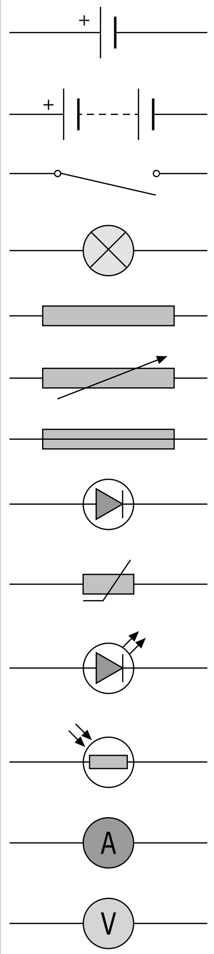
### Key terms

**Make sure you can write a definition for these key terms.**

ampere
charge
coulomb
current
electric field
electrostatic force
LDR
parallel
potential difference
resistance
series
static
thermistor

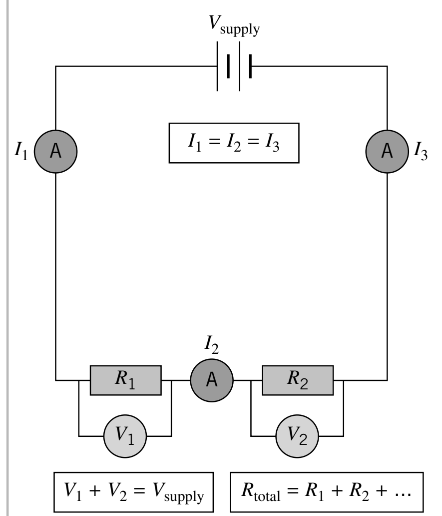
### Circuit components

Name the circuit components




### Series circuits

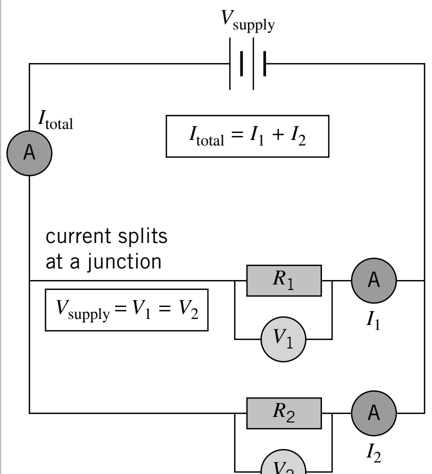
In a series circuit, the components are connected one after the other in a ______ loop. If one component in a series circuit stops working the ______ circuit will stop working.




Components with a higher ______ will transfer a larger share of the total p.d. because $V = IR$ (and current is the same through all components).

### Parallel circuits

A parallel circuit is made up of two or more ______ through which current can flow. If one branch of a parallel circuit stops working, the other branches ______.




The total resistance of two or more components in parallel is always ______ than the smallest resistance of any branch. This is because adding a loop to the circuit provides another route for the current to flow, so more current can flow in total even though the p.d. has not changed. Adding more ______ in parallel decreases the total resistance of a circuit.

# Chapter 4: Electric circuits

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P4 questions | Answers |
|---|---|---|
| 1 | How does a material become charged? | |
| 2 | What will two objects carrying the same type of charge do if they are brought close to each other? | |
| 3 | What is an electric field? | |
| 4 | What happens to the strength of an electric field as you get further from the charged object? | |
| 5 | What is electric current? | |
| 6 | What units are charge, current, and time measured in? | |
| 7 | What is the same at all points when charge flows in a closed loop? | |
| 8 | What must there be in a closed circuit so that electrical charge can flow? | |
| 9 | Which two factors does current depend on and what are their units? | |
| 10 | What happens to the current if the resistance is increased but the p.d. stays the same? | |
| 11 | What is an ohmic conductor? | |
| 12 | What happens to the resistance of a filament lamp as its temperature increases? | |
| 13 | What happens to the resistance of a thermistor as its temperature increases? | |
| 14 | What happens to the resistance of a light-dependent resistor when light intensity increases? | |
| 15 | What are the main features of a series circuit? | |
| 16 | What are the main features of a parallel circuit? | |

# Chapter 5: Electricity in the home

## Knowledge organiser

### Mains electricity

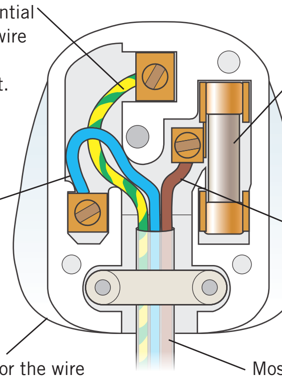
A cell or a battery provides a **direct current (dc)**. The current only flows in one direction and is produced by a **direct potential difference**.

Mains electricity provides an **alternating current (ac)**. The current repeatedly reverses direction and is produced by an **alternating potential difference**.

The positive and negative terminals of an alternating power supply swap over with a regular frequency.

The frequency of the mains electricity supply in the UK is 50 Hz and its voltage is 230 V.

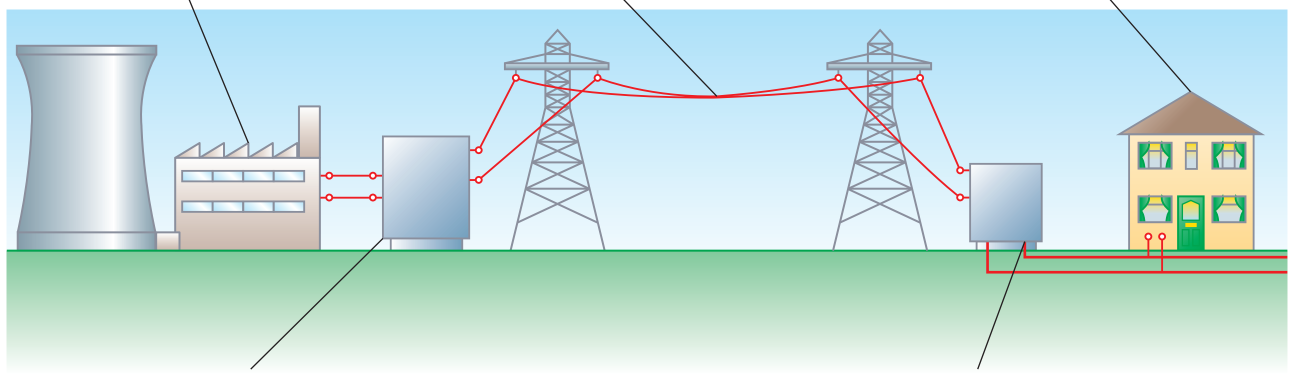
### Plugs




### The National Grid

The **National Grid** is a nationwide network of cables and transformers that link power stations to homes, offices, and other consumers of mains electricity.

