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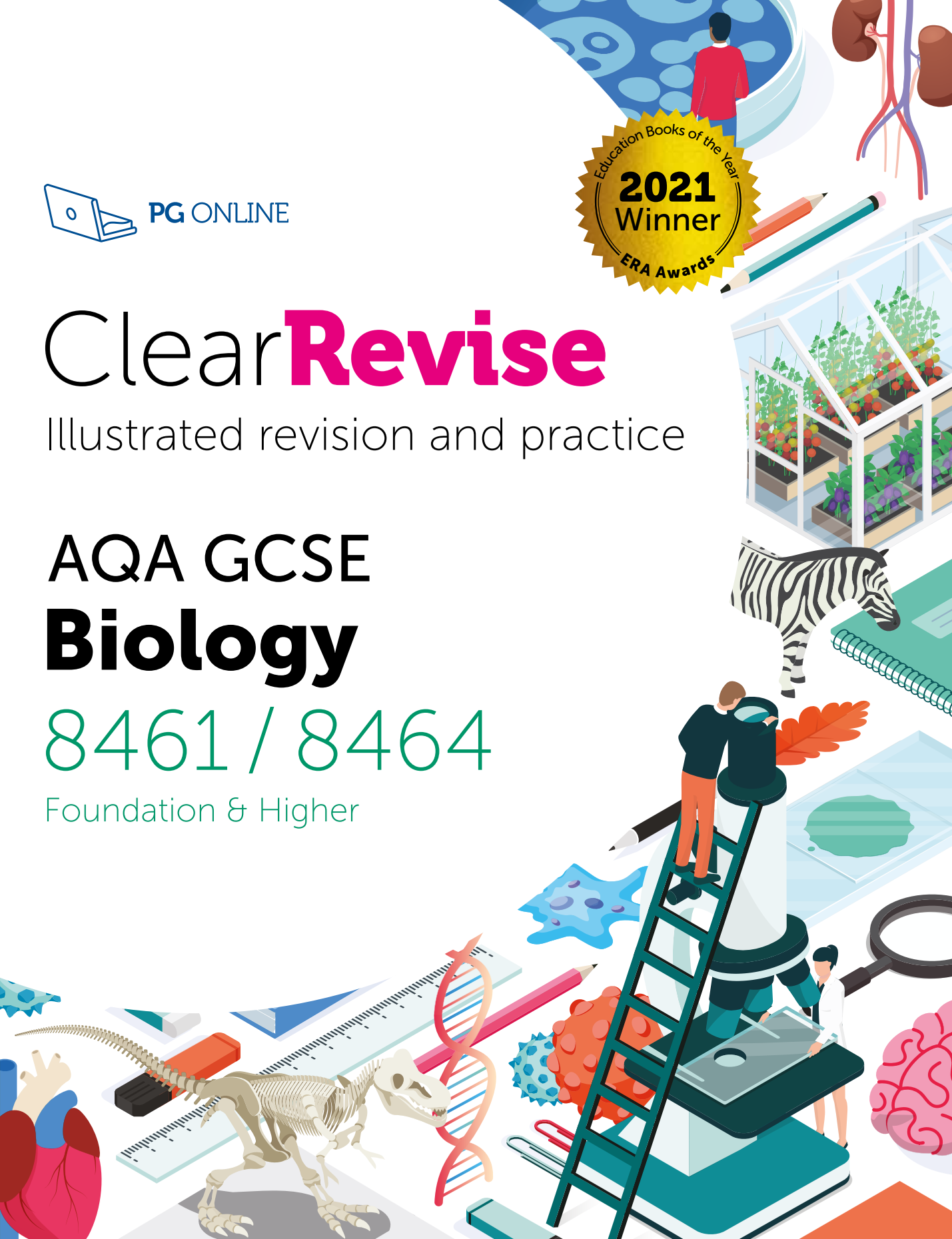

ClearRevise™

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Foundation and Higher
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PREFACE

Absolute clarity! That's the aim.

This is everything you need to ace the examined component in this course and beam with pride. Each topic is laid out in a beautifully illustrated format that is clear, approachable and as concise and simple as possible.

Each section of the separate Biology and combined science (Trilogy) specifications are clearly indicated to help you cross-reference your revision. The checklist on the contents pages will help you keep track of what you have already worked through and what's left before the big day.

We have included worked exam-style questions with answers for almost every topic. This helps you understand where marks are coming from and to see the theory at work for yourself in an exam situation. There is also a set of exam-style questions at the end of each section for you to practise writing answers for. You can check your answers against those given at the end of the book.

LEVELS OF LEARNING

Based on the degree to which you are able to truly understand a new topic, we recommend that you work in stages. Start by reading a short explanation of something, then try and recall what you've just read. This has limited effect if you stop there but it aids the next stage. Question everything. Write down your own summary and then complete and mark a related exam-style question. Cover up the answers if necessary but learn from them once you've seen them. Lastly, teach someone else. Explain the topic in a way that they can understand. Have a go at the different practice questions – they offer an insight into how and where marks are awarded.

ACKNOWLEDGEMENTS

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THE SCIENCE OF REVISION

Illustrations and words

Research has shown that revising with words and pictures doubles the quality of responses by students.[1] This is known as 'dual-coding' because it provides two ways of fetching the information from our brain. The improvement in responses is particularly apparent in students when asked to apply their knowledge to different problems. Recall, application and judgement are all specifically and carefully assessed in public examination questions.

Retrieval of information

Retrieval practice encourages students to come up with answers to questions.[2] The closer the question is to one you might see in a real examination, the better. Also, the closer the environment in which a student revises is to the 'examination environment', the better. Students who had a test 2–7 days away did 30% better using retrieval practice than students who simply read, or repeatedly reread material. Students who were expected to teach the content to someone else after their revision period did better still.[3] What was found to be most interesting in other studies is that students using retrieval methods and testing for revision were also more resilient to the introduction of stress.[4]

Ebbinghaus' forgetting curve and spaced learning

Ebbinghaus' 140-year-old study examined the rate in which we forget things over time. The findings still hold power. However, the act of forgetting things and relearning them is what cements things into the brain.[5] Spacing out revision is more effective than cramming – we know that, but students should also know that the space between revisiting material should vary depending on how far away the examination is. A cyclical approach is required. An examination 12 months away necessitates revisiting covered material about once a month. A test in 30 days should have topics revisited every 3 days – intervals of roughly a tenth of the time available.[6]

Summary

Students: the more tests and past questions you do, in an environment as close to examination conditions as possible, the better you are likely to perform on the day. If you prefer to listen to music while you revise, tunes without lyrics will be far less detrimental to your memory and retention. Silence is most effective.[5] If you choose to study with friends, choose carefully – effort is contagious.[7]

1. Mayer, R. E., & Anderson, R. B. (1991). Animations need narrations: An experimental test of dual-coding hypothesis. *Journal of Education Psychology*, (83)4, 484–490.
2. Roediger III, H. L., & Karpicke, J.D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, 17(3), 249–255.
3. Nestojko, J., Bui, D., Kornell, N. & Bjork, E. (2014). Expecting to teach enhances learning and organisation of knowledge in free recall of text passages. *Memory and Cognition*, 42(7), 1038–1048.
4. Smith, A. M., Floerke, V. A., & Thomas, A. K. (2016) Retrieval practice protects memory against acute stress. *Science*, 354(6315), 1046–1048.
5. Perham, N., & Currie, H. (2014). Does listening to preferred music improve comprehension performance? *Applied Cognitive Psychology*, 28(2), 279–284.
6. Cepeda, N. J., Vul, E., Rohrer, D., Wixted, J. T. & Pashler, H. (2008). Spacing effects in learning a temporal ridgeline of optimal retention. *Psychological Science*, 19(11), 1095–1102.
7. Busch, B. & Watson, E. (2019), *The Science of Learning*, 1st ed. Routledge.

CONTENTS

Paper 1

Topic 1 Cell biology

Topic 2 Organisation

Topic 3 Infection and response

Topic 4 Bioenergetics

Paper 2

Topic 5 Homeostasis and response

Topic 6 Inheritance, variation and evolution

Topic 7 Ecology

MARK ALLOCATIONS

Green mark allocations[1] on answers to in-text questions throughout this guide help to indicate where marks are gained within the answers. A bracketed '1' e.g.[1] = one valid point worthy of a mark. In longer answer questions, a mark is given based on the whole response. In these answers, a tick mark[✓] indicates that a valid point has been made. There are often many more points to make than there are marks available so you have more opportunity to max out your answers than you may think.

TOPICS FOR PAPER 1

Information about Paper 1:

Separate Biology 8461:

Written exam: 1 hour 45 minutes
Foundation and Higher Tier
100 marks
50% of the qualification grade
All questions are mandatory

Trilogy 8464:

Written exam: 1 hour 15 minutes
Foundation and Higher Tier
70 marks
16.7% of the qualification grade
All questions are mandatory

Specification coverage

The content for this assessment will be drawn from
Topics 1–4 Cell biology; Organisation; Infection and response; and Bioenergetics.

Questions

A mix of calculations, multiple-choice, closed short answer and open response questions assessing knowledge, understanding and skills.

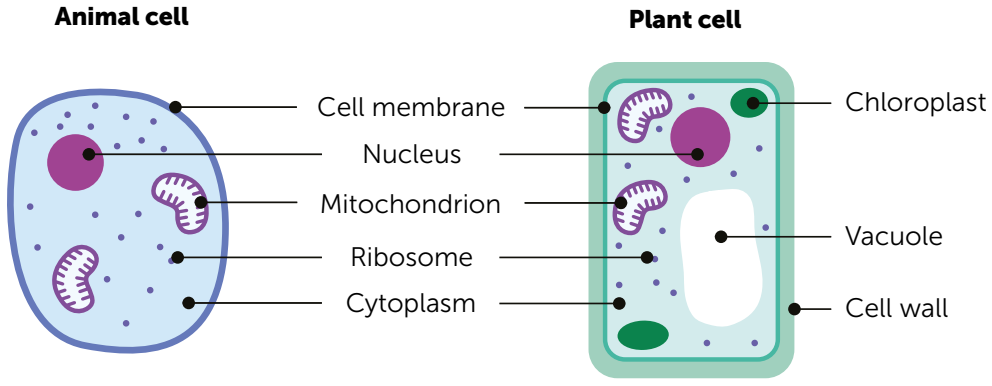
Questions assess skills, knowledge and understanding of Biology.

EUKARYOTES AND PROKARYOTES

Plant and animals are known as **eukaryotes**. Bacteria are **prokaryotes** and have a different cell structure.

Eukaryotic cells

Eukaryotic cells have a **cell membrane** containing **cytoplasm**. Within the cytoplasm is a **nucleus**. The genetic material, made of **DNA** organised into chromosomes, is enclosed within the membrane of the nucleus.

