EXAM PAPERS PRACTICE

GCSE Biology Edexcel

YOUR NOTES

1. Key Concepts in Biology

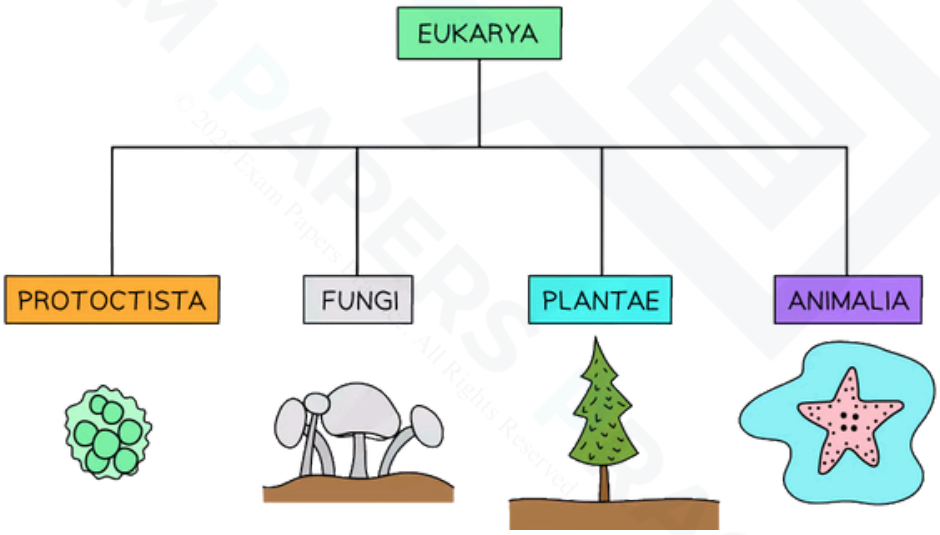
CONTENTS

1.1 Cell Structure

1.1.1 Eukaryotic Organisms

Common Features of Eukaryotic Organisms: Basics

- All living organisms can be grouped or 'classified' using a classification system that consists of five kingdoms. These five kingdoms are:
  - Animals
  - Plants
  - Fungi
  - Protoctists
  - Prokaryotes
- The first four kingdoms in this list (the animals, plants, fungi and protoctists) can actually be grouped together, as they are all eukaryotic organisms (also known as eukaryotes)



Animals, plants, fungi and protoctists are all eukaryotes

- Eukaryotic organisms can be multicellular or single-celled and are made up of cells that contain a nucleus with a distinct membrane

YOUR NOTES

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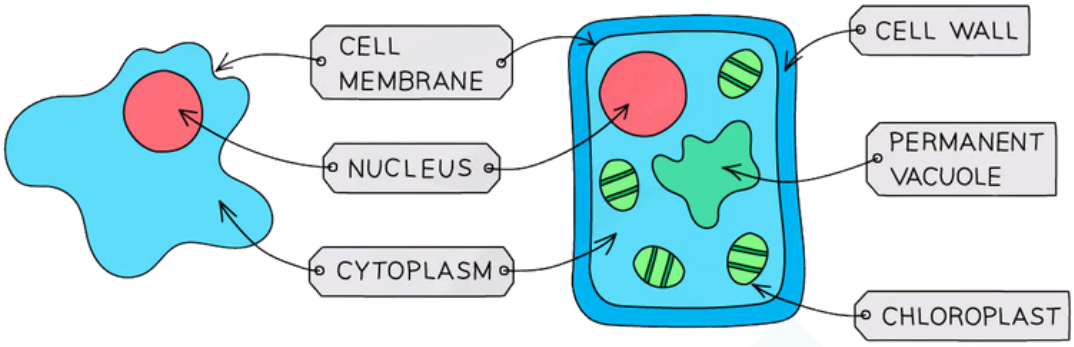


An animal cell (left) and plant cell (right) as seen under a light microscope. They are both eukaryotic cells as they both have a distinct membrane-bound nucleus.

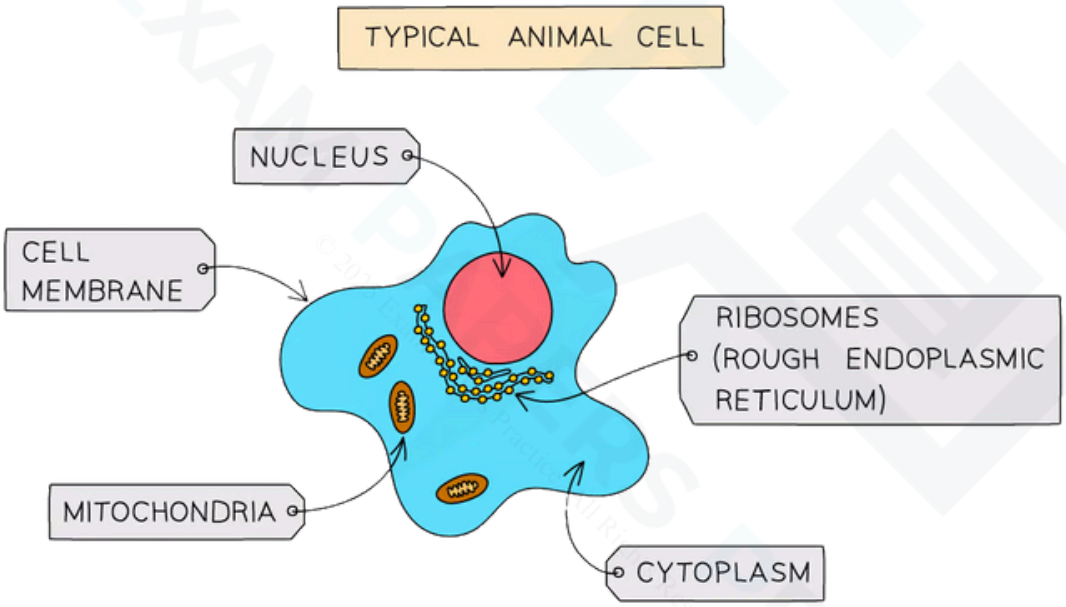
- Prokaryotic organisms (also known as prokaryotes) are in a separate kingdom and are different from eukaryotes as they are always single-celled and do not contain a nucleus (instead, the nuclear material of prokaryotic cells is found in the cytoplasm)
  - Bacteria are prokaryotic organisms
- Prokaryotic cells are substantially smaller than eukaryotic cells

1.1.2 Eukaryotic Organisms: Animals & Plants

Animals

YOUR NOTES

- The main features of animals:
  - They are multicellular
  - Their cells contain a nucleus with a distinct membrane
  - Their cells do not have cellulose cell walls
  - Their cells do not contain chloroplasts (so they are unable to carry out photosynthesis)
  - They feed on organic substances made by other living things
  - They often store carbohydrates as glycogen
  - They usually have nervous coordination
  - They are able to move from place to place



A typical animal cell

Cell Structures Found in Both Animal and Plant Cells Table

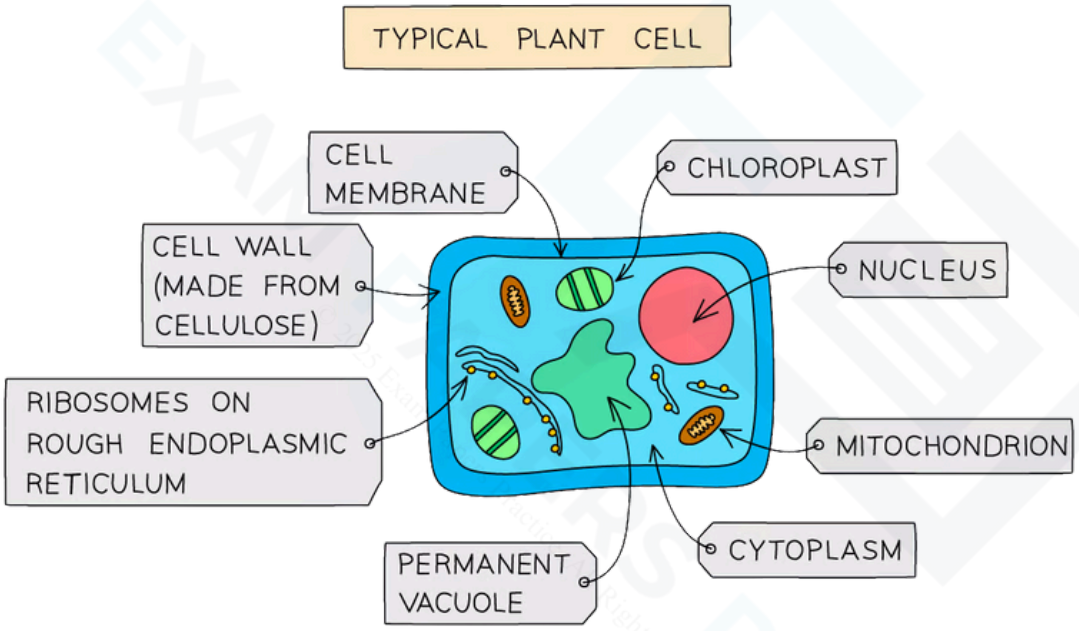
STRUCTURE	FUNCTION
NUCLEUS	• CONTAINS THE GENETIC MATERIAL (DNA) WHICH CONTROLS THE ACTIVITIES OF THE CELL
CYTOPLASM	• A GEL–LIKE SUBSTANCE COMPOSED OF WATER AND DISSOLVED SOLUTES • SUPPORTS INTERNAL CELL STRUCTURES • SITE OF MANY CHEMICAL REACTIONS, INCLUDING ANAEROBIC RESPIRATION
CELL MEMBRANE	• HOLDS THE CELL TOGETHER, SEPARATING THE INSIDE OF THE CELL FROM THE OUTSIDE • CONTROLS WHICH SUBSTANCE CAN ENTER AND LEAVE THE CELL
RIBOSOMES	• FOUND IN THE CYTOPLASM • SITE OF PROTEIN SYNTHESIS
MITOCHONDRIA	• SITE OF MOST OF THE REACTIONS INVOLVED IN AEROBIC RESPIRATION, WHERE ENERGY IS RELEASED TO FUEL CELLULAR PROCESSES • CELLS WITH HIGH RATES OF METABOLISM (CARRYING OUT MANY DIFFERENT CELL REACTIONS) HAVE SIGNIFICANTLY HIGHER NUMBERS OF MITOCHONDRIA THAN CELLS WITH FEWER REACTIONS TAKING PLACE

YOUR NOTES

P lants

YOUR NOTES

- The main features of plants:
  - They are multicellular
  - Their cells contain a nucleus with a distinct membrane
  - Their cells have cell walls made out of cellulose
  - Their cells contain chloroplasts (so they can carry out photosynthesis)
  - They feed by photosynthesis
  - They store carbohydrates as starch or sucrose
  - They do not have nervous coordination