**Transformers** are devices that can change the potential difference of an alternating current.




By making the grid potential difference much higher, a smaller current is needed to transfer the same power. Therefore, the National Grid is an efficient way to transfer power due to less heating loss in the wire.

### Why do transformers improve efficiency?

A high potential difference across the transmission cables means that a lower current is needed to transfer the same amount of power, since:

power (W) = current (A) × potential difference (V)

$$P = IV$$

A lower current in the cables means less electrical power is wasted due to heating of the cables, since the power lost in heating a cable is:

power (W) = current$^2$ (A) × resistance (Ω)

$$P = I^2R$$

This makes the National Grid an efficient way to transfer energy.

If 100% efficiency is assumed:

primary potential difference × primary current = secondary potential difference × secondary current

$$V_p I_p = V_s I_s$$

### Energy transfer in electrical appliances

Electrical appliances transfer energy.

For example, an hairdryer transfers energy electrically from a chemical store (e.g., the fuel in a power station) to the kinetic energy store of the fan inside the hairdryer and to the thermal energy store of the heating filaments inside the hairdryer.

When you turn an electrical appliance on, the potential difference of the mains supply causes charge (carried by electrons) to flow through it.

You can calculate the **charge flow** using the equation:

charge flow (C) = current (A) × time (s)

$$Q = It$$

You can find the energy transferred to an electrical appliance when charge flows through it using:

energy transferred (J) = charge flow (C) × potential difference (V)

$$E = QV$$

You can find the energy transferred by an electrical appliance using the equation:

energy transferred (J) = power (W) × time (s)

### Key terms

**Make sure you can write a definition for these key terms.**

alternating current, alternating potential difference, charge flow, coulombs, direct current, direct potential difference, fuse, National Grid, short circuit, step-down transformer, step-up transformer

# Chapter 5: Electricity in the home

## Knowledge organiser

### Mains electricity

A cell or a battery provides a ______ ______. The current only flows in ______ direction and is produced by a ______ **potential difference**.

Mains electricity provides an ______ ______. The current repeatedly ______ direction and is produced by an ______ **potential difference**.

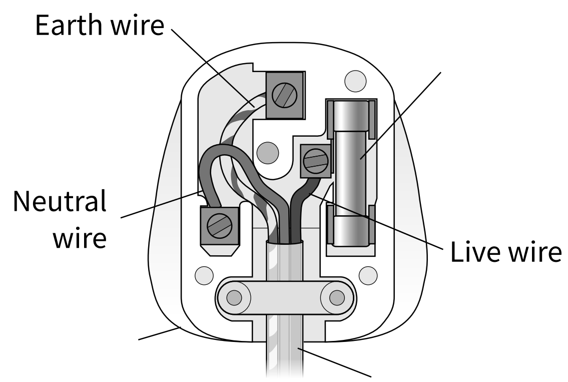
The ______ and ______ terminals of an alternating power supply swap over with a regular ______.

The frequency of the mains electricity supply in the UK is ______ and its voltage is ______.

### Plugs

Label the diagram and name the colours of the wires in the table.

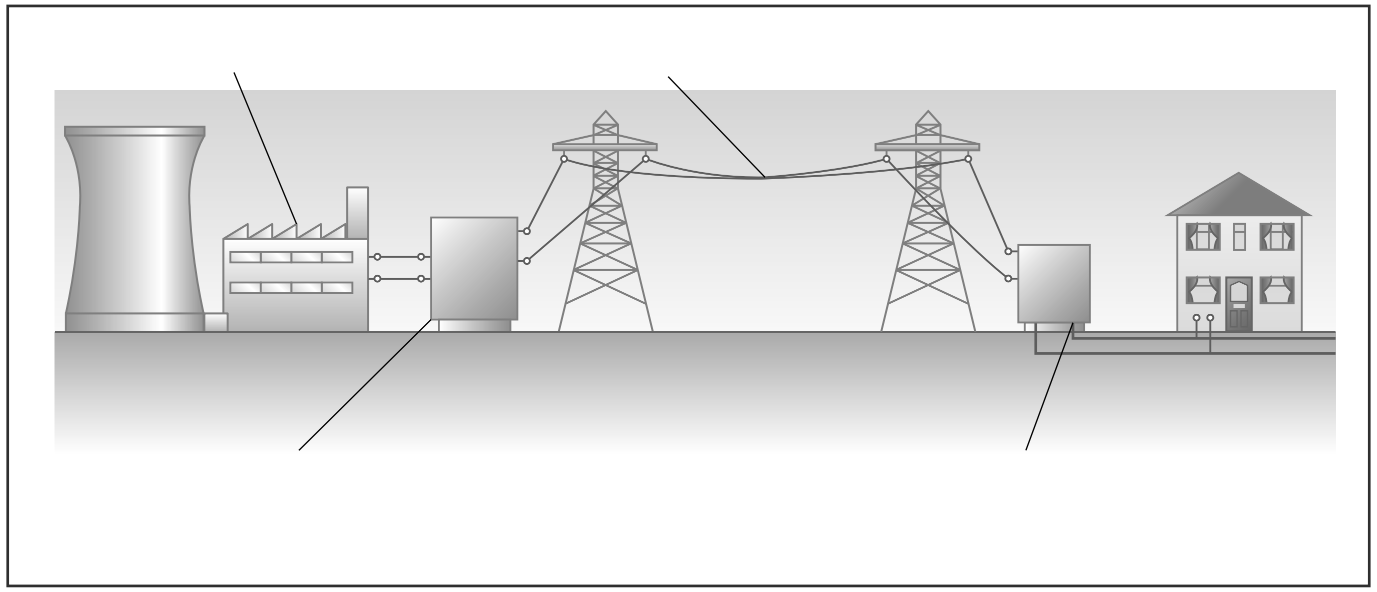
| Wire | Colour |
|---|---|
| Live | |
| Neutral | |
| Earth | |




### The National Grid

The **National Grid** is a nationwide ______ of cables and transformers that link ______ ______ to homes, offices, and other consumers of mains electricity.

**Transformers** are devices that can change the ______ ______ of an alternating current.



By making the grid potential difference much ______, a smaller current is needed to transfer the same power. Therefore, the National Grid is an efficient way to transfer power due to less ______ loss in the wire.

### Why do transformers improve efficiency?

A high potential difference across the transmission cables means that a ______ current is needed to transfer the same amount of power, since:

*power* (W) = ______ (A) × ______ (V)

$P$ = ______ (L)

A lower current in the cables means less electrical power is ______ due to heating of the cables, since the power lost in heating a cable is:

*power* (W) = ______$^2$ (A) × ______ (Ω)

$P$ = ______ (L)

This makes the National Grid an ______ way to transfer energy.

If 100% ______ is assumed:

______ potential difference × primary current = ______ potential difference × secondary current

$V_p I_p = V_s I_s$

### Energy transfer in electrical appliances

Electrical appliances ______ energy.