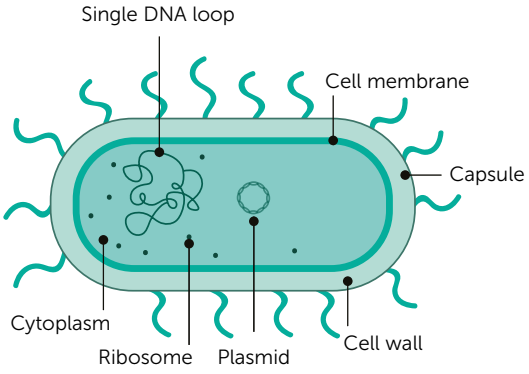


1. The genetic material of prokaryotic and eukaryotic cells is organised in different ways. State **two** differences between the genetic material of prokaryotic and eukaryotic cells. [2]
2. Give **two** similarities between the structure of prokaryotic and eukaryotic cells. [2]
3. State the function of the bacterial plasmid. [1]

1. *Genetic material is found within a nucleus only in eukaryotes.[1] DNA is organised in a single loop and smaller plasmids in bacteria, but in eukaryotes it is found in chromosomes.[1]*
2. *Both have cytoplasm[1], a cell membrane[1] and ribosomes[1].*
3. *Carries additional genes.[1] Allows genes to be passed from one bacterial cell to another.[1]*

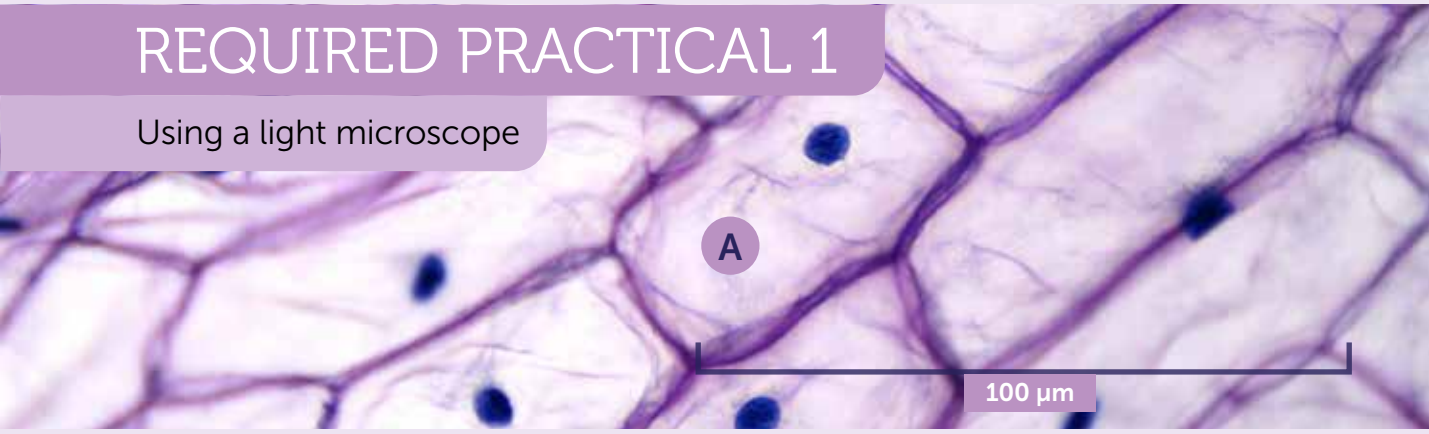
Prokaryotic cells

Prokaryotic cells are much smaller than **eukaryotic** cells. They have a cell wall, which surrounds a cell membrane. The membrane contains cytoplasm but there is no nucleus. Instead, the genetic material is a single **DNA loop** floating freely within the cytoplasm. There may also be one or more small rings of DNA called **plasmids**.



REQUIRED PRACTICAL 1

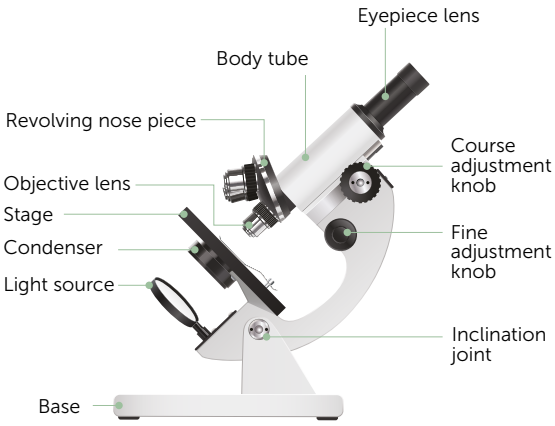
Using a light microscope



This activity helps you measure, observe, draw and label cells.

Using the microscope

1. Place tissue on a glass slide with a coverslip on top.
2. Put the slide on the microscope stage and look through the **eyepiece lens**.
3. First use the lowest power **objective lens** to find cells.
4. Turn the coarse adjustment knob to focus on the cells.
5. Use the fine adjustment knob to focus more clearly.
6. Switch to a higher power lens to see finer detail, using only the fine adjustment knob to focus.



1. What is the purpose of the different objective lenses on a light microscope? [2]
2. The image above shows stained onion cells, viewed under a light microscope.
   (a) Using the scale bar, estimate the length of cell A, shown above. [1]
   (b) Draw plant cell A. Label three cell structures that can be seen. [3]
   (c) The cells were viewed with a ×10 eyepiece and a ×40 objective lens. Write the magnification used to view the cells onto your drawing. [1]

1. To magnify[1] the image. Different objectives vary magnification levels.[1]

2. (a) 50 µm.[1] ~Half the length of the scale bar

(b) Large drawing, with clear unbroken lines and no shading.[1] Shape and proportions match cell A.[1] Nucleus, cell wall and cytoplasm labelled using clear label lines / If cell membrane is labelled, the end of the label line must be clearly just inside the cell wall.[1]

(c) 40 × 10 = 400 = ×400.[1]

Making a scientific drawing of cells

An examination question may ask you to draw cells from a microscope photograph. Draw exactly what you see, don't draw 'textbook' cells. The drawing should be as large as space allows. Use a sharp pencil to draw lines that are clear and not sketchy. Don't use shading. Label only those parts that you can see. Use a ruler to draw label lines with no arrowheads. Write the label at the end of the label line. Write the magnification used to view the cells onto the drawing (multiply the objective **magnification** by the eyepiece magnification).

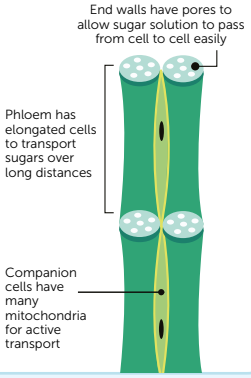
CELL SPECIALISATION

Similar **cells** are organised into **tissues**, tissues are organised into **organs** and organs into **organ systems**. These components work together to carry out a particular function. Cells have different structures so they can carry out their function.

Specialised plant cells

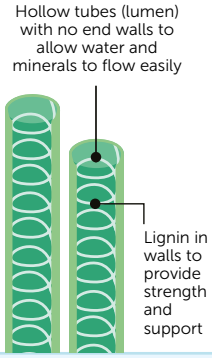
Phloem

Phloem cells transport sugars made in leaves to the rest of the plant.



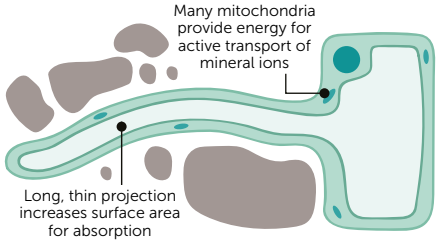
Xylem

Xylem cells transport water and mineral ions through the plant.



Root hair cell

Root hair cells absorb water and mineral ions from soil.



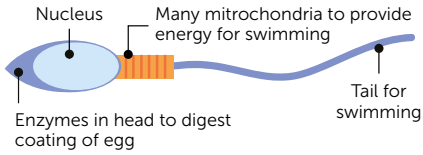
1. Phloem cells are elongated. How does this helps them to carry out their function? [2]
2. Explain how one structure of a sperm cell helps it to reach the egg cell. [2]

1. *It helps transport sugars[1] over a distance[1].*
2. *Tail for swimming.[1] Lots of mitochondria to release energy for swimming.[1] OR Enzymes in head[1] help to digest coating of egg[1].*

Specialised animal cells

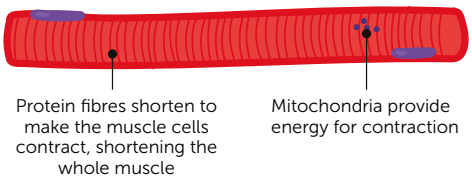
Sperm cell

Their function is to carry genetic material to the egg cell.



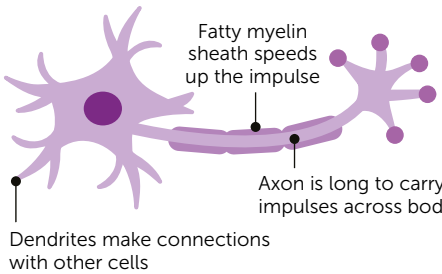
Muscle cell

Their function is to produce movement.



Nerve cell (neurone)

The role of nerve cells is to carry electrical impulses around the body. The pattern of these impulses represents a 'message'.

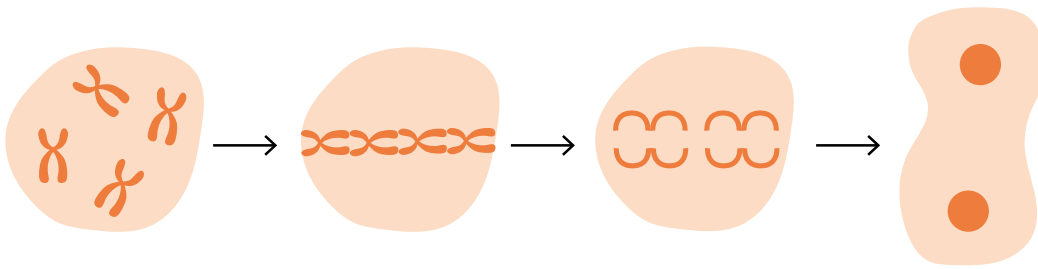


MITOSIS

Mitosis is the process of cell division. The replicated chromosomes separate and then two new nuclei form.

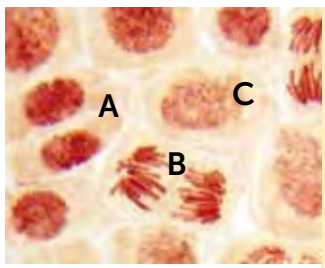
Stages of mitosis

1. At the start of mitosis, the newly replicated chromosomes are joined together
2. They move to the centre of the cell
3. Chromosomes are pulled apart and move to opposite ends of the cell
4. The nucleus divides. Each new nucleus contains one full set of chromosomes



Cell division by mitosis

Cells divide by mitosis to make new, genetically identical cells. It is how multicellular organisms grow. Mitosis must happen many millions of times for a fertilised egg to grow into an adult human. Mitosis also makes new cells for repair and replacement of cells.



1. Look at the photograph of cells taken down a microscope. Cells A, B and C are all at different stages in the cell cycle. Describe what is happening in each cell. [3]
2. A scientist counted 100 cells on the slide, 11 of these were in stage B. The cell cycle takes 20 hours in this tissue.
   Calculate how much time in minutes is spent in stage B. [1]
3. Skin cells are continuously lost. Skin has several layers of differentiated cells and one layer of undifferentiated cells. Explain how new skin cells form. [3]

1. *The cytoplasm and cell membrane of cell A are dividing; it is undergoing cell division.[1] Mitosis is taking place in cell B[1], chromosomes are moving to opposite ends of the cell[1]. Cell C is preparing to divide, it will grow in size and replicate its DNA.[1]*
2. $\frac{11}{100} \times 20$ *hours* $\times$ *60 minutes*[1] = *132 minutes.*[1]
3. *Division by mitosis makes new cells*[1] *in the undifferentiated layer.*[1] *These cells then differentiate to form other layers.*[1]

DIFFUSION AND EXCHANGE SURFACES

Bigger organisms have a smaller surface area to volume ratio. **Multicellular organisms** must have specially adapted **exchange surfaces**, connected to a **transport system**, to supply all the cells. Without these specialised structures the movement of substances into and out of internal cells would be too low for survival.

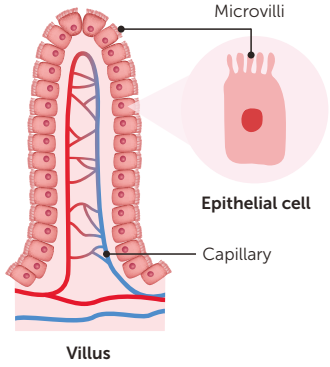
How diffusion is increased across exchange surfaces

- They have a large **surface area** – this increases the area of membrane available for molecules to diffuse across.
- They have **thin membranes** – so that the diffusion distance for particles is short.
- In animals, exchange surfaces have an **efficient blood supply**, and gas exchange surfaces are **ventilated**. This increases diffusion by keeping the concentration gradient high.

Examples of exchange organs

Small intestine

In the **small intestine** - projections of the wall (villi) and epithelial cells (microvilli) increase the surface area. The wall of the villi is thin and they are well supplied with blood from capillaries.

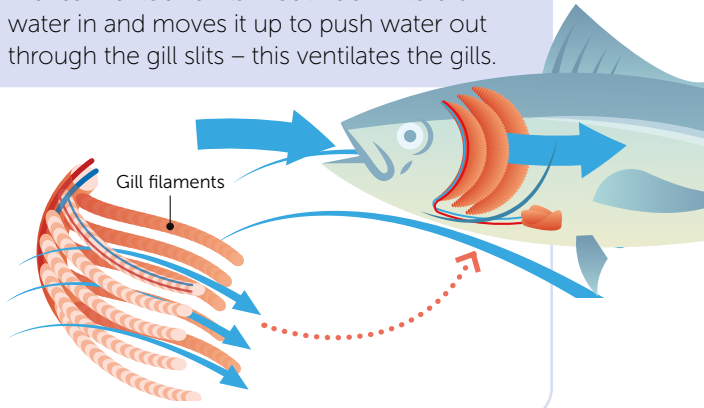


Lungs

In the **lungs** of mammals, large numbers of alveoli increase the surface area. Each alveolus is thin-walled and surrounded by capillaries. Muscles between the ribs and in the diaphragm move air in and out, ventilating the exchange surface. See more on page 33.