A typical plant cell

Cell Structures Found Only in Plant Cells Table

STRUCTURE	FUNCTION
CELL WALL	• MADE OF CELLULOSE (A POLYMER OF GLUCOSE) • GIVES THE CELL EXTRA SUPPORT, DEFINING ITS SHAPE
CHLOROPLASTS	• CONTAINS GREEN CHLOROPHYLL PIGMENTS (TO ABSORB LIGHT ENERGY) AND THE ENZYMES NEEDED FOR PHOTOSYNTHESIS
A PERMANENT VACUOLE	• CONTAINS CELL SAP; A SOLUTION OF SUGARS AND SALTS DISSOLVED IN WATER • USED FOR STORAGE OF CERTAIN MATERIALS • ALSO HELPS SUPPORT THE SHAPE OF THE CELL

Exam Tip

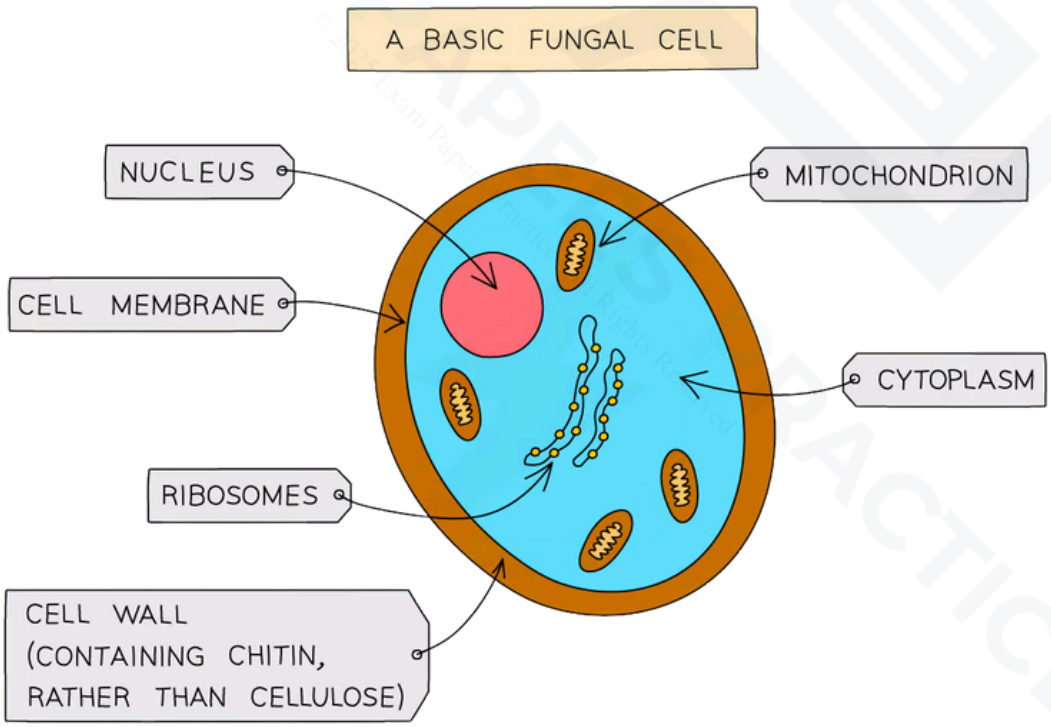
You need to be able to recognise, draw and interpret images of cells, so practice drawing and labelling animal and plant cells as part of your revision.

YOUR NOTES

YOUR NOTES

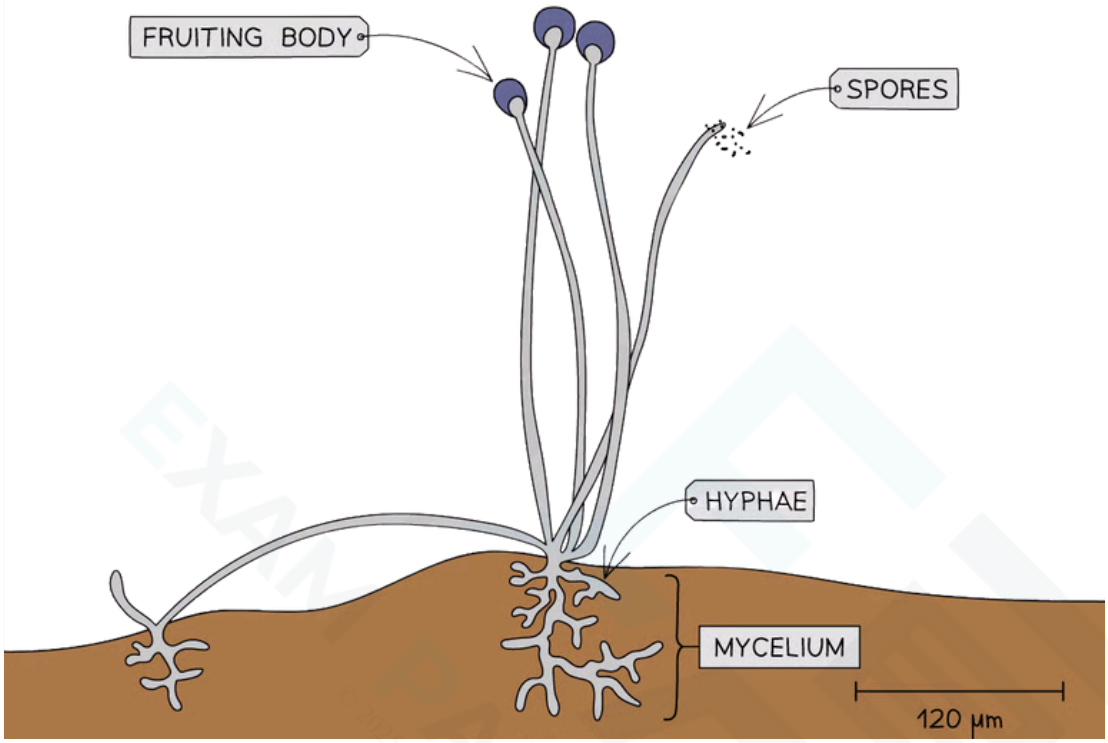
Fungi

- Main features of fungi:
  - They are usually multicellular but some are single-celled (e.g. yeast)
  - Multicellular fungi are mainly made up of thread-like structures known as hyphae that contain many nuclei and are organised into a network known as a mycelium
  - Their cells contain a nucleus with a distinct membrane
  - Their cells have cell walls made of chitin (chitinous cell walls)
  - Their cells do not contain chloroplasts (so they cannot carry out photosynthesis)
  - They feed by secreting extracellular digestive enzymes (outside the mycelium) onto the food (usually decaying organic matter) and then absorbing the digested molecules. This method of feeding is known as saprotrophic nutrition
  - Some fungi are parasitic and feed on living material
  - Some fungi store carbohydrates as glycogen
  - They do not have nervous coordination
  - Examples of fungi include: moulds, mushrooms, yeasts



A typical fungal cell

YOUR NOTES

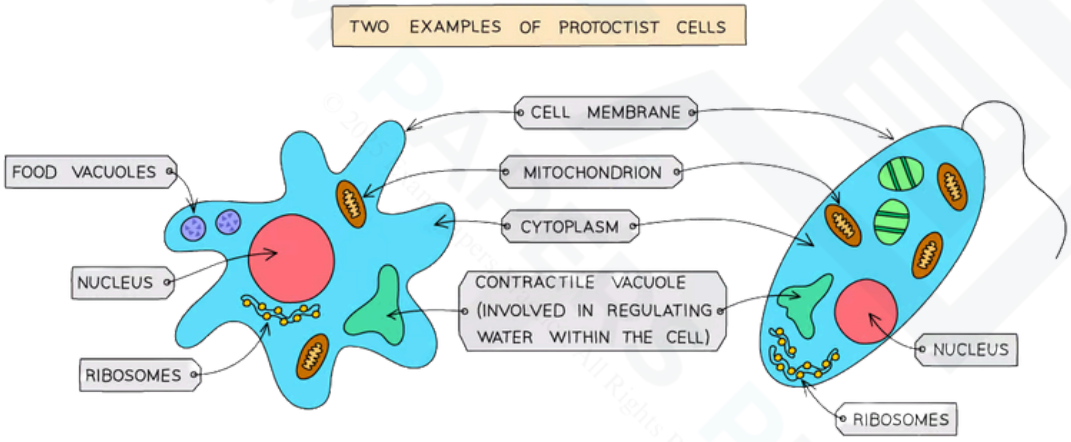


The typical structure of a multicellular fungus e.g. Mucor (bread mould)

Protoctists

YOUR NOTES

- Main features of protoctists:
  - The protoctists are a very diverse kingdom of organisms that don't really belong in any of the other eukaryotic kingdoms (animals, plants and fungi)
  - They are mainly microscopic and single-celled but some aggregate (group together) into larger forms, such as colonies or chains of cells that form filaments
  - Their cells contain a nucleus with a distinct membrane
  - Some have features making them more like animal cells e.g. *Plasmodium* (the protoctist that causes malaria)
  - Some have features, such as cell walls and chloroplasts, making them more like plant cells e.g. green algae, such as *Chlorella*
  - This means some protoctists photosynthesise and some feed on organic substances made by other living things
  - They do not have nervous coordination
  - Examples of protoctists include: amoeba, *Paramecium*, *Plasmodium*, *Chlorella*



Two examples of protoctist cells

Exam Tip

You need to be able to recognise, draw and interpret images of cells, so practice drawing and labelling fungal cells and protoctist cells as part of your revision.