For example, a hairdryer transfers energy electrically from a ______ ______ (e.g., the fuel in a power station) to the ______ ______ of the fan inside the hairdryer and to the ______ ______ ______ of the heating filaments inside the hairdryer.

When you turn an electrical appliance on, the potential difference of the ______ supply causes charge (carried by ______) to flow through it.

You can calculate the **charge flow** using the equation:

(L) *charge flow* (C) = ______ (A) × ______ (s)

$Q$ = ______

You can find the energy transferred to an electrical appliance when charge flows through it using:

(L) *energy transferred* (J) = ______ (C) × ______ (V)

$E$ = ______

You can find the energy transferred by an electrical appliance using the equation:

(L) *energy transferred* (J) = ______ (W) × ______ (s)

### Key terms

**Make sure you can write a definition for these key terms.**

alternating current, alternating potential difference, charge flow, coulombs, direct current, direct potential difference, fuse, National Grid, short circuit, step-down transformer, step-up transformer

# Chapter 5: Electricity in the home

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P5 questions | Answers |
|---|---|---|
| 1 | Why is the current provided by a cell called a direct current (d.c.)? | |
| 2 | What is an alternating current (a.c.)? | |
| 3 | What kind of current is supplied by mains electricity? | |
| 4 | What is the frequency and voltage of mains electricity? | |
| 5 | What colours are the live, neutral, and earth wires in a three-core cable? | |
| 6 | What is the function of the live wire in a three-core cable? | |
| 7 | What is the function of the neutral wire in a three-core cable? | |
| 8 | What is the function of the earth wire in a three-core cable? | |
| 9 | When is there a current in the earth wire? | |
| 10 | Why is the live wire dangerous? | |
| 11 | What is the National Grid? | |
| 12 | What are step-up transformers used for in the National Grid? | |
| 13 | What are step-down transformers used for in the National Grid? | |
| 14 | How does having a large potential difference in the transmission cables help to make the National Grid an efficient way to transfer energy? | |
| 15 | What two things does energy transfer to an appliance depend on? | |
| 16 | What are the units for power, current, potential difference, and resistance? | |

# Chapter 6: Molecules and matter

## Knowledge organiser

## Changes of state

### Changes of state and conservation of mass

Changes of state are physical changes because no new substances are produced. The mass always stays the same because the number of particles does not change.

### Particles and kinetic energy

When the temperature of a substance is increased, the kinetic energy store of its particles increases and the particles vibrate or move faster.

If the kinetic store of a substance's particles increases or decreases enough, the substance may change state.

### Density

You can calculate the density of an object if you know its mass and volume:

$$\text{density (kg/m}^3) = \frac{\text{mass (kg)}}{\text{volume (m}^3)}$$

$$\rho = \frac{m}{V}$$

L

## States of matter

| | | |
|---|---|---|
| **Gas** | **Arrangement** | • particles are spread out<br>• almost no forces of attraction between particles<br>• large distance between particles on average |
| | **Movement** | • particles move randomly at high speed |
| | **Properties** | • low density<br>• no fixed volume or shape<br>• can be compressed and can flow<br>• spread out to fill all available space |

| | | |
|---|---|---|
| **Liquid** | **Arrangement** | • particles are in contact with each other<br>• forces of attraction between particles are weaker than in solids |
| | **Movement** | • particles are free to move randomly around each other |
| | **Properties** | • usually lower density than solids<br>• fixed volume<br>• shape is not fixed so they can flow |

| | | |
|---|---|---|
| **Solid** | **Arrangement** | • particles held next to each other in fixed positions by strong forces of attraction |
| | **Movement** | • particles vibrate about fixed positions |
| | **Properties** | • high density<br>• fixed volume<br>• fixed shape (unless deformed by an external force) |

## Internal energy

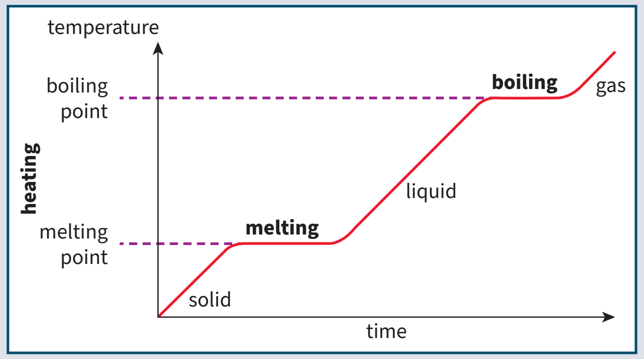
Heating a substance increases its **internal energy**.

Internal energy is the sum of the total kinetic energy the particles have due to their motion and the total potential energy the particles have due to their positions relative to each other.

## Latent heat

In a graph showing the change in temperature of a substance being heated or cooled, the flat horizontal sections show when the substance is changing state.

The energy transfers taking place during a change in state do not cause a change in temperature, but do change the internal energy of the substance.




The energy transferred when a substance changes state is called the **latent heat**.

**Specific latent heat** – the energy required to change 1 kg of a substance with no change in temperature.

**Specific latent heat of fusion** – the energy required to melt 1 kg of a substance with no change in temperature.

**Specific latent heat of vaporisation** – the energy required to evaporate 1 kg of a substance with no change in temperature.

The energy needed to change the state of a substance can be calculated using the equation:

$$\text{thermal energy for a change in state (J)} = \text{mass (kg)} \times \text{specific latent heat (J/kg)}$$

$$E = m \times l$$

## The relationship between temperature and pressure in gases

### Gas temperature

The particles in a gas are constantly moving in random directions and with random speeds.

The temperature of a gas is related to the average kinetic energy of its particles.

When a gas is heated, the particles gain kinetic energy and move faster, so the temperature of the gas increases.

### Gas pressure

The pressure a gas exerts on a surface, such as the walls of a container, is caused by the force of the gas particles hitting the surface.

The pressure of a gas produces a net force at right angles to the walls of a container or any surface.

If the temperature of a gas in a sealed container is increased, the pressure increases because

- the particles move faster so they hit the surfaces with more force
- the number of these impacts per second increases, exerting more force overall.

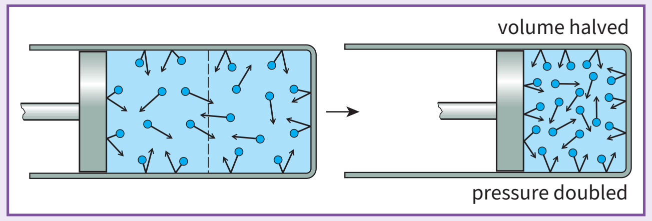
If a gas is compressed quickly, for example, in a bicycle pump, its temperature can rise. This is because

- compressing the gas requires a force to be applied to the gas – this results in work being done to the gas, since work done = force × distance
- the energy gained by the gas is not transferred quickly enough to its surroundings.