Fish gills

The **gills** of fish are adapted for gas exchange in water. Many gill filaments increase the surface area. Filaments are well supplied with blood. They are thin-walled to reduce the length of the diffusion pathway. The fish moves the floor of its mouth down to draw water in and moves it up to push water out through the gill slits – this ventilates the gills.



Roots and leaves of plants

In plants, many root hair cells increase the surface area of **roots** for absorption of mineral ions and water. **Leaves** are adapted for gas exchange. They have a large internal surface area for diffusion of gases and are thin to reduce the diffusion distance to cells.
See more on pages 41-43.

EXAMINATION PRACTICE

01 The table lists some sub-cellular structures that may be found in cells.

01.1 For each type of cell, fill in the table boxes with a tick if a sub-structure is present and a cross if it is not. One row has been completed for you. [2]

01.2 Describe where the genetic material is found in prokaryotic cells. [2]

Sub-cellular structure	Eukaryotic cell	Prokaryotic cell
Cytoplasm	✓	✓
Nucleus		
Cell membrane		

02 Name **three** cell parts belonging to plant cells that animal cells do not have. [3]

03 The diagram below shows a drawing of a red blood cell. The actual red blood cell was 8 μm in length.

03.1 The function of these cells is to carry oxygen. They are packed with a substance called haemoglobin that binds to oxygen. Red blood cells have no nucleus. Suggest why red blood cells have no nucleus. [2]

03.2 Calculate what the length of the red blood cell would be in metres. Give your answer in standard form. [2]

03.3 A student drew the red blood cell. The red blood cell on the drawing was 6 cm in length. Calculate the magnification of the drawing. [2]

03.4 Muscle cells bring about movement of the body. Explain why muscle cells contain many mitochondria. [2]

03.5 Describe **one** other feature of muscle cells that allows them to carry out their function. [1]

04 Ribosomes are small structures found in cells. They were discovered after the invention of the electron microscope.

04.1 Explain why an electron microscope was needed to observe ribosomes. [3]

04.2 Suggest why cells are often stained before observing with a light microscope. [1]

04.3 Light microscopes have a coarse focus and a fine focus knob. Explain how these features are used when observing cells on a slide. [2]

05 Micro-organisms can be grown in the laboratory on agar plates. The agar contains added substances.

05.1 Explain the purpose of the agar. [2]

PRINCIPLES OF ORGANISATION

The cells of multicellular organisms are organised into levels of tissues, organs and organ systems.

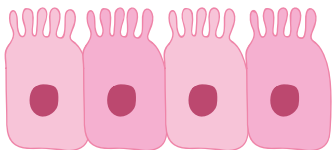
Cells

Cells are the basic building blocks of all living organisms.

Epithelial cell in the small intestine

Tissues

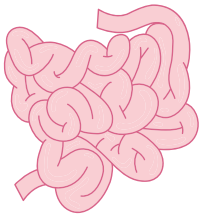
A **tissue** is a group of cells with a similar structure and function.



Epithelial tissue in the small intestine

Organs

Organs are collections of tissues performing specific functions.



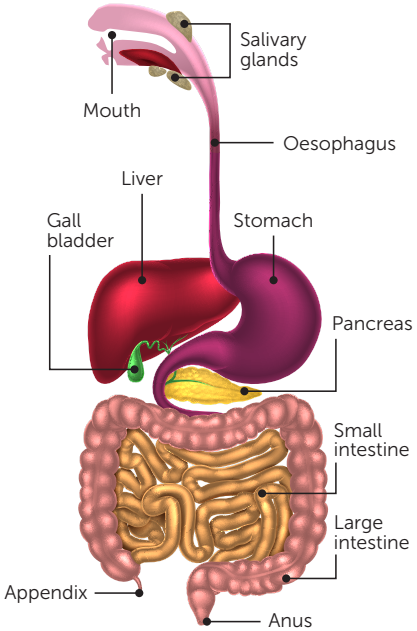
The small intestine – an organ

Organ systems

Organs are organised into **organ systems**.

The **digestive system** is an example of an organ system. Several organs work together to carry out the function of digesting and absorbing food.

Different organ systems work together to form the whole living thing – the **organism**.



You should know the main parts of the digestive system and what they do from your Key Stage 3 studies.

1. In plants, tightly packed cells carry out most of the photosynthesis.
   Name:
   (a) the tissue in which the cells are found. [1]
   (b) the organ in which they are found. [1]
2. Name the animal organ system that neurone cells belong to. [1]
3. The stomach organ contains muscle tissue. Explain the function of this tissue. [3]

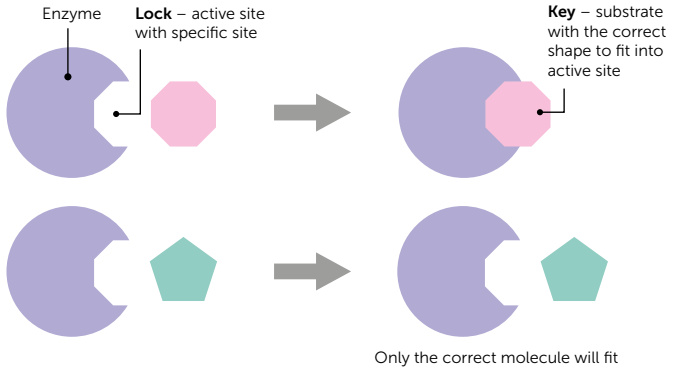
1 (a) Palisade mesophyll tissue.[1]
(b) Leaf.[1]
2. Nervous system.[1]
3. It contracts[1], mixing food with acid and enzymes[1] speeding up digestion.[1]

ENZYMES

Enzymes are biological catalysts. Catalysts speed up the rate of a reaction but are not used up in the reaction.

Lock and key theory

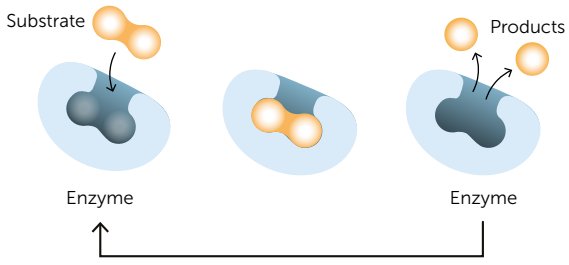
Each type of enzyme catalyses one reaction in a living organism. Enzymes have an area called an **active site** that has the correct shape to bind to one type of molecule. This molecule is called the **substrate**. Enzymes **catalyse** specific reactions according to the shape of their active site. The 'lock and key theory' is a simple model that explains enzyme action.



How enzymes work

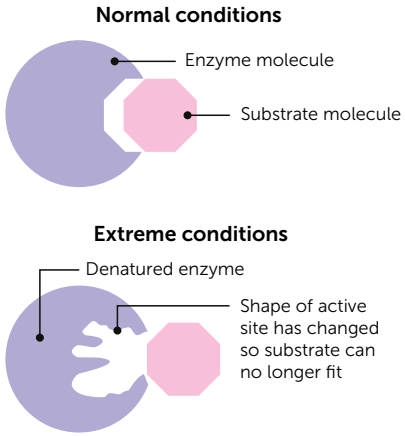
Without enzymes, all the reactions of our **metabolism** would be too slow for survival. Some enzymes work to break down a substrate into products that are smaller molecules. **Digestive enzymes** work like this. They convert food into small soluble molecules that can be absorbed into the bloodstream.

The products of digestion are used to build new **carbohydrates**, **lipids** and **proteins**. Enzymes are also involved in this process. These enzymes catalyse the reaction to join small molecules together to make larger ones. Some glucose from digestion is also used in respiration - a reaction which is also catalysed by enzymes.



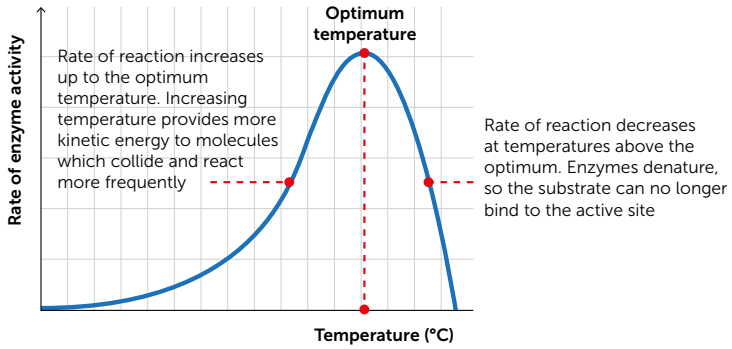
Enzymes are proteins

Enzymes are large protein molecules that are folded into a ball-like shape. This shape is held together by chemical bonds. Extremes of temperature and pH can affect this folding and change the enzyme's shape, including the shape of the active site. If the shape of the active site changes too much, the substrate will not fit so the reaction will no longer be catalysed. This means that the enzyme has been **denatured**.



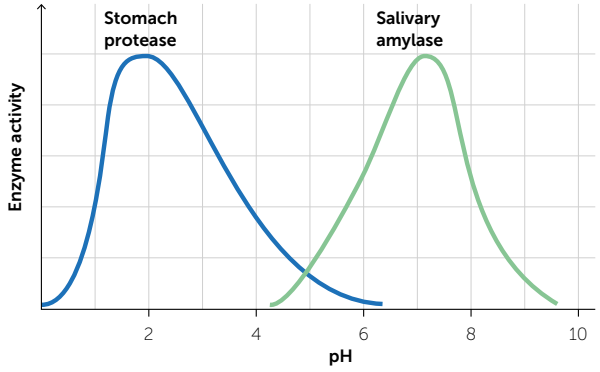
The effect of temperature on enzyme activity

Enzymes have the highest activity at their **optimum temperature**. This is usually around 40°C for human enzymes but can be different for other enzymes. They work slowly at low temperatures and stop working all together at higher temperatures.



The effect of pH on enzyme activity

Each enzyme has an **optimum pH** at which its activity is highest. The acid or alkaline conditions at other pH levels interfere with the shape of the enzyme and it works less effectively. At extreme pH the enzyme will denature.



This is also covered in Required Practical Activity 5 on page 30.

1. Explain the differences in the optimum pH of salivary amylase and pepsin.
   Use the graph above. [3]
2. Salivary amylase breaks down starch. Explain why it will not break down proteins. [2]
3. The enzyme catalase breaks down hydrogen peroxide and releases oxygen gas. In an investigation, the enzyme produced 30 cm^3 of oxygen in 10 minutes. Calculate the rate of the reaction. [2]

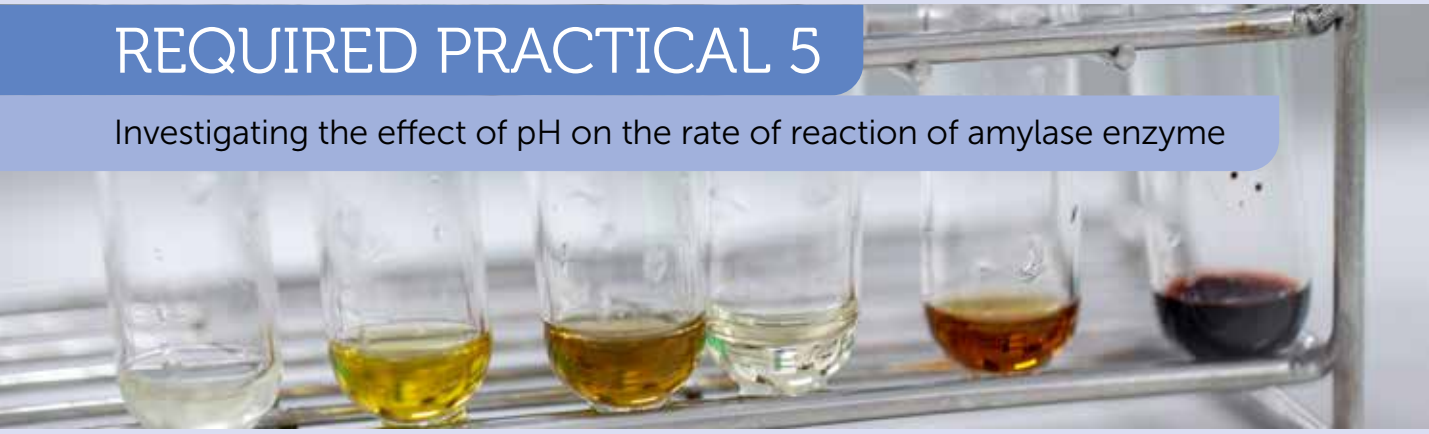
1. *The optimum pH of amylase is 7 and pepsin is 2.[1] Conditions in the stomach are acidic and those in the mouth are neutral[1], so each enzyme has the optimum pH for maximum activity in the area where they are released.[1]*
2. *The active site shape is specific to starch.[1] It is the wrong shape to bind to proteins.[1]*
3. $\frac{30}{10} = 3$[1] cm^3/min^{-1}.[1]

Measuring the rate of reactions

A reaction rate describes the amount of product made per unit time. We can calculate the rate of enzyme reactions by calculating the gradient of a graph or by dividing by the time taken for the reaction to take place.