1.1.4 Prokaryotic Organisms

YOUR NOTES

Prokaryotes

- All living organisms can be grouped or 'classified' using a classification system that consists of five kingdoms. These five kingdoms are:
  - Animals
  - Plants
  - Fungi
  - Protoctists
  - Prokaryotes

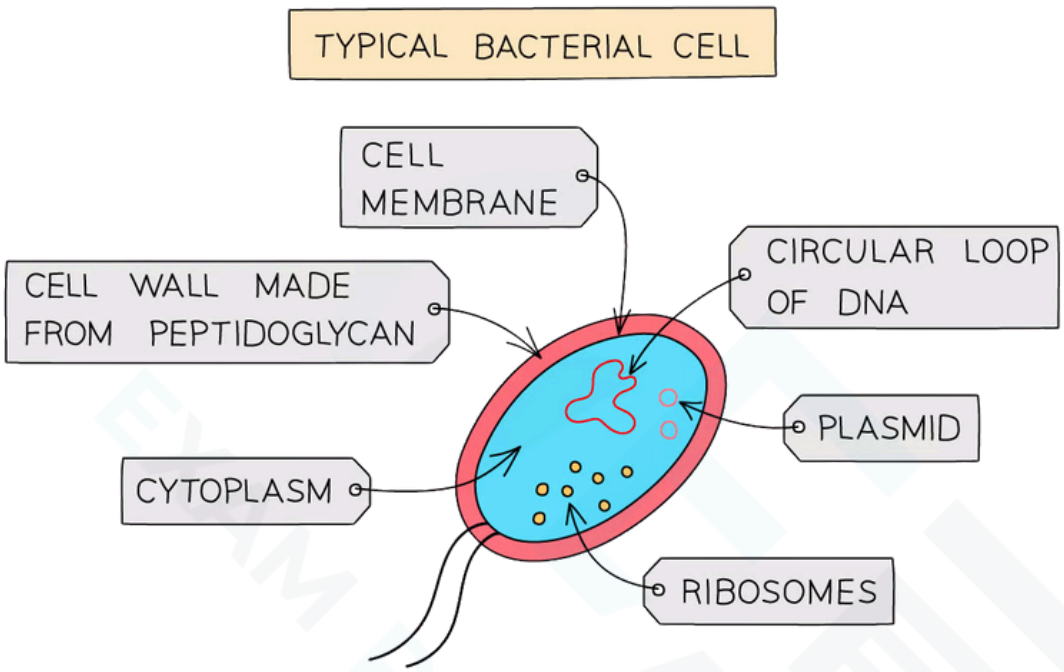
- The prokaryotes are different from the other four kingdoms (which are all eukaryotes) as prokaryotic organisms are always single-celled and do not contain a nucleus
- Instead, the nuclear material of prokaryotic cells is found in the cytoplasm
- Prokaryotic cells are also much smaller (about x1000 smaller) than eukaryotic cells
- They are too small to contain chloroplasts or mitochondria
- Bacteria are prokaryotic organisms

Bacteria

- Bacteria, which have a wide variety of shapes and sizes, all share the following biological characteristics:
  - They are microscopic single-celled organisms
  - Possess a cell wall (made of peptidoglycan, not cellulose), cell membrane, cytoplasm and ribosomes
  - Lack a nucleus but contain a circular chromosome of DNA that floats in the cytoplasm
  - Plasmids are present in prokaryotes - these are small rings of DNA (also floating in the cytoplasm) that contain extra genes to those found in the chromosomal DNA
  - They lack mitochondria, chloroplasts and other membrane-bound organelles found in eukaryotic cells

- Some bacteria also have a flagellum (singular) or several flagella (plural). These are long, thin, whip-like tails attached to bacteria that allow them to move
- Examples of bacteria include:
  - Lactobacillus (a rod-shaped bacterium used in the production of yoghurt from milk)
  - Pneumococcus (a spherical bacterium that acts as the pathogen causing pneumonia)

YOUR NOTES



A typical bacterial cell

1.1.5 Specialised Cells

YOUR NOTES

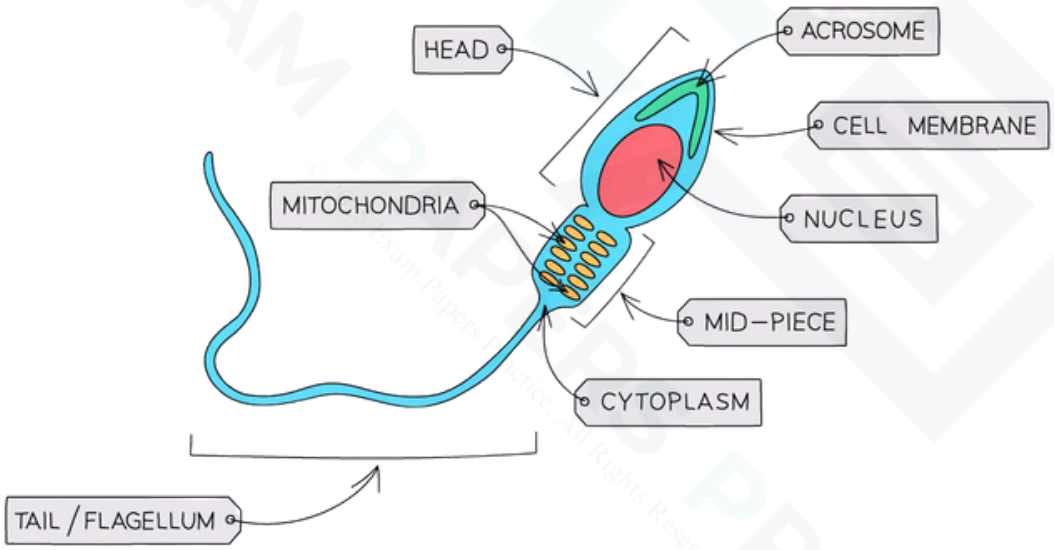
Specialised Cells

YOUR NOTES

- Specialised cells are those which have developed certain characteristics (known as adaptations) in order to perform particular functions
- Cells specialise by undergoing di erentiation: this is a process by which cells develop the structure and characteristics needed to be able to carry out their functions
- Examples of specialised cells in animals include:
  - Sperm cells
  - Egg cells
  - Ciliated epithelial cells

Sperm cells

- Sperm cells are highly specialised for their role in reproduction, i.e. to carry the DNA of the male to the egg cell (the ovum) of the female



Sperm cell

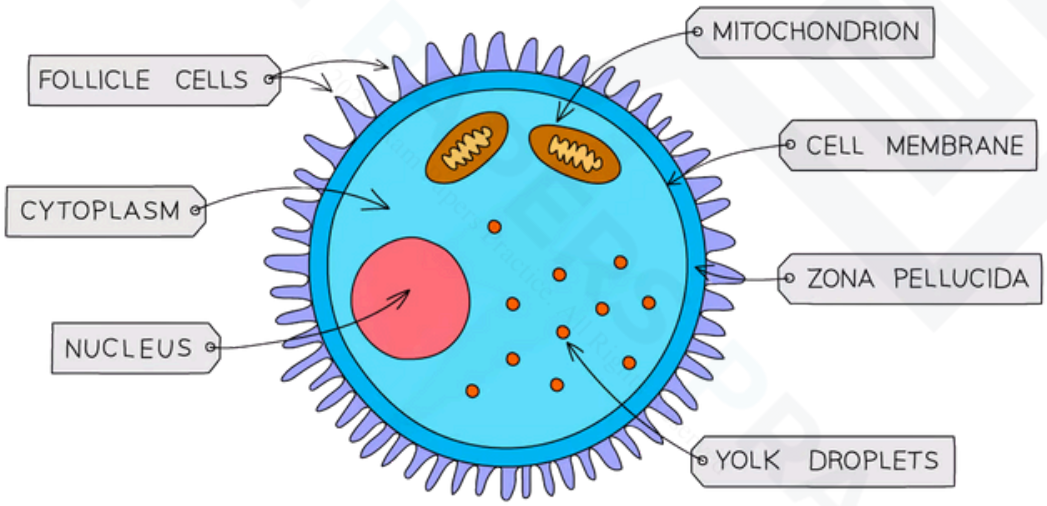
Sperm Cell Adaptations Table

YOUR NOTES

Cell	Function	Adaptations
Sperm cell	Reproduction	◦ The head contains the genetic material for fertilisation in a **haploid nucleus** (containing half the normal number of chromosomes) ◦ The **acrosome** in the head contains digestive **enzymes** so that a sperm can penetrate an egg ◦ The mid-piece is packed with **mitochondria** to release **energy** needed to swim and fertilise the egg ◦ The **tail** enables the sperm to **swim**

Egg cells

- Egg cells are also highly specialised for their role in reproduction, i.e. to be fertilised by a single sperm and to develop into an embryo



Egg cell

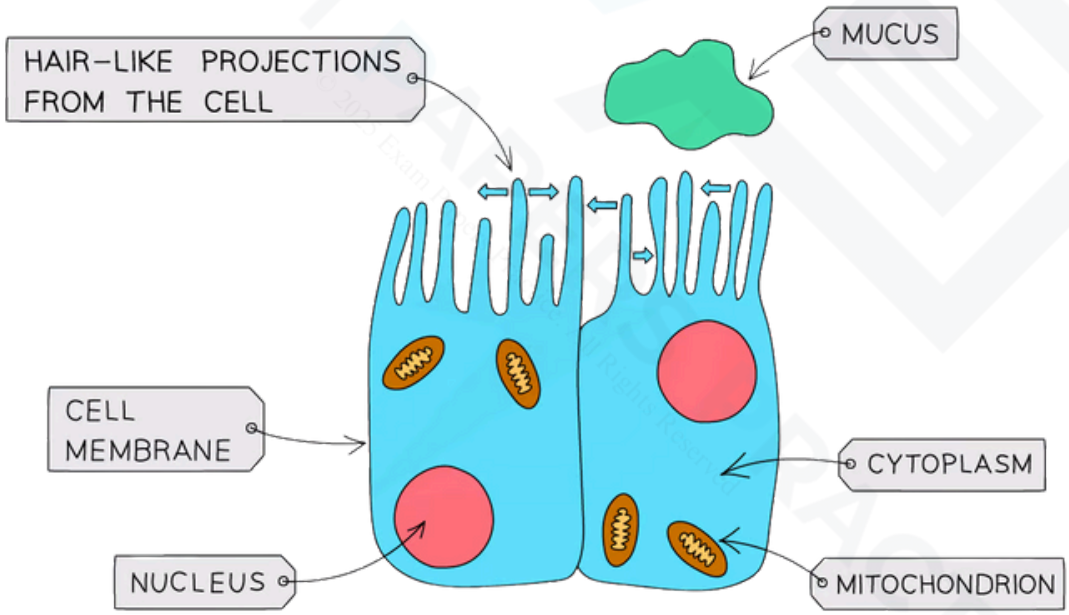
Egg Cell Adaptations Table

YOUR NOTES

Cell	Function	Adaptations
Egg cell (ovum)	Reproduction	◦ Contains a **lot of cytoplasm** which has **nutrients** for the growth of the early embryo ◦ **Haploid nucleus** contains the genetic material for fertilisation ◦ Cell membrane **changes after fertilisation** by a single sperm so that **no more sperm** can enter

Ciliated epithelial cells

- Ciliated epithelial cells are highly specialised for their role in wafting bacteria and other particles (trapped by mucus) up to the throat (to be coughed out) or down to the stomach (to be digested)



Ciliated epithelial cells

Ciliated Epithelial Cell Adaptations Table

Cell	Function	Adaptations
Ciliated cell	Movement of mucus in the trachea and bronchi	◦ Extensions of the cytoplasm at the surface of the cell form hair-like structures called **cilia** which **beat to move mucus** and trapped particles up to the throat

YOUR NOTES

Exam Tip

Remember: Cilia and microvilli are not the same.

Cilia are hair-like projections that can move ('waft') mucus along, whereas microvilli are multiple indentations of the small intestinal epithelial cell membrane, designed to increase the surface area for absorption. Microvilli cannot move by themselves as cilia can.