## The relationship between volume and pressure in gases

If the volume of a fixed mass of gas at a constant temperature is decreased, the pressure increases because

- the distance the particles travel between each impact with a container wall is smaller
- the number of impacts per second increases, so the total force of impacts increases.




Similarly, if the volume is increased, the pressure decreases. This is because

- the distance the particles travel between each impact with a wall of the container is greater
- the number of impacts per second decreases, so the total force of the impacts decreases.

The pressure and volume of a fixed mass of gas at a constant temperature are linked by the equation:

$$\text{pressure (Pa)} \times \text{volume (m}^3) = \text{constant}$$

$$p \times V = \text{constant}$$

Rearranging this equation gives:

$$p = \frac{\text{constant}}{V} \quad \text{and} \quad V = \frac{\text{constant}}{p}$$

This shows that pressure is inversely proportional the volume of a gas.

## Key terms

**Write a definition for these key terms.**

boiling, condensation, conservation of mass, density, evaporation, freezing, fusion, internal energy, latent heat, melting, specific latent heat, sublimation, vaporisation

# Chapter 6: Molecules and matter

## Knowledge organiser

## Changes of state

### Changes of state and conservation of mass

Changes of state are ______ changes because no new substances are produced. The mass always stays the ______ because the number of particles does not change.

### Particles and kinetic energy

When the temperature of a substance is ______, the ______ energy store of its particles increases and the particles vibrate or move ______.

If the kinetic store of a substance's particles increases or decreases enough, the substance may change ______.

### Density

You can calculate the density of an object if you know its mass and volume:

$$\text{density (kg/m}^3\text{)} = \frac{\_\_\_\_\_\_ \text{ (kg)}}{\_\_\_\_\_\_ \text{ (m}^3\text{)}}$$

$$\rho = \frac{m}{V}$$

L

## Internal energy

______ a substance increases its **internal energy**.

Internal energy is the ______ of the total kinetic energy the particles have due to their ______ and the total potential energy the particles have due to their positions relative to each other.

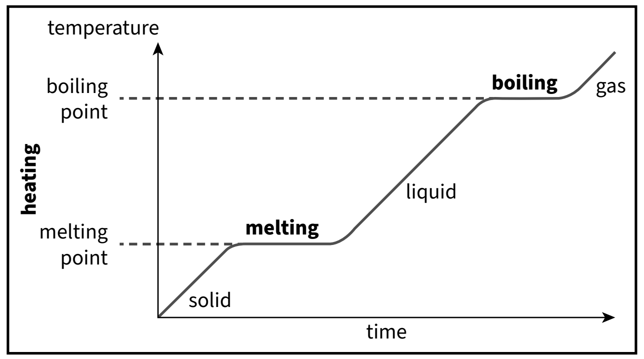
## States of matter

| State | | |
|---|---|---|
| Gas | **Arrangement** | • <br>• <br>• |
| | **Movement** | • |
| | **Properties** | • <br>• <br>• <br>• |
| Liquid | **Arrangement** | • <br>• |
| | **Movement** | • |
| | **Properties** | • <br>• <br>• |
| Solid | **Arrangement** | • |
| | **Movement** | • |
| | **Properties** | • <br>• <br>• |

## Latent heat

In a graph showing the change in ______ of a substance being heated or cooled, the flat horizontal sections show when the substance is changing state.

The energy transfers taking place during a change in state do not cause a change in temperature, but do change the ______ energy of the substance.




The energy transferred when a substance changes state is called the ______ ______. Define the following terms.

**Specific latent heat** – ______

**Specific latent heat of fusion** – ______

**Specific latent heat of vaporisation** – ______

The energy needed to change the state of a substance can be calculated using the equation:

$$\text{thermal energy for a change in state (J)} = \_\_\_\_\_\_ \text{ (kg)} \times \_\_\_\_\_\_ \text{ (J/kg)}$$

$$E = m \times l$$

## The relationship between temperature and pressure in gases

### Gas temperature

The particles in a gas are constantly moving in ______ directions and with random ______.

The temperature of a gas is related to the average ______ energy of its particles.

When a gas is heated, the particles gain kinetic energy and move ______, so the temperature of the gas increases.

### Gas pressure

The pressure a gas exerts on a ______, such as the walls of a container, is caused by the force of the gas particles hitting the surface.

The pressure of a gas produces a ______ force at right angles to the walls of a container or any surface.

If the temperature of a gas in a sealed container is increased, the pressure increases because

- the particles move ______ so they hit the surfaces with more force
- the number of these impacts per second increases, exerting more ______ overall.

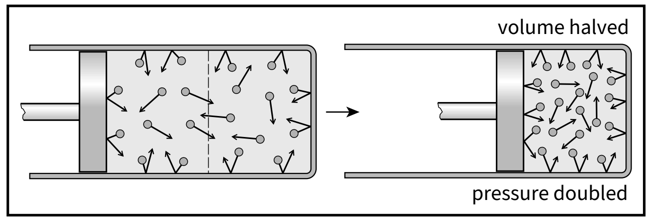
If a gas is compressed quickly, for example, in a bicycle pump, its temperature can ______. This is because

- compressing the gas requires a ______ to be applied to the gas – this results in work being done to the gas, since work done = force × distance
- the energy ______ by the gas is not transferred quickly enough to its surroundings.

## The relationship between volume and pressure in gases

If the volume of a fixed mass of gas at a constant temperature is decreased, the pressure ______ because

- the distance the particles travel between each impact with a container wall is ______
- the number of impacts per second increases, so the total force of impacts increases.




Similarly, if the volume is increased, the pressure decreases. This is because

- the distance the particles travel between each impact with a wall of the container is ______
- the number of impacts per second ______, so the total force of the impacts decreases.

The pressure and volume of a fixed mass of gas at a constant temperature are linked by the equation:

______ (Pa) × ______ ($m^3$) = ______

$$p \times V = \text{constant}$$

Rearranging this equation gives:

$$p = \frac{\text{constant}}{V} \quad \text{and} \quad V = \frac{\text{constant}}{p}$$

This shows that pressure is ______ ______ the volume of a gas.