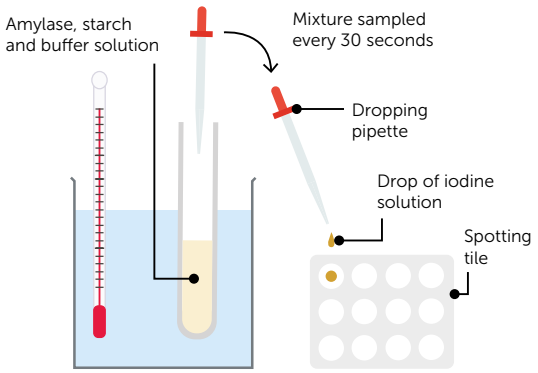
REQUIRED PRACTICAL 5

Investigating the effect of pH on the rate of reaction of amylase enzyme

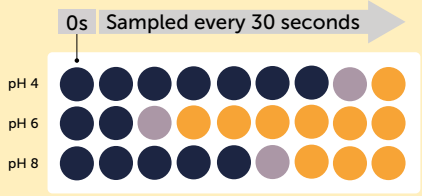


Continuous sampling

The diagram shows how continuous sampling is used to measure the time taken for amylase to digest a starch solution at a range of pH values. Different **buffer solutions** are added which keep the pH at a particular value.
The timer is started when the amylase and starch solutions are mixed together. **Iodine** reagent is used to test for starch every 30 seconds. Iodine will turn from orange-brown to blue-black if starch is still present. The time taken for all the starch to be digested (when the iodine first remains orange-brown) is recorded. This approach measures the reaction time to the nearest 30 seconds.



1. Explain why the water bath is used in this investigation. [2]
2. Use the diagram of example results to draw a results table. [3]
3. A student looked at the example results in the diagram. They wrote 'pH 6 is the optimum pH for amylase.' Explain why this may not be a valid conclusion. [2]
3. Use the diagram of example results to draw a results table. [3]



4. The rate of reaction can be calculated using $\frac{1}{\text{Time taken}}$ for the reaction.
Calculate the rate of reaction for pH 6. Include appropriate units. [2]

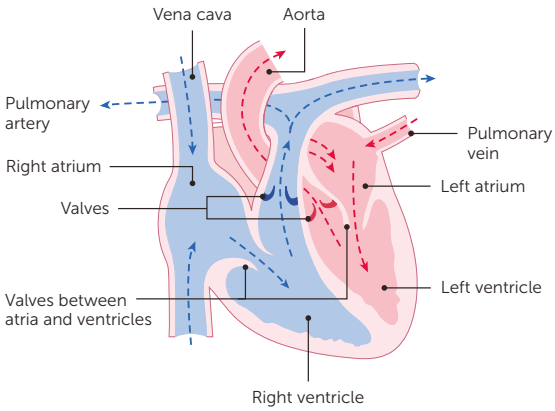
1. *To keeps the temperature constant, because changes in temperature affect the rate of enzyme reactions.[1] Raises the temperature to 30°C which speeds up the reaction so results can be obtained more quickly.[1]*
2. *See table. Times calculated correctly (e.g. pH 4 takes 8 × 30 s to react completely = 240 s) [1]. Table headings correct.[1]*
3. *Not enough different pH levels were tested to make this conclusion.[1] The optimum pH could be anywhere between pH4 and pH8. [1]*
4. *Rate = $\frac{1}{90}$ = 0.11[1] per second, or s^{-1}.[1]*

pH	Time for reaction (s)
4	240
6	90
8	180

THE HEART AND CIRCULATION

Structure of the heart

The **heart** is an organ that pumps blood around the body. It has walls made of cardiac muscle with four chambers inside. The right ventricle pumps blood to the lungs, where **gas exchange** takes place. The left ventricle pumps blood around the rest of the body. The atria collect blood as it returns and pump it into the ventricles. The atria contract together just before the ventricles contract. Blood shown as blue in the diagram has given up its oxygen to body cells – it is **deoxygenated**. The blood shown as red has been **oxygenated** in the lungs. Valves between the atria and ventricles, and in the veins, prevent blood flowing backwards.



1. The left ventricle has a thicker wall than the right ventricle. Suggest why. [2]
2. Give the benefits of a double circulation. [3]
3. Coronary arteries run down the outside of the heart. State the role of these arteries [1]

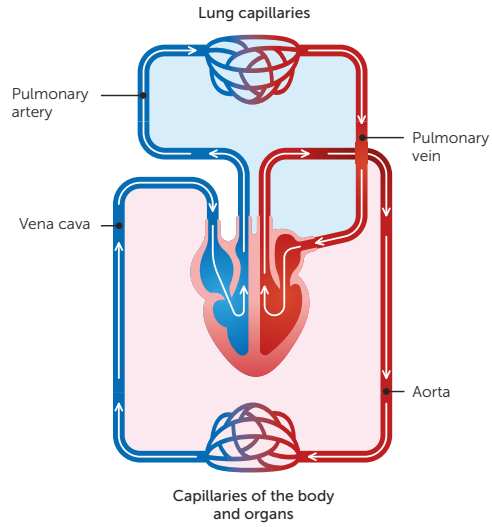
1. The thicker muscle generates greater force[1] needed to push blood around the body compared to through the lungs.

2. Passing through twice allows a higher pressure to be maintained[1] increasing blood flow to the tissues.[1] Oxygenated and deoxygenated blood do not mix.[1]

3. They supply the cells of the heart / heart muscle with oxygen.[1]

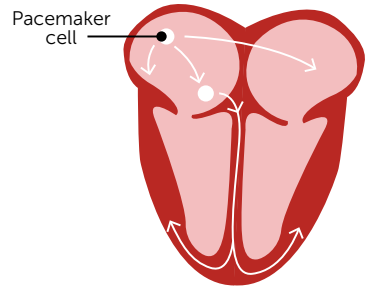
A double circulatory system

Mammals have a double circulation – blood flows through the heart twice during one complete circulation.



Heart rate

Heart rate is the frequency with which the heart contracts. It is measured in **beats per minute**. The natural resting heart rate is controlled by a group of cells found in the right atrium. They act as a **pacemaker**, producing regular impulses that travel through the heart causing it to contract. **Artificial pacemakers** are electrical devices used to correct irregularities in the heart rate.



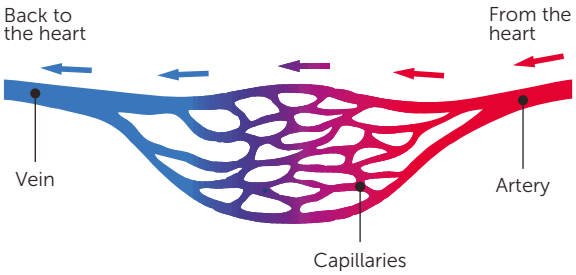
BLOOD VESSELS

The body contains three different types of blood vessel: arteries, veins and capillaries.

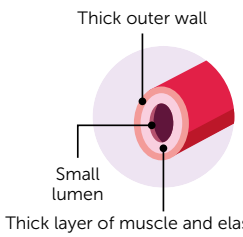
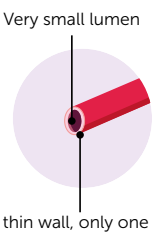
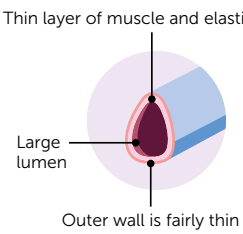
The aorta branches into different arteries that carry blood to the major organs. These branch more and more until they form tiny vessels within tissues called capillaries. Capillaries then join up to form veins.

Note that the muscle in arteries does **NOT** pump blood, it simply adjusts the size of the lumen.

Blood flow



Blood vessel structure and function

	Arteries	Capillaries	Veins
			
Function	Carry blood at high pressure away from the heart	Exchange of substances with cells	Return blood at low pressure to the heart
Lumen	Narrow to maintain pressure	Very narrow. Keeps red blood cells close to tissue cells	Large, so there is less resistance to blood flow
Wall	Elastic fibres stretch and recoil to maintain pressure. Thick wall resists bursting	Very thin – Short distance to maximise exchange by diffusion	Low pressure so no need for a thick elastic wall
Valve	No – High pressure blood keeps moving	No	Yes – Prevents backflow of low pressure blood

1. A person has a stroke volume of 0.06 dm^3 and a heart rate of 65 beats per minute (bpm). Calculate the cardiac output. [2]
2. Explain how blood keeps flowing in veins despite the low blood pressure in these vessels. [3]

1. *0.06 × 65 = 3.9[1] dm^3 per minute[1].*
2. *Skeletal muscles press on the veins during activity and squeeze blood along.[1] Valves prevent the blood from going in the wrong direction.[1] The lumen is large so there is little resistance to flow.[1]*

Rate of blood flow

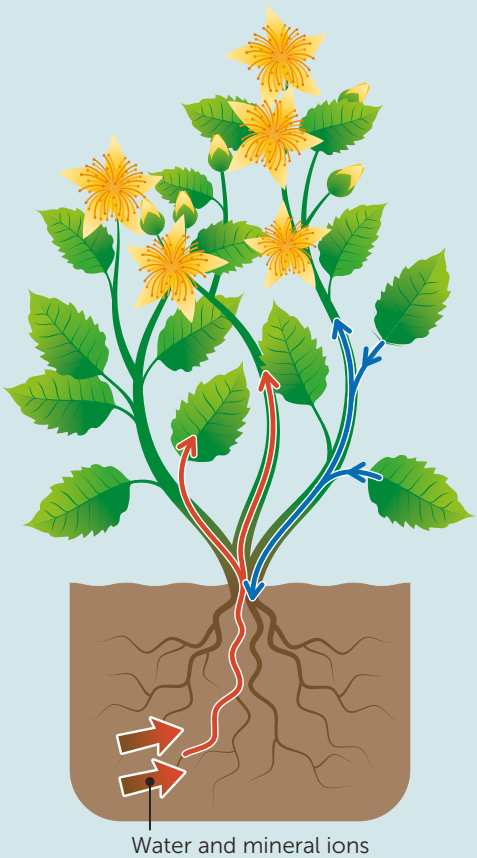
The rate of blood flow from the heart into the aorta is called the cardiac output. It is calculated from the stroke volume (the volume pumped with each heartbeat) and the heart rate.

Cardiac output (dm^3 per minute) = stroke volume (dm^3) × heart rate (beats per minute)

4.2.3.2

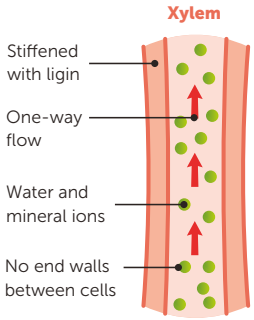
PLANT ORGAN SYSTEM

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



Transport of water and minerals

Root hair cells take up water from the soil by **osmosis**, and mineral ions by **active transport**. For adaptations see section (4.1.1.3) page 6.



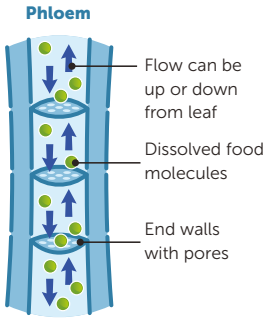
Xylem tissue then carries this mineral and water solution from the roots to the stems and leaves. The flow of water up through the plant is called the **transpiration stream**. Water is lost from the leaves of a plant by evaporation and diffusion – a process called **transpiration**. This loss of water from the leaf pulls more water up through the xylem.