YOUR NOTES

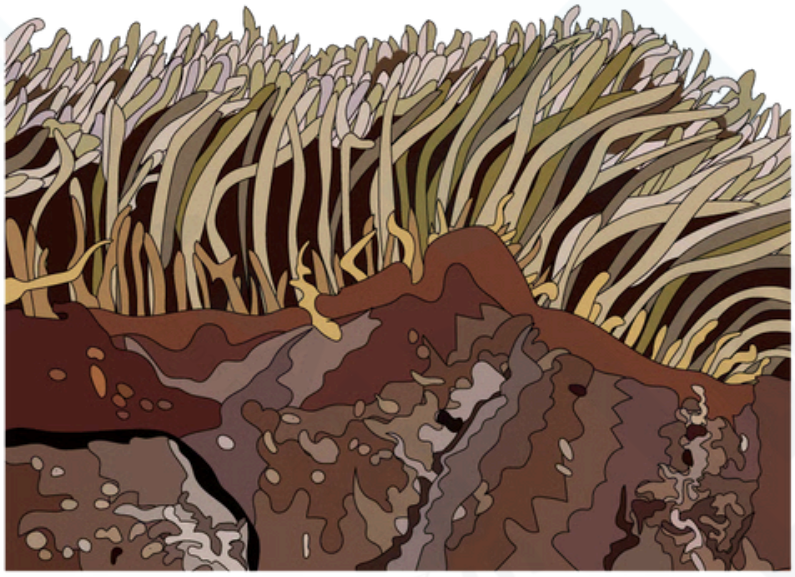
A Brief History of the Microscope

- Microscopy techniques have developed over time, increasing our understanding of cell structures and organelles
  - This has also increased our understanding of the role of subcellular structures
- The first light microscopes were developed in the 17th Century
- Scientists such as Anton van Leeuwenhoek and Robert Hooke are responsible for using microscopes to develop our first understanding of cells
  - The first cells (of a cork) were observed by Robert Hooke in 1665 using a light m icros cope
- Light microscopes use light and lenses to form a magnified image of a specimen
- Over the centuries, the design of the light microscope has evolved, increasing magnification and resolution to enhance the detail of what can be visualised
- With a modern light microscope, it is possible to see images of cells and large subcellular structures (like nuclei and vacuoles), although stains are often required to highlight certain parts of cells
  - The most powerful light microscopes today have a maximum magnification of approximately 1000 to 2000×
- The first electron microscopes were developed in the first half of the 20th Century (in the 1 930s)
  - Electron microscopes use beams of electrons, rather than light, to visualise s pecim en s
  - The wavelength of an electron beam is much smaller than that of visible light, which gives electron microscopes a much higher resolution and magnification

Electron Microscopes

YOUR NOTES

- An electron microscope has much higher magnification and resolving power than a light m icros cope
- They can therefore be used to study cells in much finer detail, enabling biologists to see and understand many more subcellular structures such as the mitochondria, chloroplasts and ribosomes
- They have also helped biologists develop a better understanding of the structure of the nucleus and cell membrane
- Electron microscopes have a maximum magnification of approximately 2,000,000×



An example of an electron micrograph (of ciliated epithelium tissue) produced by an electron microscope. Notice the high level of detail included. The colour has been added by a computer programme.

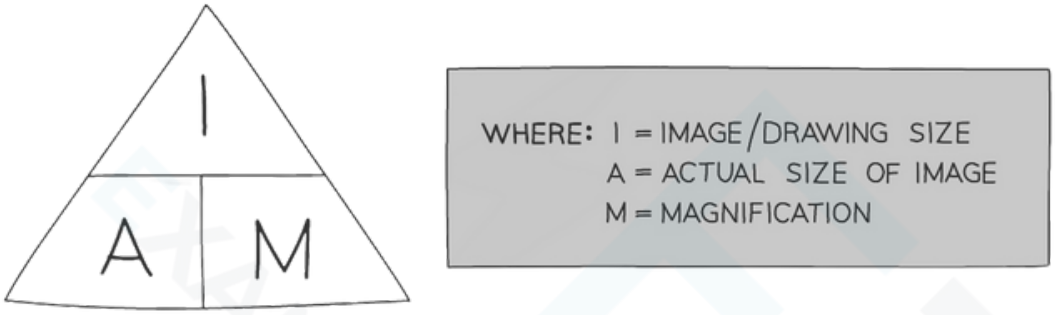
Magnification Calculations

YOUR NOTES

Magnification is calculated using the following equation:

Magnification = Drawing size ÷ Actual size

A better way to remember the equation is using an equation triangle:



An equation triangle for calculating magnification

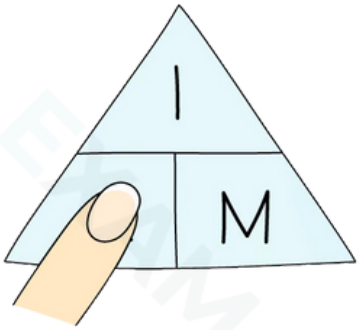
- Rearranging the equation to find things other than the magnification becomes easy when you remember the triangle – whatever you are trying to find, place your finger over it and whatever is left is what you do, so:
  - Magnification = image size ÷ actual size
  - Actual size = image size ÷ magnification
  - Image size = actual size × magnification
- Remember magnification does not have any units and is just written as 'X 10' or 'X 5000'

YOUR NOTES

Worked Example

An image of an animal cell is 30 mm in size and it has been magnified by a factor of X 3000. What is the actual size of the cell?

To find the actual size of the cell:



$$A = \frac{I}{M} = \frac{30\,mm}{3000} = 0.01\,mm$$

$$0.01\,mm = 10\,\mu m$$

Worked example using the equation triangle for magnification

- You may also be asked to calculate the total magnification of a light microscope if given the magnification of the eyepiece lens and the magnification of the objective lens
- As these are two separate parts of a light microscope, each with its own magnifying power, you can simply multiply the two values to calculate the total magnification:

Magnification of light microscope = Magnification of eyepiece lens × Magnification of objective lens

Exam Tip

It is easy to make silly mistakes with magnification calculations. To ensure you do not lose marks in the exam:

- Always look at the units that have been given in the question – if you are asked to measure something, most often you will be expected to measure it in millimetres NOT in centimetres – double-check the question to see!
- Learn the equation triangle for magnification and always write it down when you are doing a calculation – examiners like to see this!

YOUR NOTES

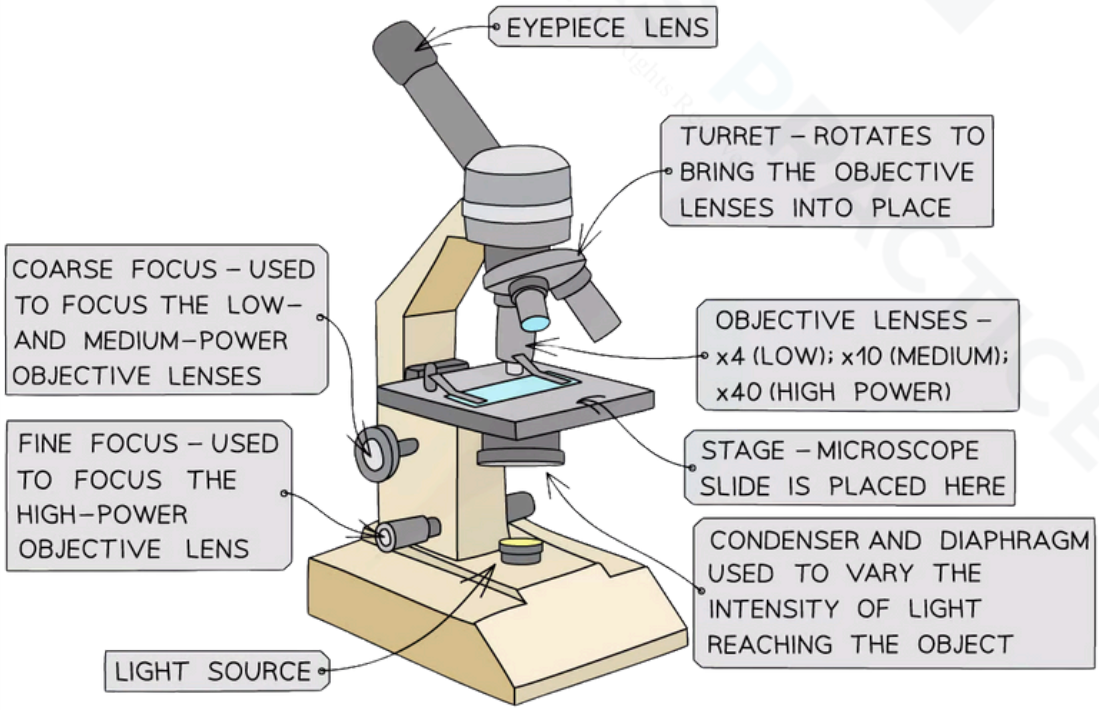
Practical: Microscopy

- Many biological structures are too small to be seen by the naked eye
- Optical microscopes are an invaluable tool for scientists as they allow for tissues, cells and organelles to be seen and studied
- Light is directed through a thin layer of biological material (containing the tissue(s), cell(s) or organelle(s) to be observed) that is supported on a glass slide
- This light is focused through several lenses so that an image is visible through the eyepiece

A p p aratu s

- The key components of an optical microscope you will need to use are:
  - The eyepiece lens
  - The objective lenses
  - The stage
  - The light source
  - The coarse and fine focus

- Other apparatus used:
  - Forceps
  - Scis s ors
  - Scalpel
  - C ov ers lip
  - Slides
  - Pipette