**Key terms**

**Write a definition for these key terms.**

*boiling* *condensation* *conservation of mass* *density* *evaporation* *freezing* *fusion* *internal energy* *latent heat* *melting* *specific latent heat* *sublimation* *vaporisation*

# Chapter 6: Molecules and matter

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P6 questions | Answers |
|---|---|---|
| 1 | Which two quantities do you need to measure to find the density of a solid or liquid? | |
| 2 | What happens to the particles in a substance if its temperature is increased? | |
| 3 | Why are changes of state physical changes? | |
| 4 | Why is the mass of a substance conserved when it changes state? | |
| 5 | What is the internal energy of a substance? | |
| 6 | Why does a graph showing the change in temperature as a substance cools have a flat section when the substance is changing state? | |
| 7 | What is the name given to the energy transferred when a substance changes state? | |
| 8 | What is the specific latent heat of a substance? | |
| 9 | What is the specific latent heat of fusion a substance? | |
| 10 | What is the specific latent heat of vaporisation of a substance? | |
| 11 | On a graph of temperature against time for a substance being heated up or cooled down, what do the flat (horizontal) sections show? | |
| 12 | What property of a gas is related to the average kinetic energy of its particles? | |
| 13 | What causes the pressure of a gas on a surface? | |
| 14 | Give two reasons why the pressure of a gas in a sealed container increases if its temperature is increased. | |
| 15 | Give two reasons why the temperature of a gas increases if it is compressed quickly. | |
| 16 | Explain why the pressure of a fixed mass of gas decreases if the volume is increased and kept at constant temperature. | |

# Chapter 7: Radioactivity 1

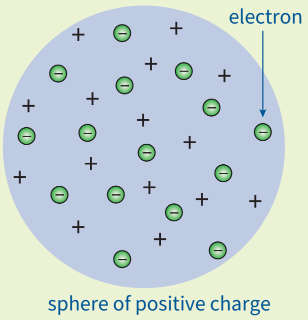
## Knowledge organiser

### Dalton's model

John Dalton thought the atom was a neutral solid sphere you cannot divide into smaller parts.

### Plum pudding model

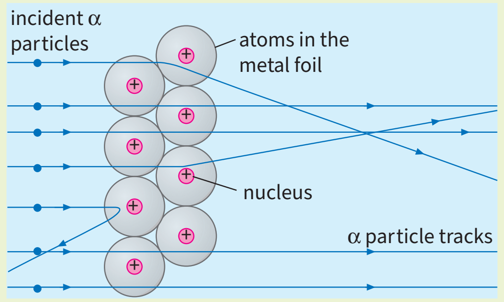
The discovery of negatively charged electrons led to the plum pudding model – a cloud of positive charge with electrons embedded in it.




### Alpha scattering experiment

Positively charged alpha particles were fired at a thin sheet of gold foil.

- Most went straight through
- Some were deflected by small amounts
- 1 in 10 0000 deflected through large angles




### Nuclear model

To explain the results, scientists deduced that there is a small positively charged nucleus at the centre of the atom where most of the mass is concentrated. The negative electrons orbit the nucleus.

### Bohr's model

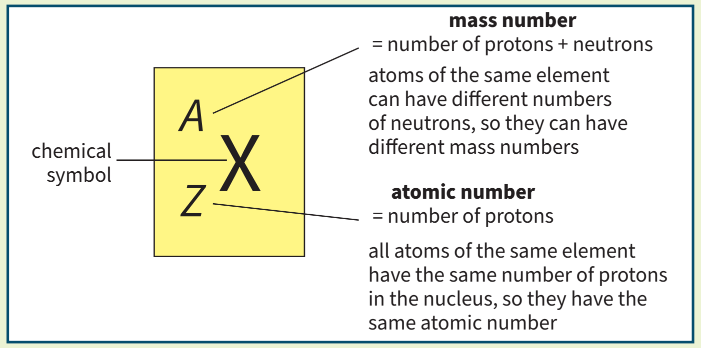
Bohr suggested the electrons orbit at specific distances called energy levels.

### Basic structure of an atom

The nucleus, which is 10 000 times smaller than the radius of the atom, consists of two particles:

- positively charged protons
- neutrons which are neutral

An atom is uncharged overall and has equal numbers of protons and electrons.




**Isotopes** are atoms of the same element, with the same number of protons but a different numbers of neutrons.

## Radioactive decay

**Radioactive** decay is when nuclear radiation is emitted by unstable atomic nuclei so that they become more stable. It is a *random* process. This radiation can knock electrons out of atoms in a process called **ionisation**.

| Type of radiation | Change in the nucleus | Ionising power | Range in air | Stopped by | Decay equation |
|---|---|---|---|---|---|
| $\alpha$ alpha particle (two protons and two neutrons) | nucleus loses two protons and two neutrons | highest ionising power | travels a few centimetres in air | stopped by a sheet of paper | $^{A}_{Z}X \rightarrow ^{(A-4)}_{(Z-2)}Y + ^{4}_{2}\alpha$ |
| $\beta$ beta particle (fast-moving electron) | a neutron changes into a proton and an electron | high ionising power | travels ≈ 1 m in air | stopped by a few millimetres of aluminium | $^{A}_{Z}X \rightarrow ^{A}_{(Z+1)}Y + ^{0}_{-1}\beta$ |
| $\gamma$ gamma radiation (short-wavelength, high-frequency EM radiation) | some energy is transferred away from the nucleus | low ionising power | virtually unlimited range in air | stopped by several centimetres of thick lead or metres of concrete | $^{A}_{Z}X \rightarrow ^{A}_{Z}X + ^{0}_{0}\gamma$ |

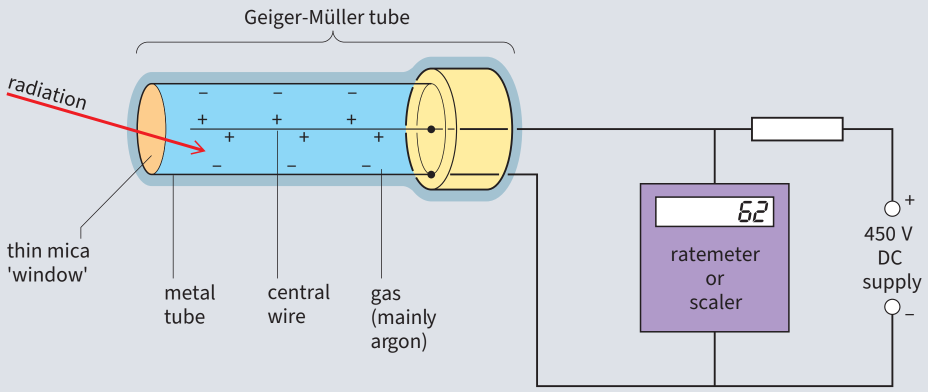
## Activity and count rate

The **activity** of a radioactive source is the rate of decay of an unstable nucleus, measured in becquerel (Bq).

*1 Bq = 1 decay per second*

Detectors (e.g., **Geiger-Müller tubes**) record a **count rate** (number of decays detected per second).

$$\text{count rate after } n \text{ half-lives} = \frac{\text{initial count rate}}{2^n}$$




## Half-life

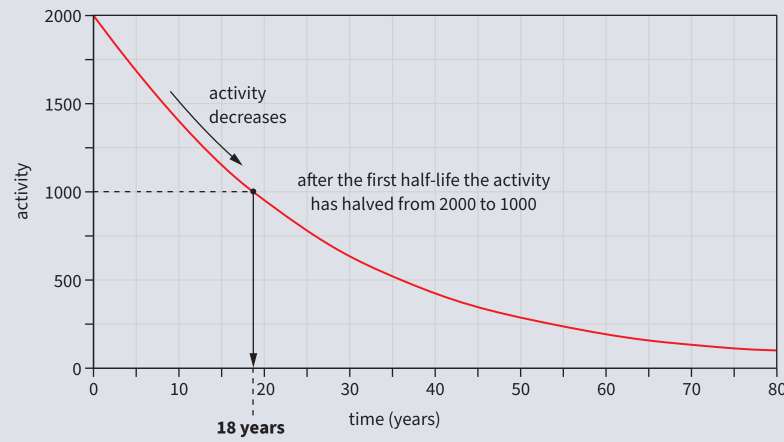
The **half-life** of a radioactive source is the time

- for half the number of unstable nuclei in a sample to decay
- for the count rate or activity of a source to halve.