Transport of dissolved food

The movement of dissolved food molecules through **phloem tissue** is called translocation.

Food molecules are produced in the leaves by photosynthesis. This food is transported in the phloem to the rest of the plant, mostly as dissolved sugars. This sugar may be used immediately by cells or may be converted into starch for storage.

Food molecules can be transported upwards towards growing shoots or down towards roots and storage organs.



1. Describe **two** adaptations of phloem cells for transport of dissolved sugar. [2]
2. Suggest **two** ways in which sugar is used by cells. [2]
3. Give **one** difference and **one** similarity between transpiration and translocation. [2]

1. *Phloem cells are elongated to carry sugar over longer distances.*[1] *Pores in the end walls allow cell sap containing sugar to pass from one phloem cell to the next.*[1]
2. *Sugar may be used in respiration*[1] *or used for growth / to make cell walls*[1].
3. *A similarity is that both are important for transport of substances through the plant.* [1] *A difference is that transpiration drives the transport of water in the xylem, whereas translocation is the movement of dissolved food molecules / sugar in the phloem.*[1]

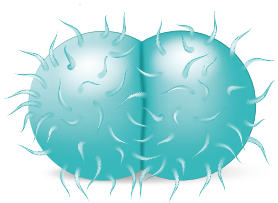
BACTERIAL DISEASES

Bacteria are prokaryotes. Their structure is revised on page 3. Most bacteria are not pathogens. Some bacteria can infect the body where they divide rapidly by binary fission. Some thrive in body fluids. Others can invade body cells. Many types produce toxins that cause damage to body cells and illness.

Gonorrhoea

Gonorrhoea is a **sexually transmitted disease** (**STD**). The symptoms of infection are a thick green or **yellow discharge** from the vagina or penis and **pain** on urinating. As it is caused by a bacterium, it was once easily treated with the **antibiotic** penicillin. The number of people with Gonorrhoea has increased recently because many antibiotic resistant strains have appeared.

The Gonorrhoea bacterium



In the UK, all commercial poultry is vaccinated to prevent the spread of Salmonella

Salmonella

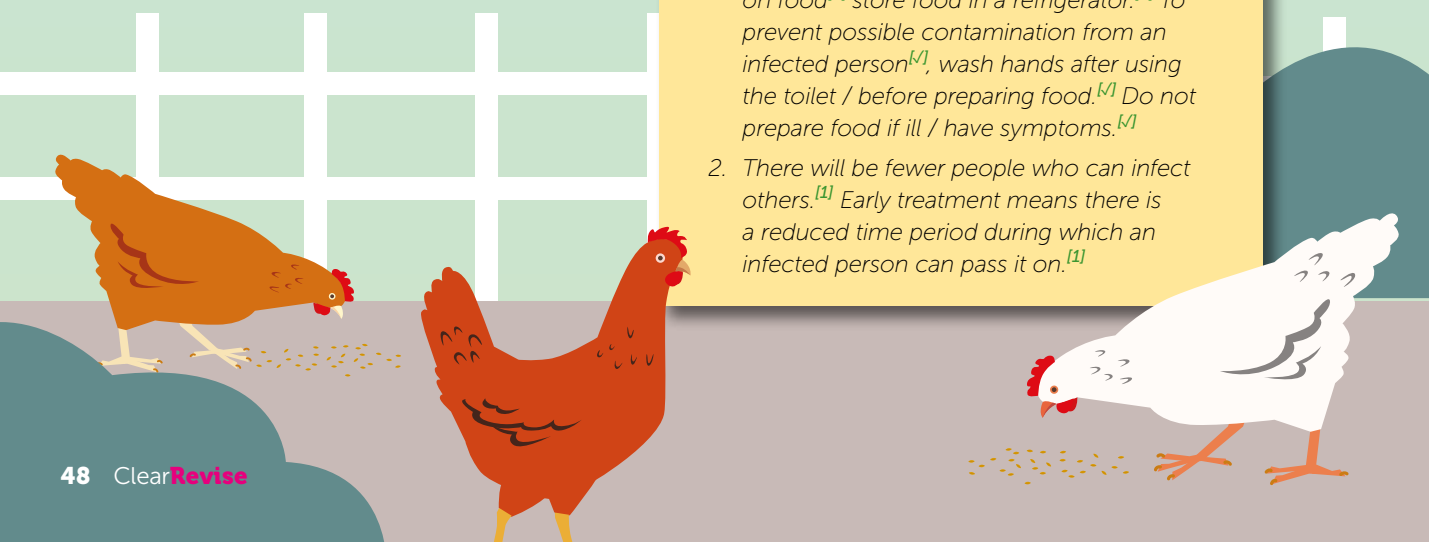
Salmonella is a common cause of **food poisoning**. It is usually spread when the bacteria are present in food that is eaten. The source of infection can usually be traced to contamination with faeces from an infected animal or person. Salmonella transmission is more likely when food is prepared in an unhygienic way.

The main symptoms of Salmonella are **fever**, painful **abdominal cramps**, **vomiting** and **diarrhoea**. Symptoms result from the bacteria invading tissues and secreting damaging toxins.

1. Salmonella can be spread when food is prepared in unhygienic conditions. Explain the actions that kitchen workers can take to reduce the spread of Salmonella. [5]
2. Explain why early treatment with antibiotics can help to reduce the spread of Gonorrhoea. [2]

1. To kill bacteria and reduce spread from contaminated food.[M] Wash hands after handling raw meat.[M] Disinfect surfaces / utensils.[M] Cook food thoroughly.[M] Use separate cutting boards for meat and other foods.[M] To prevent growth of salmonella on food[M] store food in a refrigerator.[M] To prevent possible contamination from an infected person[M], wash hands after using the toilet / before preparing food.[M] Do not prepare food if ill / have symptoms.[M]

2. There will be fewer people who can infect others.[1] Early treatment means there is a reduced time period during which an infected person can pass it on.[1]



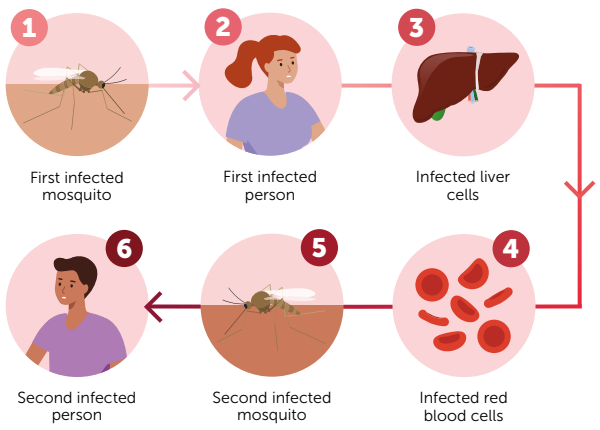
PROTIST DISEASES

Protists are a varied group of eukaryotic organisms. Most are single-celled, but some are multicellular. Some are pathogens but most are not.

Malaria infection

Malaria is caused by a single-celled protist called Plasmodium. The malarial protist has a complicated life cycle. A stage inside a host **mosquito** is an essential part of this life cycle. Malaria is not spread directly from person to person. It is only spread when a mosquito bites an infected person and feeds on blood containing the protist. The mosquito becomes infected and can then infect another person when it bites them. The mosquito is a **vector** for malaria.

The symptoms of malaria are repeated **episodes of fever** with a high temperature and a headache. The disease can be fatal. Globally there are more than four hundred thousand deaths a year from malaria, mostly in young children.



Control of malaria

The spread of malaria is mainly controlled by preventing the spread of the disease by the vector.

- Mosquitoes lay their eggs in stagnant water where their larvae develop and hatch. Malaria can be controlled if mosquitoes are **prevented from breeding** by draining water from ditches and small ponds, or by using insecticides to kill the larvae.
- **Mosquito nets**. Mosquitoes are most active during the night so this is effective in preventing people being bitten while asleep. Some nets also contain an insecticide.

1. The mosquito is a disease vector. State the meaning of the term 'disease vector'. [1]
2. Describe **two** ways that the spread of malaria is controlled. [2]
3. Populations of carnivorous fish have been introduced to ponds in some malaria regions. Suggest how this may reduce local cases of malaria. [3]

1. *A disease vector is an organism that carries and spreads a disease.*[1]
2. *Mosquito nets prevent bites that transmit the disease.*[1] *Draining areas of still water and using insecticides prevent mosquitoes from breeding.*[1]
3. *The fish will eat mosquito larvae that live in the ponds.*[1] *There will be fewer adult mosquitoes to spread malaria.*[1] *The malaria protist must infect mosquitoes to complete its life cycle.*[1]

4.3.1.8 4.3.1.8

ANTIBIOTICS AND PAINKILLERS

Some medicines cure diseases, others just reduce the symptoms.

Antibiotics

Antibiotics are medicines that are used to cure bacterial diseases. They **kill bacteria** inside the body. Antibiotics do not kill viruses.

The earliest antibiotics, such as **penicillin**, were collected from microorganisms, but now they are made artificially. Different types are needed to treat specific bacterial diseases.

The use of antibiotics since the 1940s has greatly reduced deaths from infectious bacterial diseases, but this great benefit of antibiotics is at risk of being lost. New strains of bacteria constantly arise that are **resistant** to antibiotics. There is a race to develop new types of antibiotics to kill resistant strains as they develop. **See page 120** for more detail on resistant bacteria.

Painkillers

Painkillers are one type of medicine that will only treat the **symptoms** of disease. They do not kill pathogens and will not cure the disease. Examples of painkillers include aspirin and paracetamol.

1. Antibiotics do not kill viruses. Explain why it is difficult to develop drugs that kill viruses. [1]
2. Antiseptics were used to treat surface wounds before antibiotics were discovered. Suggest **one** advantage of antibiotics over antiseptics [1]

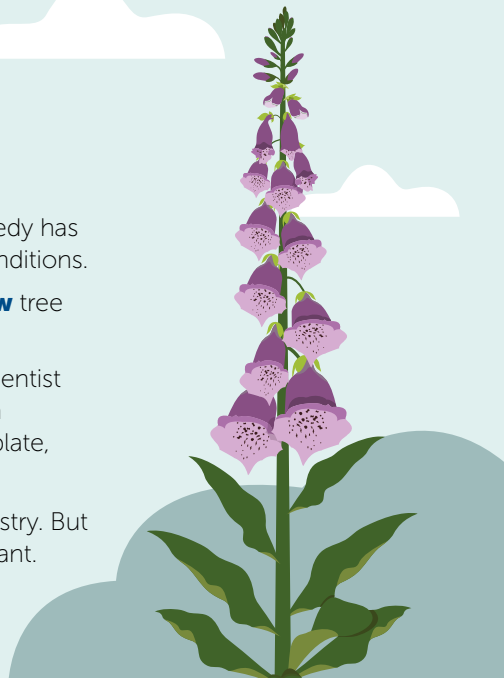
1. Viruses live inside cells, so they are difficult to kill without also damaging the body's own tissues.[1]

2. Antibiotics can be used to kill bacteria inside the body. Antiseptics can only be used externally.[1]

4.3.1.9 6.3.1.9

DISCOVERY OF DRUGS

Traditionally, drugs were extracted from plants and microorganisms.



- The drug **digitalis** originates from **foxgloves**. This ancient herbal remedy has been used as a drug by doctors since the 18th century to treat heart conditions.
- The painkiller **aspirin** originates from a chemical extracted from **willow** tree bark.
- The antibiotic **penicillin** was discovered by the Scottish doctor and scientist **Alexander Fleming**. It comes from the mould ***Penicillium***. This was a chance discovery when the *Penicillium* fungus contaminated an agar plate, killing the bacteria that Fleming was culturing.

Most new drugs are now made by chemists in the **pharmaceutical** industry. But even today the starting point may still be a substance extracted from a plant.