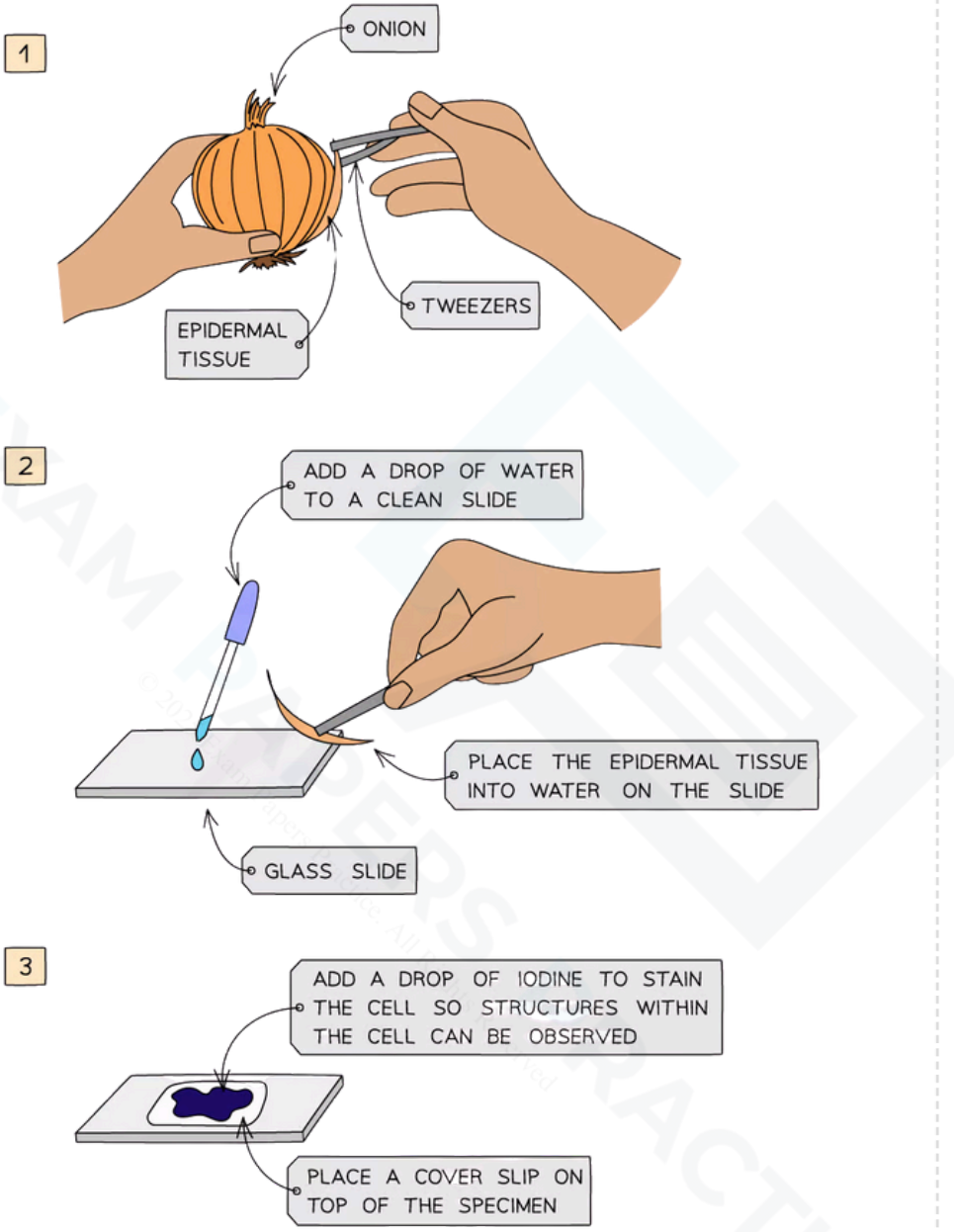
The components of an optical microscope

M eth od

YOUR NOTES

- Specimens must be prepared on a microscope slide to be observed under a light m icros cope
- This must be done carefully to avoid damaging the biological specimen and the structures within it
- The most common specimens to observe under a light microscope are cheek cells (animal cells) and onion cells (plant cells)
- Preparing a slide using a liquid specimen:
  - Add a few drops of the sample to the slide using a pipette
  - Cover the liquid/smear with a coverslip and gently press down to remove air bubbles
  - Wear gloves to ensure there is no cross-contamination of foreign cells
- Preparing a slide using a solid specimen:
  - Use scissors to cut a small sample of the tissue
  - Peel away or cut a very thin layer of cells from the tissue sample to be placed on the slide (using a scalpel or forceps)
  - Some tissue samples need to be treated with chemicals to kill/make the tissue rigid
  - Gently place a coverslip on top and press down to remove any air bubbles
  - A stain may be required to make the structures visible depending on the type of tissue being examined. Commonly used stains include methylene blue to stain cheek cells and iodine to stain onion cells
  - Take care when using sharp objects and wear gloves to prevent the stain from dying your skin
- When using an optical microscope always start with the low power objective lens:
  - It is easier to find what you are looking for in the field of view
  - This helps to prevent damage to the lens or coverslip in case the stage has been raised too high
- Preventing the dehydration of tissue:
  - The thin layers of material placed on slides can dry up rapidly
  - Adding a drop of water to the specimen (beneath the coverslip) can prevent the cells from being damaged by dehydration
- Unclear or blurry images:
  - Switch to the lower power objective lens and try using the coarse focus to get a clearer im a ge
  - Consider whether the specimen sample is thin enough for light to pass through to see the structures clearly
  - There could be cross-contamination with foreign cells or bodies

YOUR NOTES

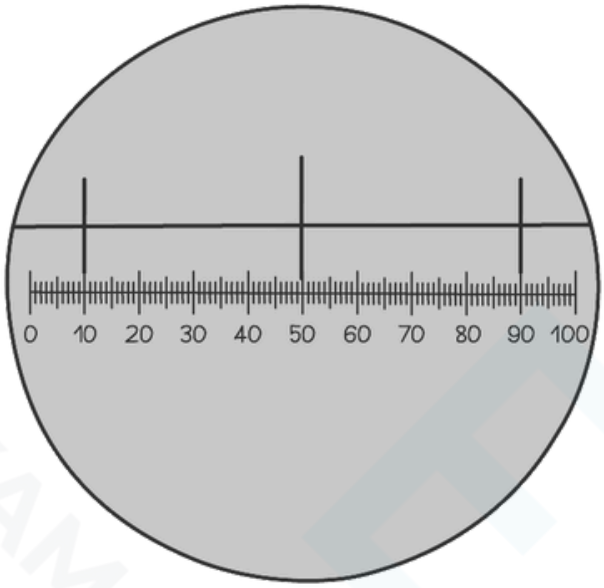


Care must be taken to avoid smudging the glass slide or trapping air bubbles under the coverslip

Results: using a graticule to measure cells, cell structures and organelles

- In order to take measurements of cells, you need to use a calibratedgraticule
- An eyepiece graticule and stage micrometer are used to measure the size of the object when viewed under a microscope

YOUR NOTES

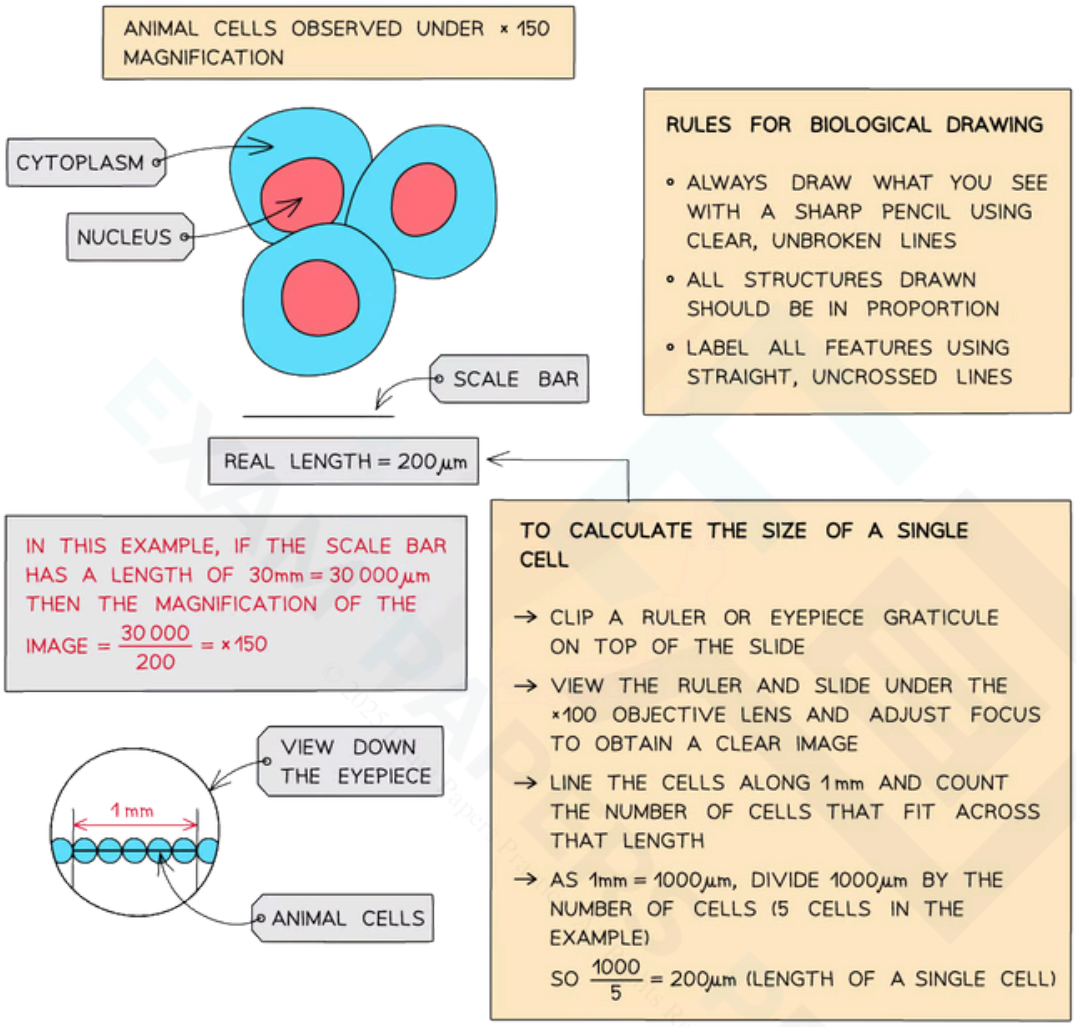


The three lines of a stage micrometer and the 100 division-markings of the eyepiece graticule, as seen if looking down the lens of a light microscope

Results - producing labelled scientific drawings from observations

- Producing biological drawings of what you see under the microscope is a key skill
- The key is not to try to be too artistic with your drawings – they are supposed to be scientific so make sure you follow the rules

YOUR NOTES



Biological drawings should be as large as possible – aim to take up at least half of the space available on the page with your drawings

Li mi tati on s

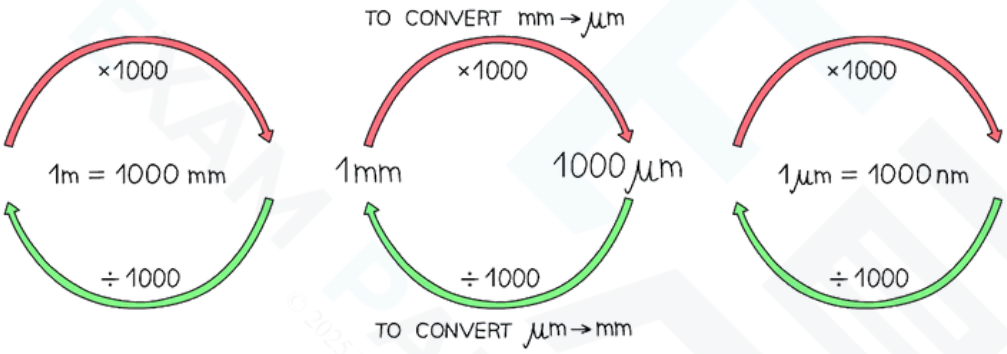
- The size of cells or structures of tissues may appear inconsistent in di erent specimen s lides
  - Cell structures are 3D and the di erent tissue samples will have been cut at di erent planes resulting in inconsistencies when viewed on a 2D slide
- Optical microscopes do not have the same magnification power as other types of microscopes and so there are some structures that cannot be seen
- The treatment of specimens when preparing slides could alter the structure of cells