The half-life of a source can be found from a graph of its count rate or activity against time.

To find the reduction in activity after a given number of half-lives:

1. calculate the activity after each half-life
2. subtract the final activity from the original activity.




The time taken for the activity to halve is 18 years. This is the half-life of this substance.

**(HT only ) Net decline** can be given as a ratio: $\text{net daecline} = \frac{\text{reduction in activity}}{\text{original activity}}$

# Chapter 7: Radioactivity 2

## Knowledge organiser

### Ionising radiation

Living cells can be damaged or killed by ionising radiation.

The risk depends on the half-life of the source and the type of radiation.

Alpha radiation is very dangerous inside the body because it affects all the surrounding tissue. Outside the body it only affects the skin and eyes because it cannot penetrate further.

Beta and gamma radiation are dangerous outside and inside the body because they can penetrate into tissues.

### Radiation dose

**Radiation dose**, measured in sievert (Sv), measures the health risk of exposure to radiation. It depends on the type and amount of radiation.

### Background radiation

**Background radiation** is radiation that is around us all the time. It comes from:

- natural sources like rocks and cosmic rays
- nuclear weapons and nuclear accidents.

Background radiation is always present but the levels are higher in some locations and in some jobs.

### Nuclear waste

When fuel rods are removed from the reactor, they are stored in large tanks in water for up to a year until they cool down.

Machines are then used to open up fuel rods and extract the unused plutonium and uranium. Any material that is left then has to be stored securely as they have lots of radioactive isotopes with long half-lives. This is done to prevent radioactive contamination.

### Irradiation versus contamination

<table>
<tr><td>irradiation</td><td>when an object is exposed to nuclear radiation</td><td rowspan="2">cause harm through ionisation</td><td>prevented by shielding, removing, or moving away from the source of radiation</td></tr>
<tr><td>contamination</td><td>when atoms of a radioactive material are on or in an object</td><td>object remains exposed to radiation as long as it is contaminated<br>contamination can be very difficult to remove</td></tr>
</table>

### Nuclear radiation in medicine

#### Exploration of internal organs

Gamma-emitting **tracers** are injected or swallowed by a patient. Gamma cameras can then create an image showing where the tracer has gone.

The half-life of the tracer must be short enough so that most of the nuclei will decay shortly after the image is taken to limit the patient's radiation dose (normally about six hours).

#### Control or destruction of unwanted tissue

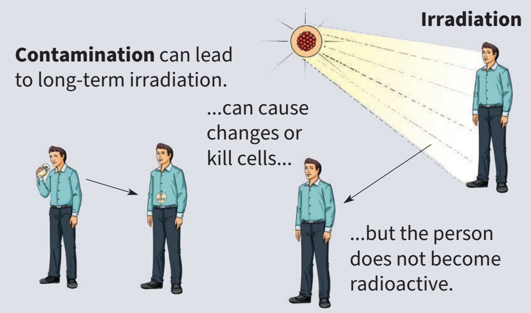
1. Narrow beams of gamma radiation can be focused on tumour cells to destroy them. Gamma is used because it can penetrate tumours from outside the body.
2. Beta- or gamma-emitting implants can be surgically placed inside (or next to) tumours. Their half-lives must be long enough to be effective, but short enough that it does not continue to irradiate the patient after treatment.

### Protection against irradiation and contamination

You can protect against irradiation and contamination by:

- maintaining a distance from the radiation source
- limiting time near the source
- shielding from the radiation.

Studies on the effects of radiation should be published, shared with other scientists, and checked by **peer review** as they are important for human health.




### Nuclear fission

**Nuclear fission** is when a large unstable nucleus absorbs an extra neutron and splits into two smaller nuclei of roughly equal size.

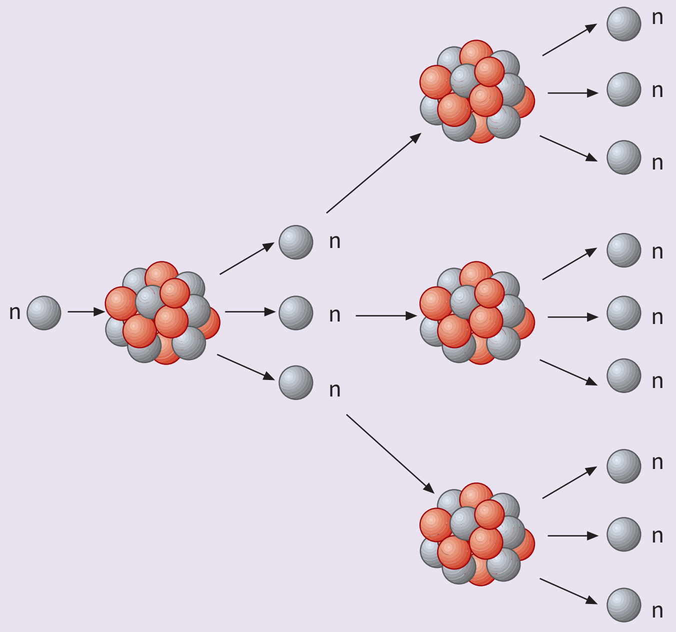
During nuclear fission:

- gamma radiation is emitted and energy is released
- two or three neutrons are emitted that can go on to cause a **chain reaction**.

The chain reaction in a power station reactor is controlled by absorbing neutrons.

Nuclear explosions are uncontrolled chain reactions.

On rare occasions an unstable nucleus splits apart without absorbing a neutron. This is called **spontaneous fission**.



### Nuclear fusion

**Nuclear fusion** is when two light nuclei join to make a heavier one.

Some of the mass is converted to energy and transferred as radiation.

Nuclear fusion in the sun's core releases energy. A fusion reactor has to be at a very high temperature so the nuclei can overcome their repulsion.

### Nuclear fusion in the future

Future fusion reactors could meet energy needs for a growing population. This is because:

- The fuel for fusion reactors is easily available as heavy hydrogen is naturally present in sea water.
- The product, helium, is an unreactive gas and non-radioactive so is harmless.
- The energy released could be used to generate electricity in the future.