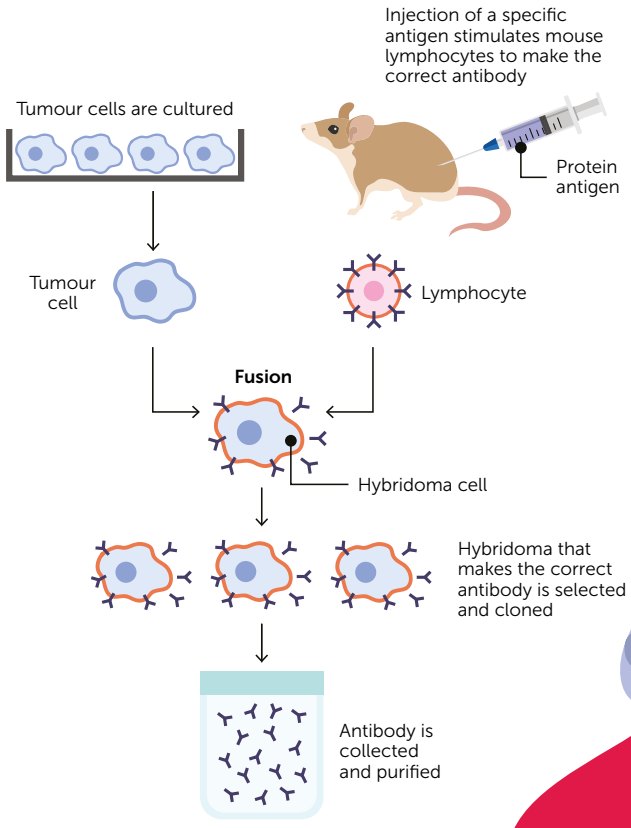
PRODUCING MONOCLONAL ANTIBODIES

What are monoclonal antibodies?

Monoclonal antibodies are made in the laboratory for a range of uses. 'Monoclonal' means that they are produced by a single clone of cells. These are genetically identical cells that produce one specific type of antibody. The antibodies are specific to one binding site on one protein antigen. This means they will target and bind to a specific chemical or to specific cells in the body.

How monoclonal antibodies are made

The process uses mouse **lymphocytes** that have been stimulated to make specific antibodies. These are fused with special **tumour cells** that can divide rapidly. This makes hybridoma cells. A **hybridoma** that makes the correct antibody is selected and cloned to make large quantities of the antibody.



1. State the usual role of a lymphocyte in the body. [1]
2. Explain why hybridoma cells are used to make monoclonal antibodies [2]
3. Why is a single hybridoma cell cloned in this process? [2]
4. Doctors developing a liver cancer drug want an antibody that will bind to liver cancer cells. Suggest what should be injected into the mouse to make this specific antibody. [2]

1. *A lymphocyte defends the body from disease.*[1]
2. *Hybridoma cells can both divide rapidly*[1] *and make the correct antibody.*[1]
3. *Cloning produces many identical cells.*[1] *Clones from a single cell will all produce the same antibody.*[1]
4. *A protein antigen*[1] *from a liver cancer cell*[1].

PLANT DISEASES

A range of pathogens can infect plants and cause disease.

Diseases caused by pathogens

- **Viral** diseases may cause wilting or leaf discolouration. One example is the **tobacco mosaic** virus (see section 4.3.1.2 page 47).
- **Bacterial** diseases may cause rot and leaf spots.
- **Fungal** diseases are much more common in plants than in animals. One example is **black spot** disease (see section 4.3.1.4 page 49).

Insect damage

Insects may feed on plants causing significant damage and loss of crops. They can also spread pathogens from plant to plant, causing further damage. **Aphids** are a common insect pest. They have piercing mouthparts that are like a sharp straw. These penetrate the plant stem so the aphids can feed on the sugary plant sap. Aphid infections can cause stunted growth and oddly shaped leaves.

Mineral ion deficiencies

Plants need a wide range of mineral ions from the soil. A poor supply of these minerals will cause symptoms of ion **deficiency**.

- A lack of **nitrate** causes **stunted growth**. Nitrates are used by plants in protein synthesis.
- **Magnesium** deficiency causes **chlorosis** (yellowing of leaves). This is because magnesium is needed to make **chlorophyll**. Chlorophyll makes leaves green and is essential for photosynthesis. Reduced photosynthesis means that less glucose is available to make cellulose and amino acids, both of which are essential for growth.

Chlorosis in wheat caused by Mg^{2+} ion deficiency

1. Aphids pierce plant stems and feed on a sugary solution.
   Name the stem tissue that the aphid feeds from. [1]
2. (a) Explain how a deficiency of nitrate could cause symptoms of stunted growth. [2]
   (b) Suggest how a farmer could prevent nitrate ion deficiency diseases. [1]

1. Phloem.[1]

2. (a) Nitrate is needed for protein synthesis[1] and proteins are essential for growth[1].
(b) Add fertiliser / manure / organic material to the soil /plant nitrogen fixing crops.[1]

TOPICS FOR PAPER 2

Information about Paper 2:

Separate Biology 8461:

Written exam: 1 hour 45 minutes
Foundation and Higher Tier
100 marks
50% of the qualification grade
All questions are mandatory

Trilogy 8464:

Written exam: 1 hour 15 minutes
Foundation and Higher Tier
70 marks
16.7% of the qualification grade
All questions are mandatory

Specification coverage

The content for this assessment will be drawn from Topics 5–7. Homeostasis and response; Inheritance, variation and evolution; and Ecology

Questions

A mix of calculations, multiple-choice, closed short answer and open response questions assessing knowledge, understanding and skills.

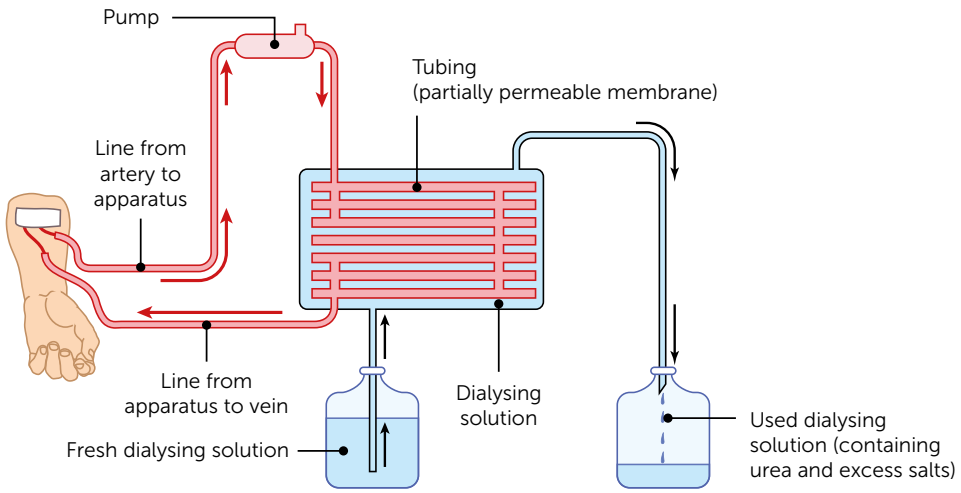
Questions assess skills, knowledge and understanding of Biology.

KIDNEY DEFECTS

If a person's kidneys fail, there are two options for treatment: kidney dialysis or a kidney transplant.

Kidney dialysis

Dialysis involves pumping the person's blood through a machine containing tubes made of a partially permeable membrane. Dialysing solution is pumped past the tubes of partially permeable membrane. Urea and excess ions diffuse out of the blood into the dialysing solution.



There are two types of dialysis – haemodialysis has to occur every 3 days in a hospital or peritoneal dialysis that can be carried out at home but every day.

Kidney transplant

A kidney transplant is performed to replace a failed kidney with a healthy kidney from a donor.

1. Suggest why dialysing fluid contains glucose at the same concentration as the patient's blood. [1]
2. Explain why dialysing solution is maintained at human body temperature. [2]
3. Evaluate the advantages and disadvantages of treating kidney failure with dialysis or transplant. [6]

1. To prevent glucose diffusing from the blood.[1]

2. It keeps the blood in the machine at body temperature[1] otherwise cooler blood returning to the body would lower body temperature below its optimum[1].

3. Dialysis: Advantage - effective life-saving treatment if kidney fails[✓] that can be given immediately[✓]; Disadvantage - logistical issues of attending hospital several times a week or performing at home[✓], fluid and diet restrictions[✓], restrictions on travel.[✓]

Kidney transplant: Disadvantage – waiting for suitable donor kidney[✓], serious operation[✓], danger of rejection[✓], life-long immunosuppressive medication[✓]; Advantage – can resume normal, healthy life.[✓]

CONTROL AND COORDINATION IN PLANTS

Plants use chemicals called hormones to control their growth in response to their surroundings.

Auxin

A hormone called **auxin** controls plant responses to light (**phototropism**) and gravity (**geotropism**). Auxin diffuses into the tissues from the tip of a shoot or root.

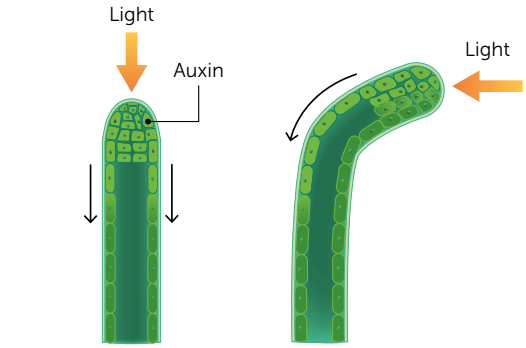
Other plant hormones — Higher Tier

Other plant hormones include:

Gibberellins	Control the start of seed germination
Ethene	Controls cell division and the ripening of fruit

Shoots

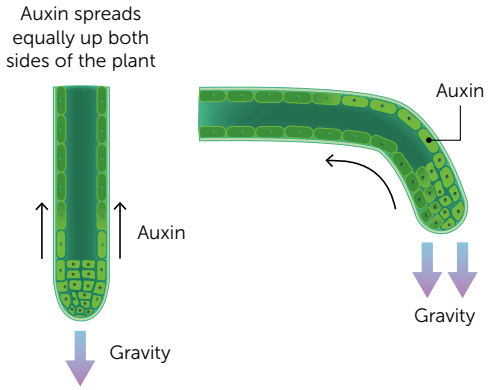
If light is coming from above, there is an even distribution of auxin in the **shoot**. If light comes from one side, more auxin moves to the shaded side of the shoot and causes unequal growth. This causes the shoot to bend towards the light.



Auxin spreads equally down both sides of the plant

Roots

If gravity acts evenly on all sides of a **root**, there is an even distribution of auxin. If gravity acts on one side, more auxin moves to the lower side of the root and causes unequal growth. The root bends downwards towards the pull of gravity.



1. Describe a geotropism. [1]
2. Explain what causes a shoot to grow towards a source of light. [2]
3. Ethene controls fruit ripening. Which other process does it control? Tick **one** box. [1]

☐ Geotropism ☐ Cell division ☐ Seed germination

1. *A plant root responding to gravity[1] by growing downwards.*
2. *Light on one side of a shoot causes an uneven distribution[1] of auxin.[1] One side of the shoot grows faster than the other[1] so the shoot bends towards the light.*
3. *Cell division.[1]*

RESISTANT BACTERIA

MRSA is a strain of bacteria resistant to antibiotics.

A mutation giving resistance to an antibiotic can occur in a bacterial pathogen in a person being treated with antibiotics. If this bacterial cell survives and reproduces, a new **strain** of bacteria has evolved.

MRSA

MRSA is resistant to a number of antibiotics. Many people carry MRSA harmlessly on their skin but it can cause serious illness if it gets inside the body. MRSA infections mainly occur in hospitals. This is because hospital patients often have surgical wounds. Once the bacteria are inside the body, the infection can be very difficult to treat.

Patients going into hospital for a planned procedure, such as an operation, are screened for MRSA. If they are carriers, they are treated beforehand. This helps reduce the risk of the patient getting an MRSA infection or passing MRSA on to another patient.

Scientists are working to develop new kinds of antibiotics to kill resistant strains of bacteria but finding new antibiotics is slow and expensive. Resistant strains could evolve faster than new antibiotics can be developed.

To slow down the evolution of antibiotic resistant strains, patients must take their full course of antibiotics so all the bacteria are killed and none can survive to mutate.

Doctors should avoid giving people antibiotics for minor bacterial infections or for infections caused by viruses. Antibiotics are not effective against viruses.

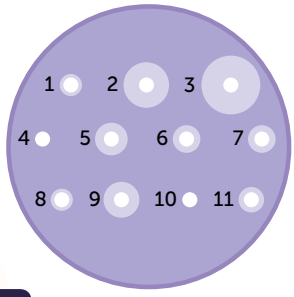
1. This image (right) shows the result of a test for antibiotic resistance. Bacteria have been grown on the agar gel. Each disc contains a different antibiotic.