1.1.8 Using Units

YOUR NOTES

Converting Units

- You may be given a question in your Biology exam where the measurements for a magnification calculation have di erent units
- You need to ensure that you convert them both into the same unit before proceeding with the calculation (usually to calculate the magnification)
- Remember the following to help you convert between mm (millimetres), µm (micrometres) and nm (nanometres):



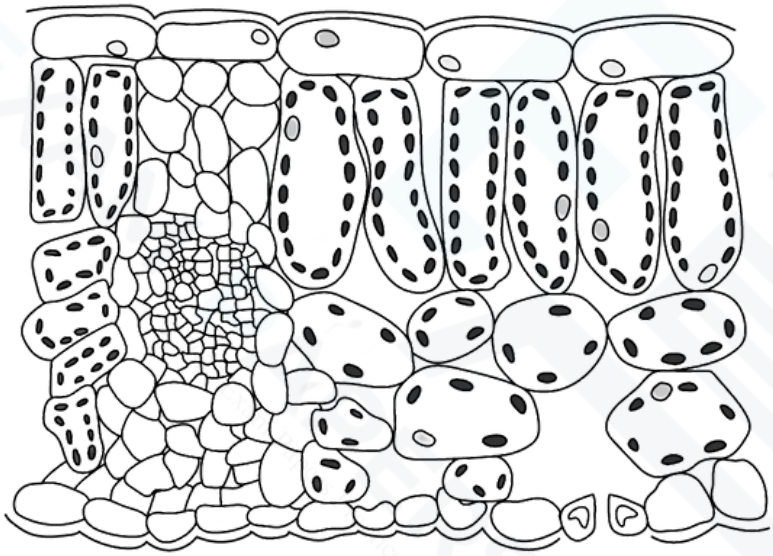
Converting between mm (millimetres), µm (micrometres) and nm (nanometres)

- If you are given a question with two di erent units in it, make sure you make a conversion so that both measurements have the same unit before doing your calculation
- For example:

YOUR NOTES

Worked Example

THE ACTUAL THICKNESS OF THE LEAF BELOW IS 2000μm, BUT THE IMAGE SIZE OF THE LEAF IN THE DIAGRAM IS 50mm



WHAT IS THE MAGNIFICATION OF THE DIAGRAM?

A x0.025 B x25 C x100 D x100 000

Step One:

- Remember that 1 mm = 1000 μm
- So to get from μm to mm you need to divide by 1000

Step Two: Calculate the thickness of the leaf in mm

- 2000 ÷ 1000 = 2, so the actual thickness of the leaf is 2 mm and the drawing thickness is 50 mm

Step Three: Put these values into the equation for calculating magnification

- Magnification = image size ÷ actual size

YOUR NOTES

- = 50 ÷ 2
- = 25

- So the magnification is x 25

Standard form

- When doing calculations and unit conversions, it is common to come across very big or very small numbers
- Standard form can be useful when working with these numbers
- Standard form is a way of writing very big and very small numbers using powers of 10

How to use standard form

- Using standard form, numbers are always written as follows: a × 10n
- The rules:
  - 1 ≤ a < 10 (the number 'a' must always be between 1 and 10)
  - n > 0 for LARGE numbers ('n' = how many times 'a' is multiplied by 10)
  - n < 0 for SMALL numbers ('n' = how many times 'a' is divided by 10)

Using standard form to convert between units

- For example, you can write 1 metre in millimetres using standard form:
  - 1 m = 1000 mm
  - So, 1 m = 1 mm × 1000
  - So, 1 m = 1 mm × 10 × 10 × 10
  - So, as we had to multiply 1 mm by 10 three times to get 1 m, we write this as:
  - 1 m = 1 × 103 mm

- Writing 1 millimetre in metres using standard form is also possible and is just the opposite:
  - 1 mm = 0.001 m
  - So, 1 mm = 1 m ÷ 1000
  - So, 1 mm = 1 m ÷ 10 ÷ 10 ÷ 10
  - So, as we had to divide 1 m by 10 three times to get 1 mm, we write this as:
  - 1 mm = 1 × 10-3 m

- Exactly the same process can be used if you needed to convert micrometres into millimetres. For example:
  1 μm = 0.001 mm
  So, 1 μm = 1 mm ÷ 1000
  So, 1 μm = 1 mm ÷ 10 ÷ 10 ÷ 10
  So, as we had to divide 1 mm by 10 three times to get 1 μm, we write this as:
  1 μm = 1 × 10-3 mm

Examples of using standard form in conversion calculations

- You could be asked to state 45 centimetres in millimetres using standard form:
  - 1 cm = 10 mm
  - So, 45 cm = 450 mm
  - So, 45 cm = 4.5 mm × 10 × 10
  - So, as we had to multiply 4.5 mm by 10 two times to get 45 cm, we write this as:
  - 45 cm = 4.5 × 102 mm

- You could also be asked to state 250 micrometres in millimetres using standard form:
  - 1 μm = 0.001 mm
  - So, 250 μm = 0.25 mm
  - So, 25 μm = 2.5 mm ÷ 10
  - So, as we had to divide 4.5 mm by 10 just once to get 250 μm, we write this as:
  - 250 μm = 2.5 × 10-1 mm

YOUR NOTES

1.2 Enzymes

1.2.1 The Action of Enzymes

The Action of Enzymes

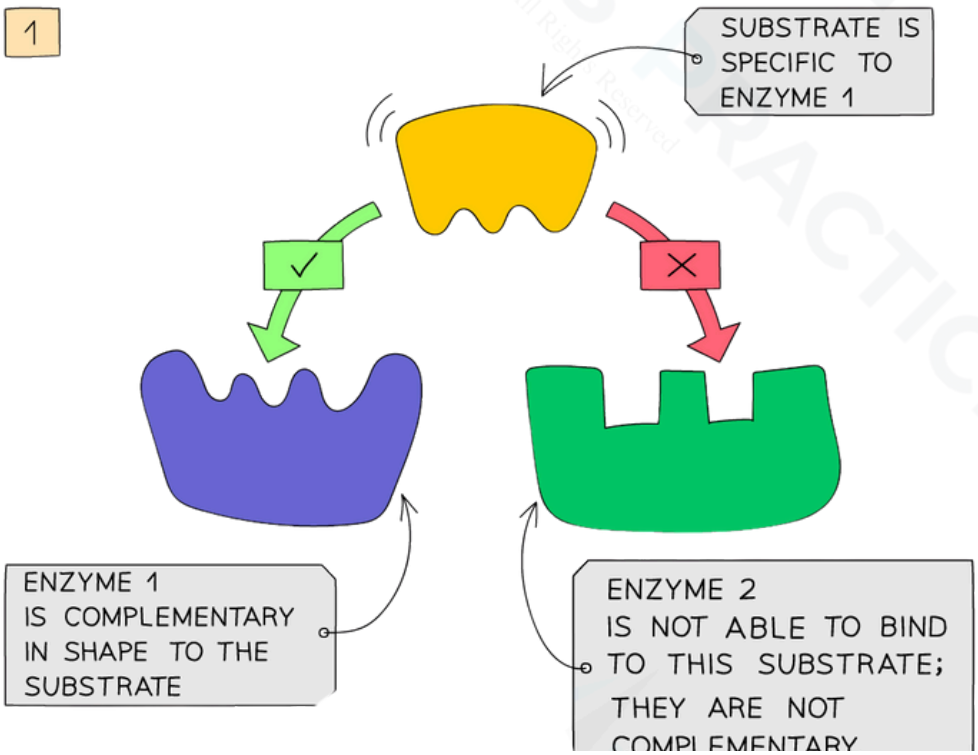
YOUR NOTES

En z ymes

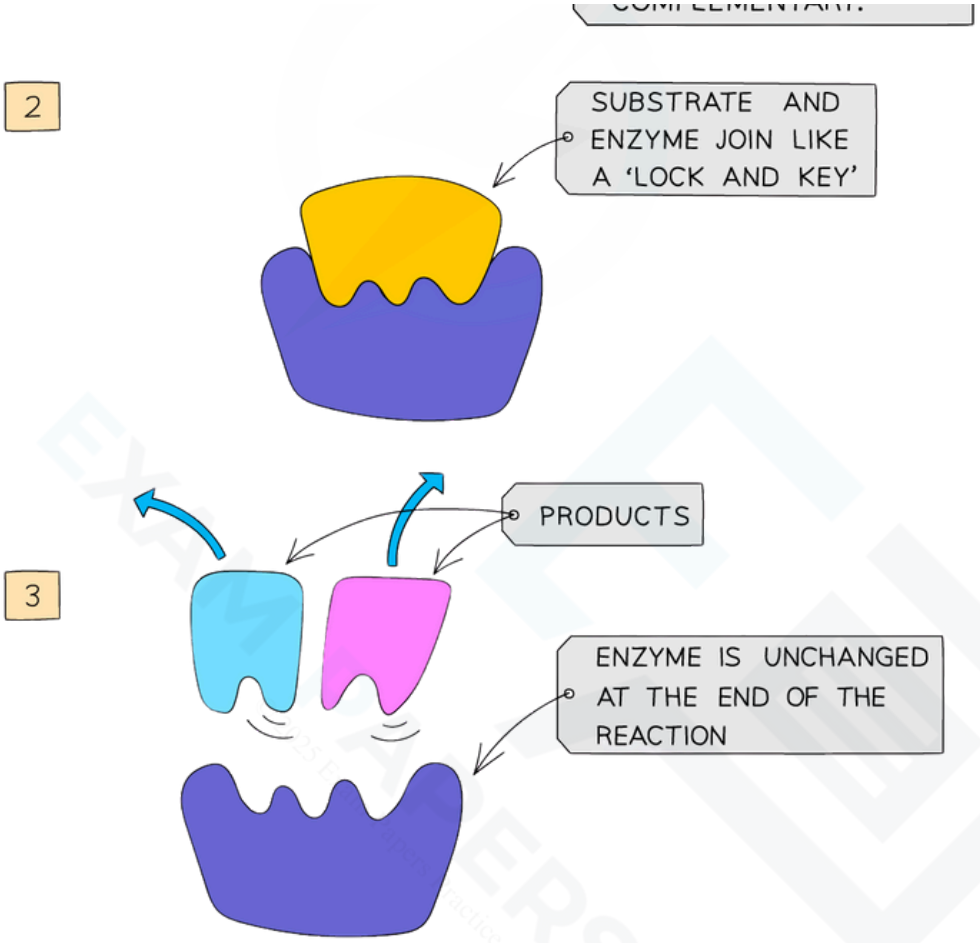
- Enzymes are proteins that act as biological catalysts to speed up the rate of a chemical reaction without being changed or used up in the reaction
- They are biological because they are made in living cells
- Enzymes are necessary to all living organisms as they allow all metabolic reactions to occur at a rate that can sustain life
    - For example, if we did not produce digestive enzymes, it would take around 2 - 3 weeks to digest one meal; with enzymes, it takes around 4 hours