### Key terms

**Make sure you can write a definition for these key terms.**

atom, alpha, activity, atomic number, background radiation, beta, chain reaction, contamination, count rate, electron, fission, fusion, gamma, Geiger-Müller tube, half-life, ionisation, irradiation, isotope, mass number, net decline, neutron, plum pudding model, proton, peer review, radiation dose, radioactive decay, spontaneous, tracer

# Chapter 7: Radioactivity 1

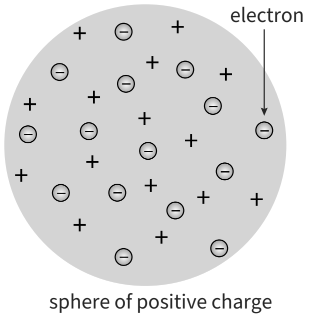
## Knowledge organiser

### Dalton's model

John Dalton thought the atom was a __________ solid sphere you cannot divide into smaller parts.

### Plum pudding model

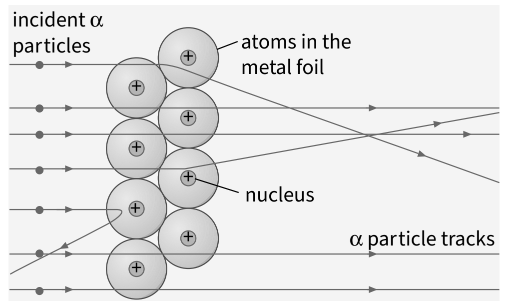
The discovery of __________ charged electrons led to the plum pudding model – a cloud of __________ charge with electrons embedded in it.




### Alpha scattering experiment

Positively charged __________ particles were fired at a thin sheet of gold foil.

- Most went __________ through
- Some were __________ by small amounts
- 1 in __________ deflected through large angles




### Nuclear model

To explain the results, scientists deduced that there is a small positively charged __________ at the centre of the atom where most of the mass is __________.
The negative electrons orbit the nucleus.

### Bohr's model

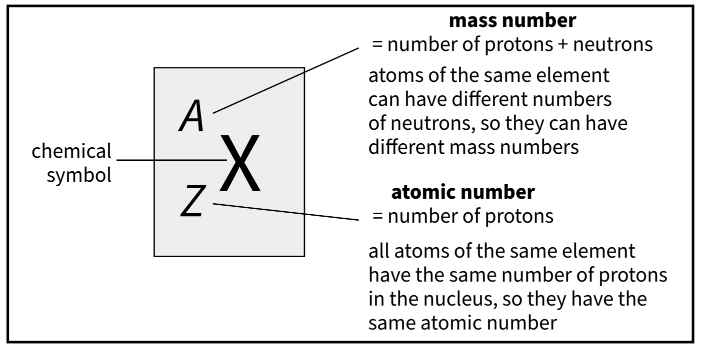
Bohr suggested the electrons __________ at specific distances called energy levels.

### Basic structure of an atom

The nucleus, which is 10 000 times smaller than the radius of the atom, consists of two particles:

- positively charged __________
- neutrons which are __________

An atom is uncharged overall and has __________ numbers of protons and electrons.




**Isotopes** are ______________________________________________.

### Radioactive decay

**Radioactive** decay is when nuclear radiation is emitted by __________ atomic nuclei so that they become more stable. It is a *random* process. This radiation can knock electrons out of atoms in a process called __________.

| Type of radiation | Change in the nucleus | Ionising power | Range in air | Stopped by | Decay equation |
|---|---|---|---|---|---|
| α<br>alpha particle<br>(two protons and two neutrons) | | | | | |
| β<br>beta particle<br>(fast-moving electron) | | | | | |
| γ<br>gamma radiation<br>(short-wavelength, high-frequency EM radiation) | | | | | |

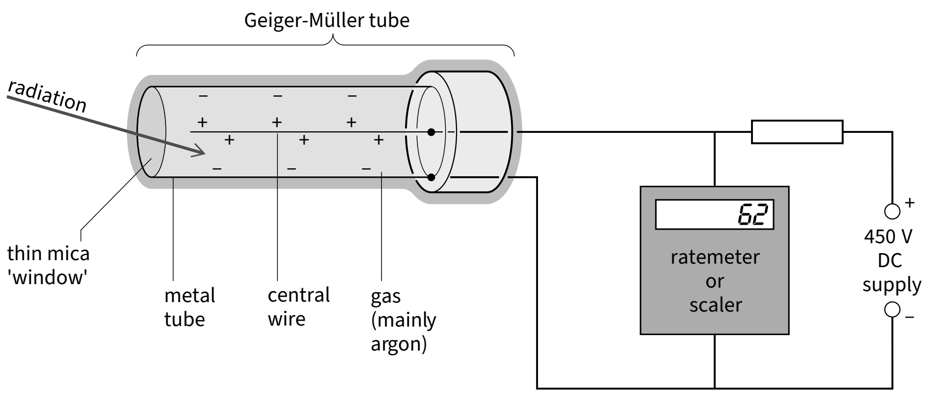
### Activity and count rate

The **activity** of a radioactive source is the rate of decay of an unstable nucleus, measured in becquerel (Bq).

1 Bq = 1 decay per second

Detectors (e.g., __________ **tubes**) record a **count rate** (number of decays detected per second).

$$\text{count rate after } n \text{ half-lives} = \frac{\text{initial count rate}}{2^n}$$




### Half-life

The **half-life** of a radioactive source is the time

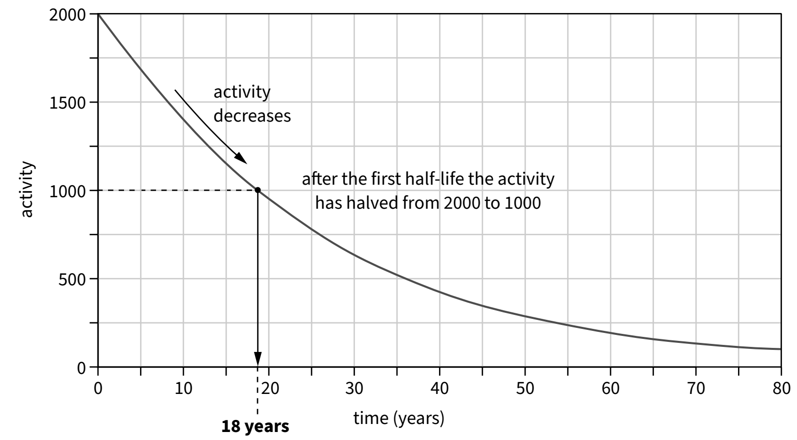
- for half the number of __________ nuclei in a sample to decay
- for the count rate or activity of a source to halve.

The half-life of a source can be found from a graph of its count rate or activity against time.

To find the reduction in activity after a given number of half-lives:

1 calculate the __________ after each half-life

2 __________ the final activity from the original activity.




The time taken for the activity to halve is 18 years. This is the half-life of this substance.