   (a) Which antibiotics are the bacteria resistant to? Tick **one** box. [1]

   ☐ 1 and 4 ☐ 4 and 10 ☐ 2 and 3 ☐ 4 and 8

   (b) Describe MRSA. [2]

2. Explain the risk if farm animals are given antibiotics in their food to keep them productive. [4]



1. (a) 4 and 10.[1]

(b) MRSA is a strain[1] of bacteria resistant to antibiotics[1].

2. There is a chance that a mutation providing antibiotic resistance[1] could occur in bacteria in an animal being fed antibiotics[1] and this resistant strain could then spread to humans[1] and there would be no effective treatment available[1].

BIOTIC FACTORS

Communities are affected by the activities of the living organisms within them. Biotic factors often determine the size of the populations in a community.

Factors

Some biotic factors which affect communities include:

- Availability of **food**
- New **predators**
- New **pathogens**
- One species **outcompeting** another, so their numbers are no longer sufficient to breed

The availability of food affects the size of the population eating it. If there are too many individuals for the amount of food available, there will be competition and some individuals may not have enough to survive. If food supply increases, the population size is able to increase.

New predators or pathogens can kill individuals and reduce the size of a population. Find out more about predator-prey relationships in **4.7.2.1 levels of organisation on page 135**.

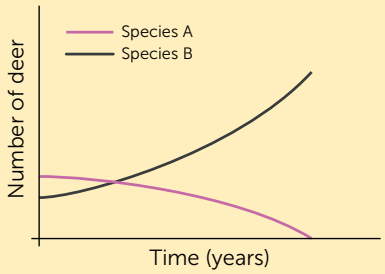
If two populations compete for the same food, one species may outcompete the other.

The graph shows the number of deer in the populations of two species. The two species both ate the same plants.

When Species B was introduced to the community, it outcompeted Species A.

Eventually, with insufficient individuals in the population of Species A to breed successfully, they died out.

1. Some fish feed on shrimps. A disease kills many of the fish. Explain the likely impact on the shrimp population. [2]
2. Describe **two** sorts of new arrival into a community which could reduce its stability. [4]
3. Look at the graph below showing the population size of two deer species. Suggest how humans could have controlled Species B to enable both species to survive. [1]



1. *Fewer shrimps are eaten[1] by fish so the shrimp population increases[1].*
2. *A new predator[1] that eats one or more of the species[1] in the community. A new pathogen[1] causing disease in a species[1] in the community.*
3. *Any one of: Introduce a pathogen which affects species A but not species B; give species A 'contraception' (limit reproduction); Feed species B; cull species A.*

SUSTAINABLE FISHERIES

A sustainable fishery enables breeding to maintain the size of the population.

Stocks

The population size or **stock** of many fish species has declined because of **over-fishing**.

Fisheries collapse if fish are removed from the stock faster than they can be replaced by reproduction. This means there are so few fish left that it is not worth fishing for them. Some species have become extinct in some areas.

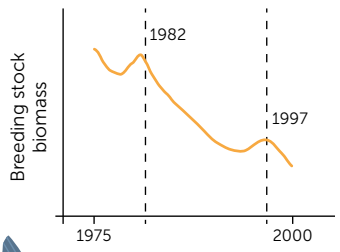
Managing fisheries

To maintain sustainable fishing, countries and organisations have introduced systems to limit how many fish are caught. These include:

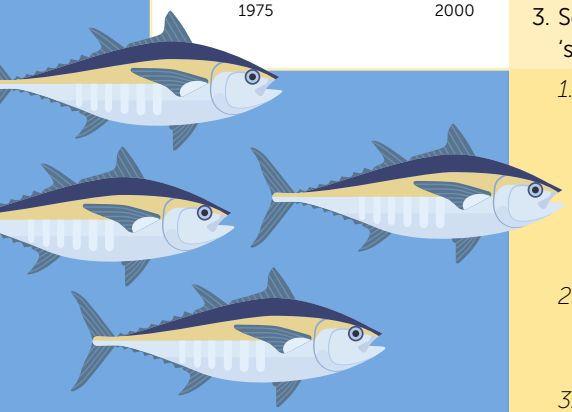
- Regulating the size of the nets used by boats, such as the length of drift nets, to restrict the number of fish caught.
- Using **quotas**. These are licences for boats, which only allow a boat to land a certain number or weight of fish in a year.

Methods such as this allow sufficient fish to survive. These fish are then able to grow to maturity and breed. Their offspring add to the stock each year.

Use connective words in your responses to multi-mark questions to help reinforce and explain your initial response for an extra mark. Connectives include, '*such as*', '*so that*', '*which means that*' and '*because*'.



1. This graph shows the breeding stock biomass of cod in the North Sea between 1975 and 2000.
   (a) The cod stock was over-fished between 1975 and 2000. Explain how the graph supports this statement. [2]
   (b) Suggest what happened in 1982 and 1997. [1]
2. Explain how quotas help to recover the stock of a low fish population. [2]
3. Some people prefer to buy fish certified as being from 'sustainable sources'. Explain what this means. [3]



1. (a) The number of fish in the population were unable to reproduce enough[1] and replenish the population. Numbers declined throughout this time, which means that cod were being fished faster than they could be replaced.[1]

(b) Less fishing occurred.[1]

2. Quotas limit the number of fish each boat can land in a year or bans are imposed[1] to ensure enough fish are left to breed.[1]

3. A sustainable source means that the size of the fish population is maintained[1] at a level which allows some fish to breed[1] and replace the number removed by fishing.[1]

EXAMINATION PRACTICE ANSWERS

Topic 1

01.1 Award one mark for each correct column. [2]

Sub-cellular structure	Eukaryotic cell	Prokaryotic cell
Nucleus	✓	×
Cell membrane	✓	✓

01.2 In a single large DNA loop [1] and in smaller circular plasmids [1]. [2]

02 Chloroplasts [1], large vacuole filled with sap [1], cell wall [1]. [3]

03.1 Without the nucleus there is more space for haemoglobin [1], so the red blood cell can carry more oxygen [1]. [2]

03.2 Correct conversion and standard form i.e. 8.0×10^{-6} m. [2] Correct answer without standard form 0.000008 m is [1] only. [2]

03.3 6 cm = 60,000 µm. [1] 60,000 ÷ 8 = magnification of ×7,500. [1] [2]

03.4 Mitochondria carry out aerobic respiration [1], which provides the energy needed for movement/muscle contraction [1]. [2]

03.5 They contain protein fibres that can shorten, causing the muscle to contract. [1]

04.1 Ribosomes are too small to see using a light microscope [1]. The electron microscope has better resolution [1] and allows greater magnification [1] than the light microscope. [3]

04.2 So that colourless or transparent structures can be more easily distinguished. [1]

04.3 The coarse focus knob is used to quickly bring the cells into view. [1] The fine focus makes smaller adjustments to bring cells into sharp focus especially at higher magnifications. [1] [2]

05.1 The agar contains nutrients that the micro-organisms feed on. [1] It provides a surface for colonies to grow on [1]. [2]

05.2 *This question should be marked with reference to the levels-based mark scheme on* ***page 175***. Indicative content: [6]
Contamination from the **air** in the laboratory [✓]. Prevented by keeping the culture covered/taping the lid on the petri dish. [✓] Using a Bunsen burner to generate upward air currents. [✓]
Contamination from the **equipment** used [✓]. Prevented by flaming the inoculation loop [✓] to kill microorganisms on it [✓] by heat sterilising / autoclaving equipment [✓].
Contamination from the **person** making the culture [✓]. Prevented by not touching the surface of the culture medium [✓], taking care not to breathe on the culture [✓], incubating at temperatures below body temperature/25 °C [✓] to avoid culturing microorganisms that can grow in the body [✓].

06.1 Differentiation. [1]

06.2 Three marks from: Cell division and differentiation for growth continues in mature plants but not in mature animals [1]. In mature animals, cell division is mainly restricted to repair of damaged tissues [1] and replacement of worn out cells [1]. [3]

07.1 *This question should be marked with reference to the levels-based mark scheme on* ***page 175***. [6]
Indicative content: Disinfectant A is more effective at killing bacteria at all concentrations [✓]. But the difference in effectiveness is small at medium and high concentrations [✓]. Disinfectant A is 5 times more expensive than B [✓]. Disinfectant B may be more cost effective / can be used at a higher concentration for a lower cost [✓]. The human toxicity of B is lower than A, so it would be safer to use [✓]. The effectiveness of both disinfectants increases as concentration increases [✓]. There is a big difference in effectiveness between the low and medium concentrations [✓]. The difference between effectiveness of medium and high concentrations is small [✓]. Manipulation of data to support reasoning e.g. Medium concentration of B is more than four times as effective than the low concentration [✓]. A conclusion is made that is consistent with the reasoning (e.g. a medium concentration of disinfectant B should be used based on effectiveness, dilution factor, cost and toxicity) [✓].

08.1 Mitosis. [1]

08.2 Risk of cell rejection as donated cells are not genetically identical to the patient. [1] Donated stem cells do not use embryos so fewer ethical or religious issues. [1] [2]

09.1 Mass would decrease. [1]

09.2 Water would move out of the solution in the bag by osmosis [1] through the partially permeable membrane [1] from the more dilute solution to the more concentrated sugar solution [1]. [3]

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LEVELS BASED MARK SCHEME FOR EXTENDED RESPONSE QUESTIONS

What are extended response questions?

Extended response questions are worth 4, 5 or 6 marks. These questions are likely to have command words such as 'compare', 'explain' or 'evaluate'. You need to write in continuous **prose** when you answer one of these questions. This means you must write in full sentences (rather than in bullet points), organised into paragraphs as necessary.

You may need to bring together skills, knowledge and understanding from two or more areas of the specification. To gain full marks, your answer needs to be logically organised, with ideas linked to give a sustained line of reasoning.

Marking

Examiners look for relevant points (indicative content) but they also use a best fit approach. This is based on your answer's overall quality and its fit to descriptors for each level.

Example level descriptors

Level descriptors vary, depending on the question being asked. Level 3 is the highest level and Level 1 is the lowest level. No marks are awarded for an answer with no relevant content. The table below gives examples of the typical features that examiners are asked to look for.

Level	Marks	Descriptors for a method	Descriptors for an evaluation
3	**5–6**	The method would lead to a valid outcome. All the key steps are given, and they are logically ordered. The response makes logical links between content points.	The answer is detailed and clear. A range of relevant points are linked logically. Most relevant data is used, if provided. Explanations show comprehensive understanding. A conclusion is made that is supported by a range of correct reasons.
2	**3–4**	The method might not lead to a valid outcome. Most of the key steps are given, but the order is not completely logical. The response makes some links between the content points.	The answer is mostly detailed but not always clear. It includes some relevant points with an attempt at linking them logically. Some relevant data is used (if provided). Some logical explanation is provided. A conclusion is given that may not fully match the reasoning made.
1	**1–2**	The method would not lead to a valid outcome. Some key steps are given, but they are not linked in a clear way.	Relevant points are made. They are not logically linked and may be unclear. Little or no data is used. Only simple descriptions are made. If a conclusion is given, it may not match the reasoning given in the answer.
0	**0**	No relevant content.	No answer has been given or the answer is not worthy of any marks.

NOTES, DOODLES AND EXAM DATES

Doodles

Exam dates

Paper 1:

Paper 2:

COMMAND WORDS

A **command word** in a question tells you what you are expected to do.

The structure of a question

You should see one command word per sentence, with the command word coming at the start. A command word might not be used however, if a question is easier to follow without one. In these cases, you are likely to see:

- What ...?
- Why ...?
- How ...?

Command word	What you need to do
Balance	Add correct balancing numbers to an equation.
Calculate	Use the numbers given to work out an answer.
Choose	Select from a range of options.
Compare	Write about **all** the similarities and/or differences between things.
Complete	Complete sentences by adding your answers in the spaces provided.
Define	Give the meaning of something.
Describe	Recall a fact, event or process accurately.
Design	Describe how something will be done, such as a practical method.
Determine	Use the data or information given to you to obtain an answer.
Draw	Produce a diagram, or complete an existing diagram.
Estimate	Work out an approximate value.
Evaluate	Use your knowledge and understanding, and the information supplied, to consider evidence for and against something. You must include a reasoned judgement in your answer.
Explain	Give the reasons why something happens, or make something clear.
Give, name, write	Only write a short answer, commonly just a single word, phrase or sentence.
Identify	Name or point out something.
Justify	Support your answer using evidence from the information given to you.
Label	Add the correct words or names to a diagram.
Measure	Use a ruler or protractor to obtain information from a photo or diagram.
Plan	Write a method.
Plot	Mark data points on a graph.
Predict	Write a likely outcome of something.
Show	Give structured evidence to come to a conclusion.
Sketch	Make an approximate drawing, such as a graph without axis units.
Suggest	Apply your knowledge and understanding to a new situation.
Use	You **must** base your answer on information given to you, otherwise you will not get any marks for the question. You might also need to use your own knowledge and understanding.