The mechanism of enzyme action

- Enzymes are specific to one particular substrate(s) as the active site of the enzyme, where the substrate attaches, is a complementary shape to the substrate
- When the substrate moves into the enzyme's active site, the enzyme-substrate complex is formed
- After the reaction has occurred, the products leave the enzyme's active site, which is then free to take up another substrate
- The steps of an enzyme catalysed reaction are shown in the diagram below and can be summarised as follows:
    - Step One: Enzymes and substrates randomly move about in solution
    - Step Two: When an enzyme and its complementary substrate randomly collide, an enzyme-substrate complex forms and the reaction occurs
    - Step Three: A product (or products) forms (from the substrate) and is then released from the active site. The enzyme is unchanged and will go on to catalyse further rea ction s



YOUR NOTES



How enzymes work

Denaturation of enzymes

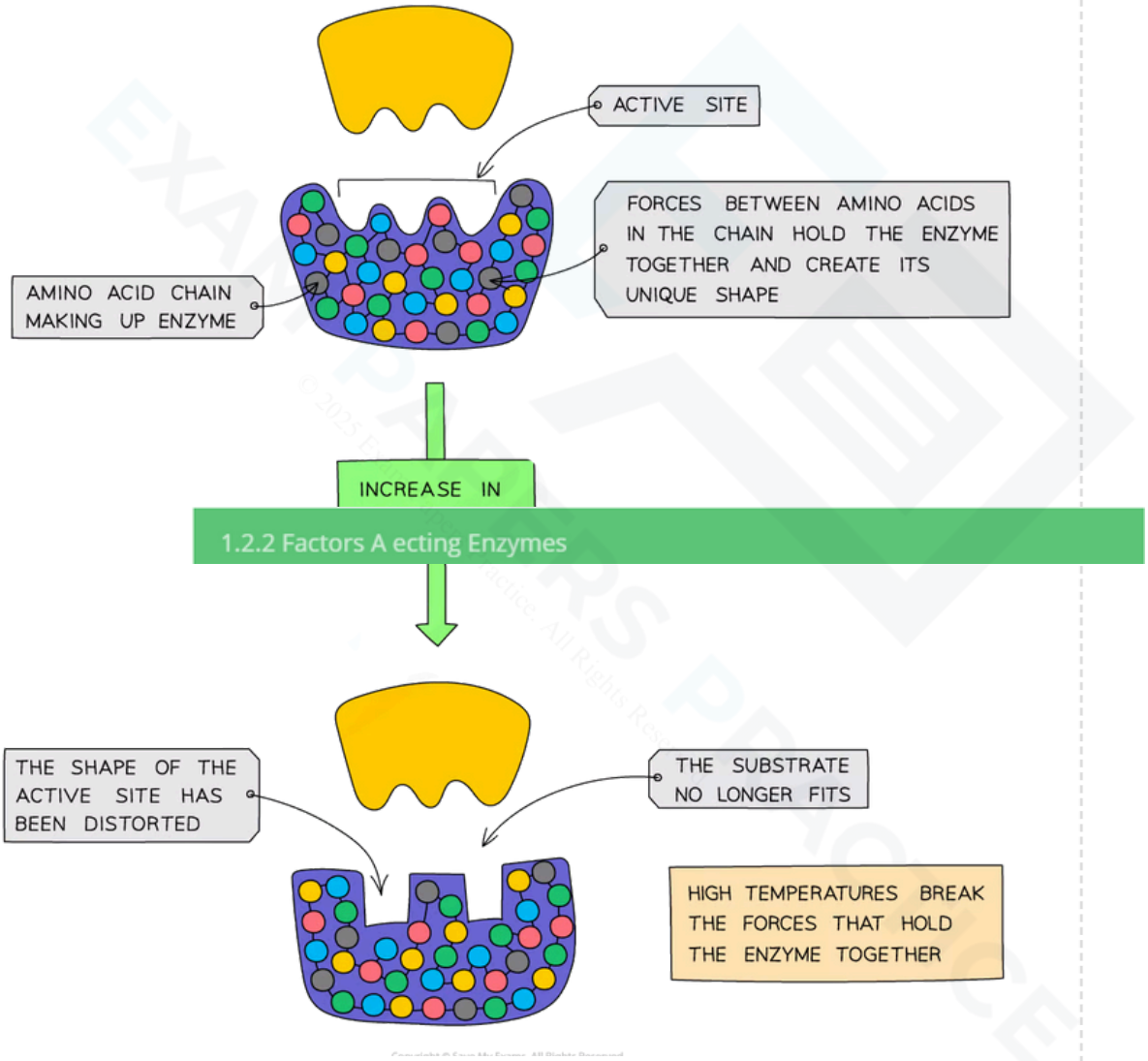
- Enzymes areproteinsand have a specific shape, held in place by bonds
- This is extremely important around the active site, as the specific shape of this area of the enzyme is what ensures the substrate will fit into the active site and enable the reaction to pr o c eed
- If the bonds that hold the enzyme together are disrupted or broken the active site it will lose its shape - this is known as denaturation
    - The enzyme is said to be denatured
    - Substrates cannot fit into denatured enzymes as the shape of their active site has been lost
    - Denaturation is irreversible – once enzymes are denatured they cannot regain their proper shape and the reaction they are catalysing will stop
    - Denaturation can occur due to high temperatures or extremes of pH

1.2.2 Factors A ecting Enzymes

Factors A ecting Enzyme Action: Temperature

YOUR NOTES

- Enzymes work fastest at their 'optimum temperature'
  - In the human body, this optimum temperature is about 37°C
- Heating to high temperatures (beyond the optimum) will break the bonds that hold the enzyme together and the active site will lose its shape
  - The enzyme has been denatured

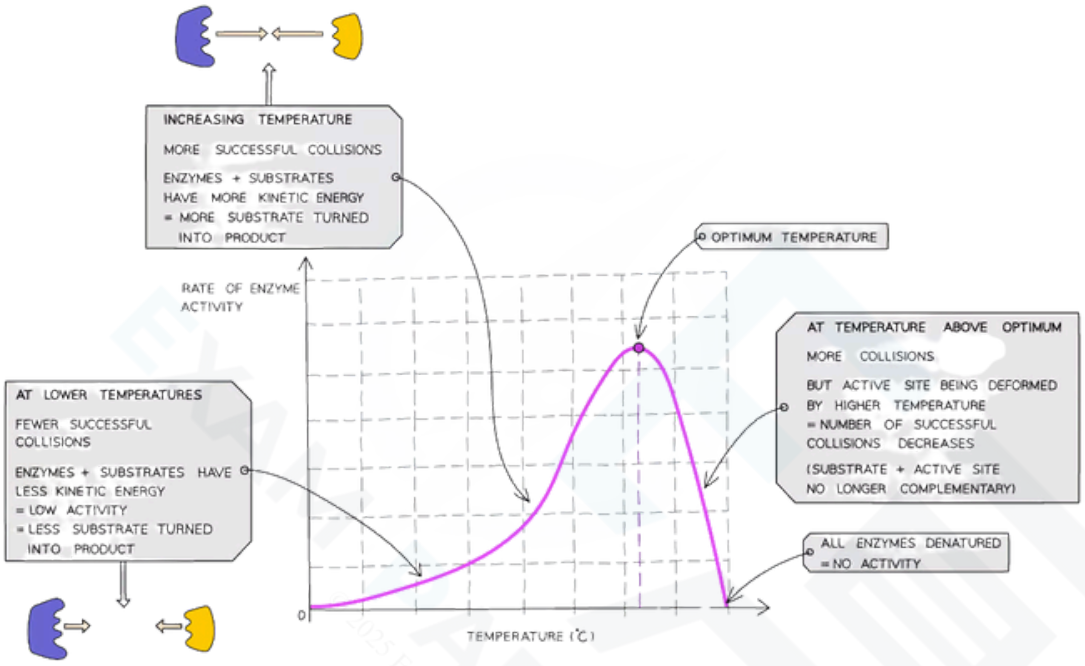


The e ect of temperature on enzyme activity

- As temperature increases (towards the optimum) the activity of enzymes increases
  - This is because the molecules have more kinetic energy, movefaster and have more successful collisions with the substrate molecules. This leads to a faster rate of reaction

- This means that low temperatures do not denature enzymes, they just make them work more slowly due to a lack of kinetic energy

YOUR NOTES



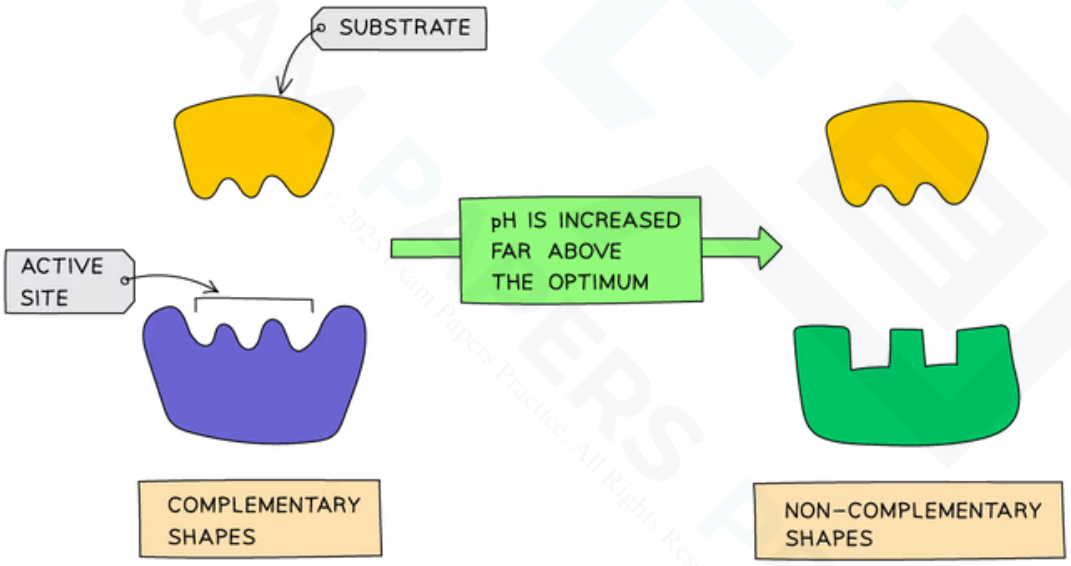
Graph showing the effect of temperature on the rate of enzyme activity