**(HT only ) Net decline** can be given as a ratio: *net daecline =* __________

# Chapter 7: Radioactivity 2

## Knowledge organiser

### Ionising radiation

__________ cells can be damaged or killed by ionising radiation.

The risk depends on the __________ of the source and the type of radiation.

Alpha radiation is very dangerous inside the body because it affects all the __________ tissue. Outside the body it only affects the __________ and __________ because it cannot penetrate further.

Beta and gamma radiation are dangerous outside and inside the body because they can penetrate into __________.

### Radiation dose

**Radiation dose**, measured in __________ (Sv), measures the health risk of exposure to radiation. It depends on the type and amount of radiation.

### Background radiation

**Background radiation** is radiation that is around us all the time. It comes from:

- 
- 

Background radiation is always present but the levels are higher in some locations and in some jobs.

### Nuclear waste

When fuel rods are removed from the __________, they are stored in large tanks in water for up to a year until they cool down.

Machines are then used to open up fuel rods and extract the unused __________ and __________. Any material that is left then has to be stored securely as they have lots of radioactive __________ with long half-lives. This is done to prevent radioactive __________.

### Irradiation versus contamination

| | | | |
|---|---|---|---|
| **irradiation** | when an object is __________ to nuclear radiation | cause harm through __________ | prevented by __________, __________, or __________ away from the source of radiation |
| **contamination** | when atoms of a radioactive material are on or in an __________ | | object remains __________ to radiation as long as it is contaminated<br>contamination can be very difficult to remove |

### Nuclear radiation in medicine

#### Exploration of internal organs

Gamma-emitting __________ are injected or swallowed by a patient. Gamma cameras can then create an image showing where the tracer has gone.

The half-life of the tracer must be short enough so that most of the nuclei will __________ shortly after the image is taken to limit the patient's radiation dose (normally about __________ hours).

#### Control or destruction of unwanted tissue

1 Narrow beams of gamma radiation can be focused on __________ cells to destroy them. Gamma is used because it can penetrate tumours from outside the body.

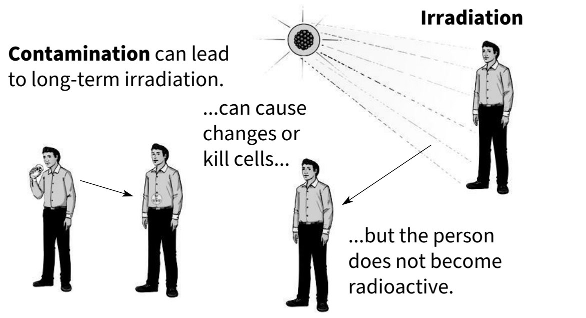
2 Beta- or gamma-emitting implants can be surgically placed inside (or next to) tumours. Their half-lives must be long enough to be effective, but short enough that it does not continue to __________ the patient after treatment.

### Protection against irradiation and contamination

You can protect against irradiation and contamination by:

- 
- 
- 

Studies on the effects of radiation should be published, shared with other scientists, and checked by __________ __________ as they are important for human health.




### Nuclear fission

**Nuclear fission** is when a large unstable __________ absorbs an extra __________ and splits into __________ smaller nuclei of roughly equal size.

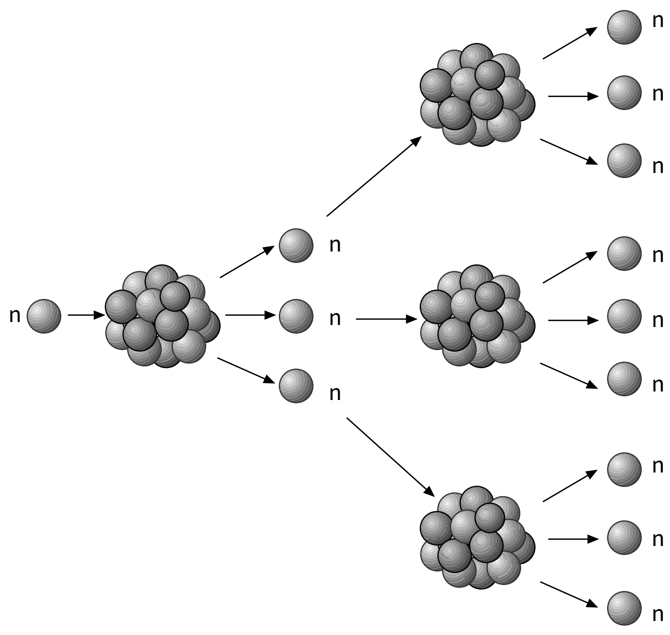
During nuclear fission:

- gamma radiation is emitted and __________ is released
- two or three neutrons are emitted that can go on to cause a __________ __________.

The chain reaction in a power station reactor is controlled by __________ neutrons.

Nuclear explosions are uncontrolled chain reactions.

On rare occasions an unstable nucleus splits apart without absorbing a neutron. This is called __________ __________.




### Nuclear fusion

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Future fusion reactors could meet energy needs for a growing population. This is because:

- The fuel for fusion reactors is easily available as heavy __________ is naturally present in __________ __________.
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- The energy released could be used to generate __________ in the future.

**Key terms**

**Make sure you can write a definition for these key terms.**

*atom* *alpha* *activity* *atomic number* *background radiation* *beta* *chain reaction* *contamination* *count rate* *electron* *fission* *fusion* *gamma* *Geiger-Müller tube* *half-life* *ionisation* *irradiation* *isotope* *mass number* *net decline* *neutron* *plum pudding model* *proton* *peer review* *radiation dose* *radioactive decay* *spontaneous* *tracer*

# Chapter 7: Radioactivity

## Retrieval questions

Answer the following questions using the information from the knowledge organiser.

| | P7 questions | Answers |
|---|---|---|
| 1 | Describe the basic structure of an atom. | |
| 2 | Describe the plum pudding model of the atom. | |
| 3 | What charges do protons, neutrons, and electrons carry? | |
| 4 | Why do atoms have no overall charge? | |
| 5 | What is the radius of an atom? | |
| 6 | What is ionisation? | |
| 7 | What is the mass number of an element? | |
| 8 | Which particle do atoms of the same element always have the same number of? | |
| 9 | What are isotopes? | |
| 10 | What were the two main conclusions from the alpha particle scattering experiment? | •<br>• |
| 11 | What are the three types of nuclear radiation? | |
| 12 | Which type of nuclear radiation is the most ionising? | |
| 13 | What is the range in air of alpha, beta, and gamma radiation? | |
| 14 | What are the equation symbols for alpha and beta particles? | |
| 15 | What is meant by the half-life of a radioactive source? | |
| 16 | What is radioactive contamination? | |
| 17 | Where does background radiation come from? | |
| 18 | Why are gamma-emitting sources used for medical tracers and imaging? | |
| 19 | What is nuclear fusion? | |
| 20 | How does nuclear fission occur? | |