KEY TERMS IN PRACTICAL WORK

Experimental design

Key term	Meaning
Evidence	Measurements or observations collected using a valid method
Fair test	When the dependent variable is only affected by the independent variable
Hypothesis	A suggested explanation for observations or facts
Prediction	A reasoned statement that suggests what will happen in the future
Valid	A valid method involves fair testing and is suitable for an investigation
Valid conclusion	A discussion of a valid experiment and what it shows

Variables

A variable is a characteristic that can be measured or observed.

Type of variable	Meaning
Categoric	It has names or labels rather than values
Continuous	It has values rather than names or labels
Control	It affects the dependent variable, so it must be kept the same or monitored
Dependent	It is measured or observed each time the independent variable is changed
Independent	It is deliberately changed by the experimenter

Measurements and measuring

Key term	Meaning
Accurate	Close to the true value
Calibrated	A device is calibrated when its scale is checked against a known value
Data	Measurements or observations that have been gathered
Interval	The measured gap between readings
Precise	Very little spread about the mean value
Range	The values between the measured maximum and minimum values
Repeatable	When the same results are obtained using the same method and apparatus
Reproducible	Someone else gets the same results, or when different apparatus and methods are used
Resolution	The smallest change a measuring device can show
True value	The value you would get in an ideal measurement
Uncertainty	An interval in which the true value will be found

Errors

Type of error	Meaning
Anomaly	Anomalous results lie outside the range explained by random errors
Measurement	The difference between the true value and a measured value
Random	Unpredictably different readings – their effects are reduced by repeats
Systematic	Readings that differ from true values by the same amount each time
Zero	A type of systematic error where a device does not read 0 when it should

MATHEMATICAL SKILLS

Mathematical skills account for at least 10% of the marks in the Biology exam. In Combined Science (Trilogy) it is 20%. This is greater because there are more maths skills needed for the Chemistry and Physics sections.

You will have used most of the maths skills that you need if you have answered the topic and exam style questions in this guide. The skills have been summarised here as a reminder, and to give you a bit more practise at applying them.

Biological calculations

You need to know how to carry out some calculations that are specific to biology topics.

1 Magnification

You should learn the equation for magnification and be able to use it. At higher tier you may need to rearrange the equation to calculate the size of an image or object. Don't forget to convert image and object measurements to the same units, for example multiply measurements in mm by 1000 to convert to μm.

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

Calculate:

(a) the magnification if a is cell 40 μm in diameter and the image of it is 20 mm.

(b) the size of the cell on a photo if a real cell of 30 μm is magnified ×1000.

(c) the real length of a cell that measures 50 mm on an image that has a magnification of ×500.

(a) 20000 / 40 = x 500

(b) 30 x 1000 = 30 000 μm (or 30 mm)

(c) 50 / 500 = 0.1 mm

2 Cross-sectional areas of colonies or clear areas around colonies

The size (area) of a colony of bacteria and the area of a clear zone where bacteria have been killed (e.g. by an antibiotic) approximate to the area of a circle. The area of a circle = πr^2. Remember that r is the radius of the circle, which is half the diameter.

Calculate the cross-sectional area of a bacterial colony that measures 38 mm in diameter.

π x (19 x 19) = 1134 mm^2

3 The number of bacteria in a population

An exam question might state the number of bacteria at the start of an experiment and give you the mean division time. This is the average time taken for the number of bacteria to double. You should be able to calculate the number of bacteria in the population after a certain time. Often, answers can be worked out using simple maths. For more difficult problems this formula can be used:

$$\text{Final population of bacteria} = \text{Number at start} \times 2^{\text{number of divisions}}$$

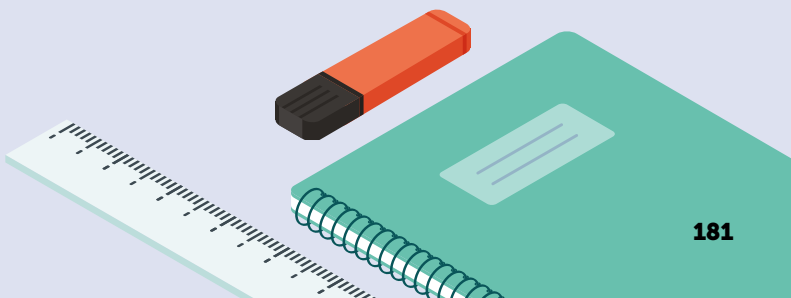
First work out the number of divisions per hour. Multiply this by time in hours to get the number of divisions.

(a) A bacterium divides every 20 minutes. Calculate the population arising from a single bacterium after 1 hour.

(b) Two bacteria contaminate a culture. They divide every 30 minutes. Calculate how many bacteria will be present after eight hours.

(a) 8 bacteria. There are 60 / 20 = 3 divisions per hour, so one bacterium gives 2, then 4, then 8.

(b) There are 60 / 30 = 2 divisions per hour, so 16 divisions in eight hours.
$2 \times 2^{16} = 2 \times 65\,536 = 131\,072$



4 Surface area to volume ratio

A cell or structure with a large surface area to volume ratio is better adapted to exchange materials with the surroundings. Divide the surface area by the volume to find how many units of surface area there are to a single unit of volume.

A cell has a volume of 27 000 μm^3 and a surface area of 5 400 μm^2. Calculate the surface area to volume ratio.

Surface area : volume = 5400 / 27 000 = 0.2 : 1

General mathematical skills

These could be applied in any topic in Biology. Many (but not all) are also covered in Chemistry or Physics. Examples of pages where these skills are covered in explanations or questions are shown in brackets. Some skills, such as drawing and interpreting graphs, calculating rates, and using decimals are used throughout the revision guide.

The core skills are to:

- Recognise and use decimals.
- Recognise and use numbers in standard form (**Topic 4.1.1.1, page 2**).
- Use ratios, fractions and percentages (including % increase and decrease).
- Make estimates (**Pages 4 & 5**).
- Use an appropriate number of significant figures (**Pages 137 & 156**).
- Find arithmetic means (**Page 137**).
- Construct and interpret frequency tables and diagrams, bar charts and histograms.
- Understand the principles of sampling as applied to scientific data (**Topic 4.7.2.1, pages 136–139**).
- Understand simple probability. This is the chance of something happening on a scale of 0 to 1 (**Topic 4.6.1.6, page 109**).
- Understand the terms mean, mode and median (**Page 137**).
- Use a scatter diagram to identify a correlation between two variables (**Topic 4.2.2.6, page 38**)
- Make order of magnitude calculations (**Topic 4.1.1, page 2**).
- Understand and use the symbols: =, <, <<, >>, >, ∝ , ~
- Solve simple algebraic equations (for example you might be given an unknown equation and asked to use it).
- Translate information between graphical and numeric form.
- Understand that y = mx + c represents a linear relationship on a graph.
- Plot a graph of two variables from experimental or other data.
- Determine the slope and intercept of a linear graph.
- Calculate rates, such as rate of reaction, rate of transpiration or rate of water uptake.
- Calculate areas of triangles and rectangles, surface areas and volumes of cubes.

EXAMINATION TIPS

When you practise examination questions, work out your approximate grade using the following table. This table has been produced using a rounded average of past examination series for this GCSE. Be aware that boundaries vary by a few percentage points either side of those shown.

GCSE Biology

Grade	9	8	7	6	5	4	3	2	1	U
F Tier (%)					63	55	41	26	12	0
H Tier (%)	67	59	52	44	35	27	21			

Combined Science: Trilogy

Grade	5–5	5–4	4–4	4–3	3–3	3–2	2–2	2–1	1–1	U
F Tier (%)	59	54	50	44	37	31	25	19	13	0

Grade	9–9	9–8	8–8	8–7	7–7	7–6	6–6	6–5	5–5	5–4	4–4	4–3	3–3
H Tier (%)	66	62	58	53	49	44	40	35	31	26	22	19	14

1. Read questions carefully. This includes any information such as tables, diagrams and graphs.
2. Remember to cross out any work that you do not want to be marked.
3. Answer the question that is there, rather than the one you think should be there. In particular, make sure that your answer matches the command word in the question. For example, you need to recall something accurately in a describe question but not say why it happens. However, you do need to say why something happens in an explain question.
4. All the examination papers will include multiple-choice questions (MCQs). Make sure you tick the correct number of boxes, or link boxes with straight lines. When completing sentences, use words from the word list if one is given.
5. Show all the relevant working out in calculations. If you go wrong somewhere, you may still be awarded some marks if the working out is there. It is also much easier to check your answers if you can see your working out. Remember to give units when asked to do so.
6. Plot the points on graphs to within half a small square. Lines of best fit can be curved or straight, but you must ignore anomalous points. If the command word is sketch rather than plot, you only need to draw an approximate graph, not an accurate one.
7. Remember that you may be asked to draw, label or complete a diagram. Sometimes you may be given the words to use. Make sure you can recall experiments you have done.
8. You could be asked to draw and label a diagram from an image. Draw only what you see, making it as big as space allows. Draw lines that are clear using a sharp pencil, don't use shading. Draw label lines with a ruler; the end of the line should just touch the item to be labelled.

Good luck!

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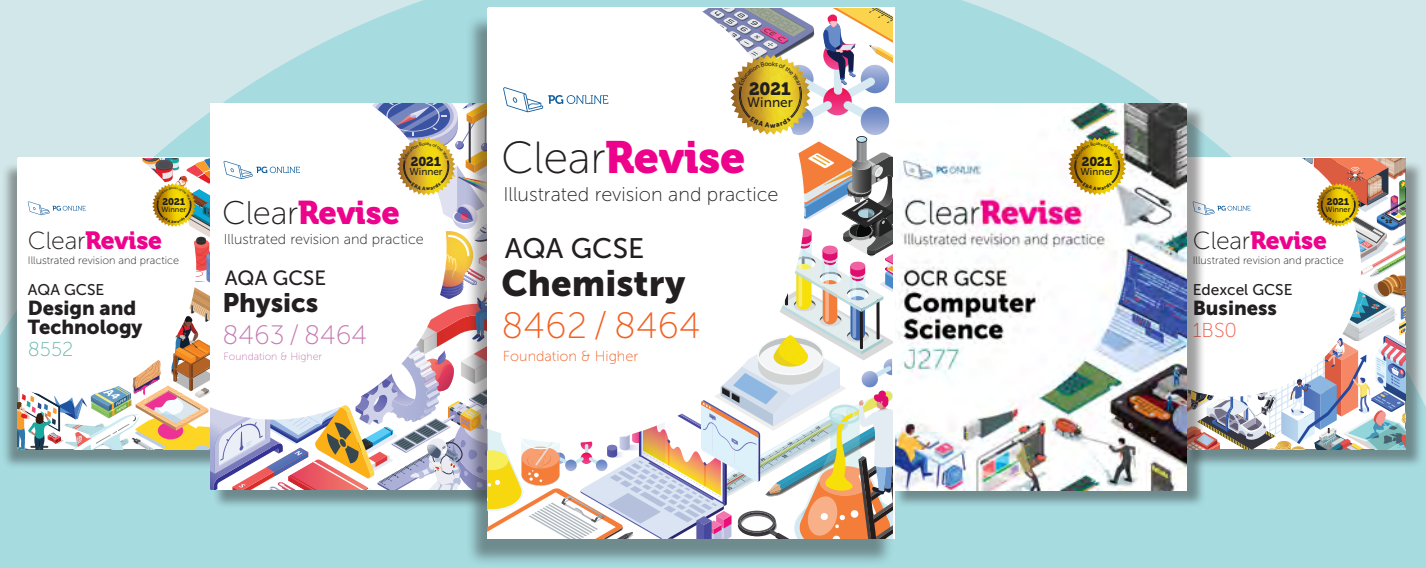

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