Factors A ecting Enzyme Action: pH

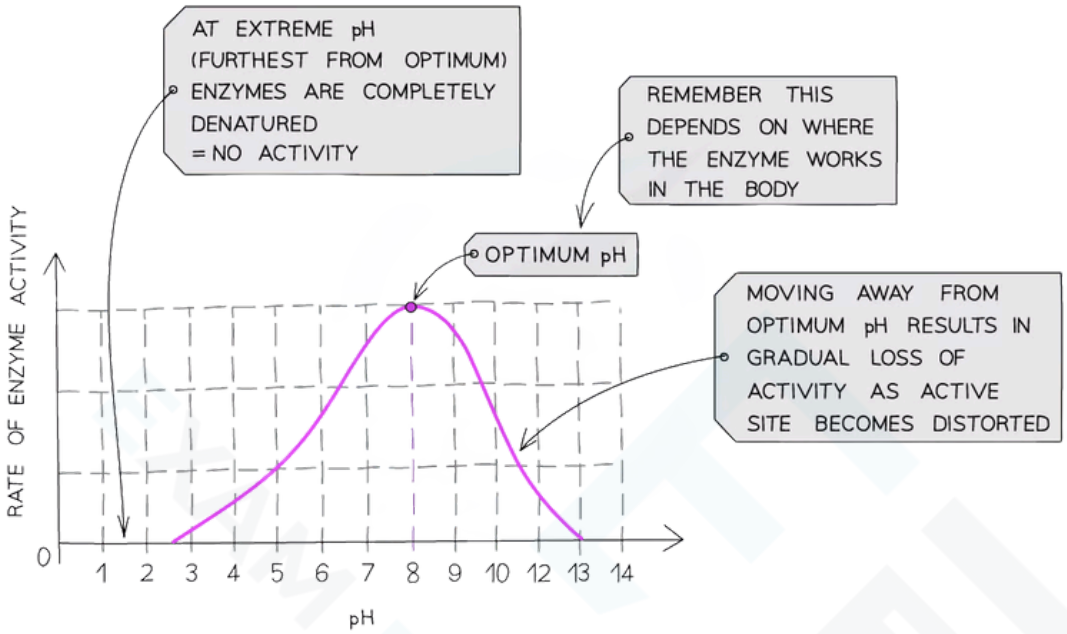
YOUR NOTES

- The optimum pH for most human enzymes is pH7
  - Some enzymes that are produced in acidic conditions, such as the stomach, have a lower optimum pH (pH 2)
  - Some that are produced in alkaline conditions, such as the duodenum, have a hi gher optimum pH (pH 8 or 9)

- If the pH is too far above or too far below the optimum, the bonds that hold the amino acid chain together to make up the protein can be disrupted or broken
- This will change the shape of the active site, so the substrate can no longer fit into it, reducing the rate of activity
- Moving too far away from the optimum pH will cause the enzyme to denaturand the reaction it is catalysing will stop



E ect of pH on enzyme activity



Graph showing the e ect of pH on the rate of activity for an enzyme from the duodenum

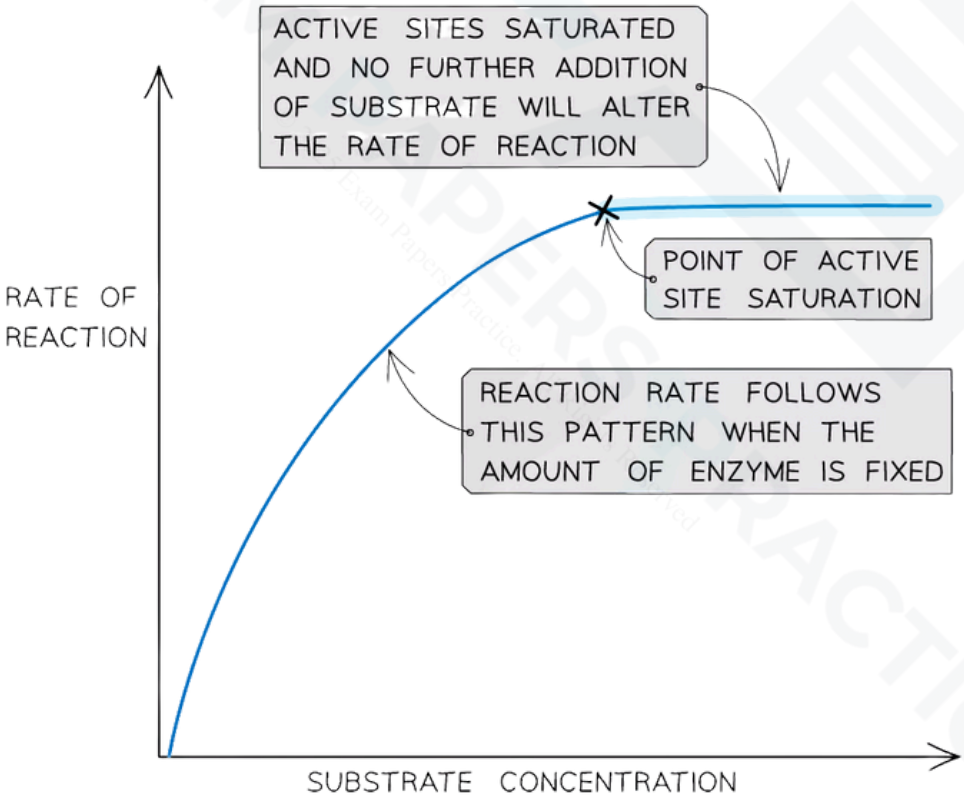
s

Factors A ecting Enzyme Action: Substrate Concentration

YOUR NOTES

- The greater the substrate concentration, the greater the enzyme activity and the higher the rate of reaction:
  - As the number of substrate molecules increases, the likelihood of enzyme-substrate complex formation increases
  - If the enzyme concentration remains fixed but the amount of substrate is increased past a certain point, however, all available active sites eventually become saturated and any further increase in substrate concentration will not increase the reaction rate
  - When the active sites of the enzymes are all full, any substrate molecules that are added have nowhere to bind in order to form an enzyme-substrate complex

- For this reason, in the graph below there is a linear increase in reaction rate as substrate is added, which then plateaus when all active sites become occupied
  - At this point (known as the saturation point), the substrate molecules are e ectively 'queuing up' for an active site to become available



The e ect of substrate concentration on the rate of an enzyme-catalysed reaction

Exam Tip

Remember the terminology when writing about enzymes is very important. Make sure you refer to an enzyme becoming 'denatured' not 'dying'.Being able to describe AND explain the e ect of each environmental condition on enzyme action is key.Practise describing and explaining using the graphs and then check your descriptions against your notes.

YOUR NOTES

Practical: Enzymes & pH

YOUR NOTES

- Amylase is an enzyme that digests starch (a polysaccharide of glucose)
- disaccharide of glucose)
- The e ect of di erent pH levels on the activity of amylase can be investigated

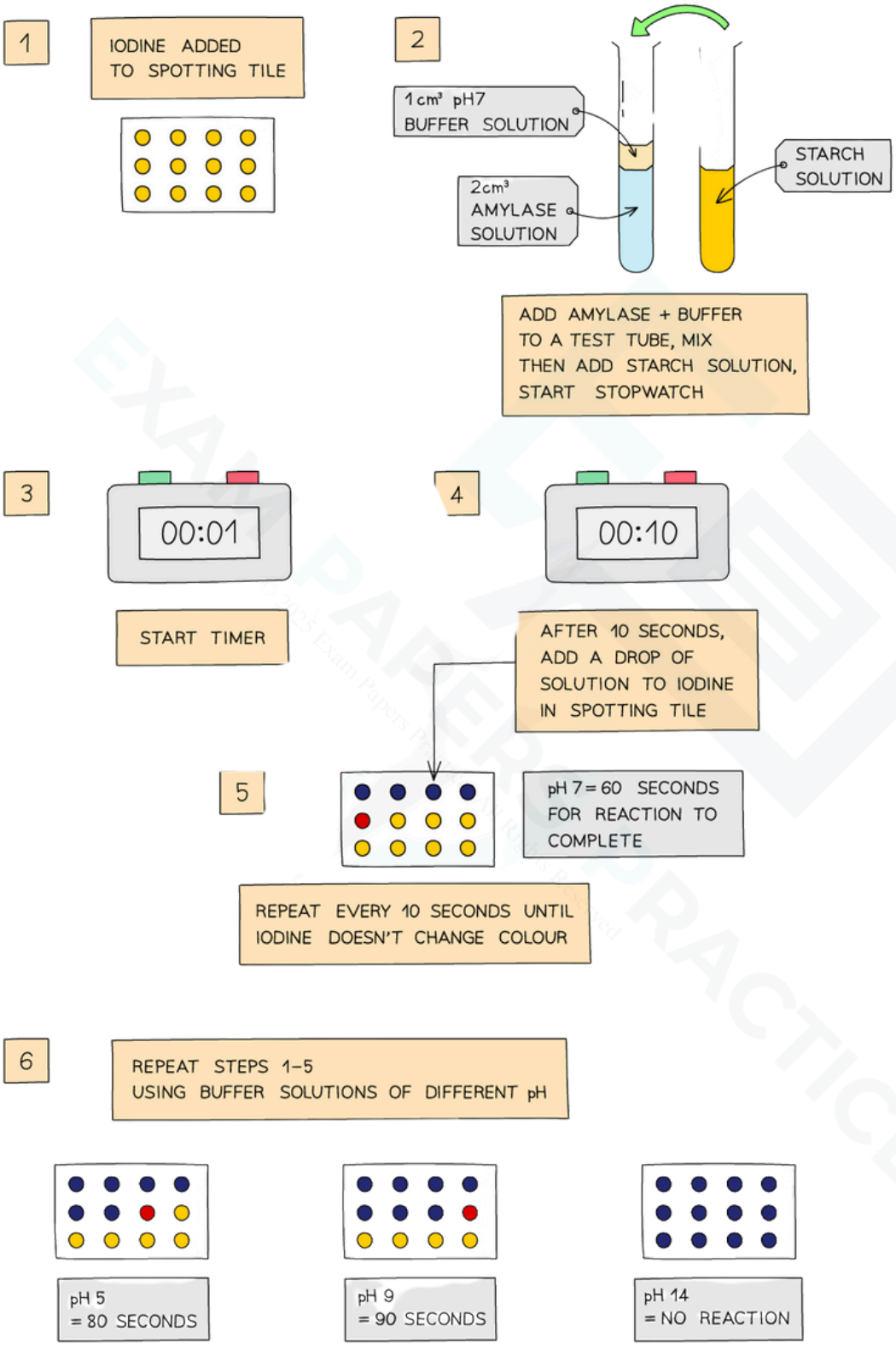
A p p aratu s

- Spotting tile
- Measuring cylinder
- Test Tube
- Syringe
- Pipette
- Stopw a tch
- Bu er solutions
- I odin e
- Starch solution
- Amylase solution

M eth od

- Add a drop of iodine to each of the wells of a spotting tile
- Use a syringe to place 2 cm3 of amylase into a test tube
- Add 1cm3 of bu er solution (at pH 2) to the test tube using a syringe
- Use another test tube to add 2 cm3 of starch solution to the amylase and bu er solution, start the stopwatch whilst mixing using a pipette
- Every 10 seconds, transfer a droplet of the solution to a new well of iodine solution (which should turn blue-black)
- Repeat this transfer process every 10 seconds until the iodine solution stops turning blue-black (this means the amylase has broken down all the starch)
- Record the time taken for the reaction to be completed
- Repeat the investigation with bu ers at di erent pH values (ranging from pH 3.0 to pH 7.0)

YOUR NOTES



Investigating the e ect of pH on enzyme activity

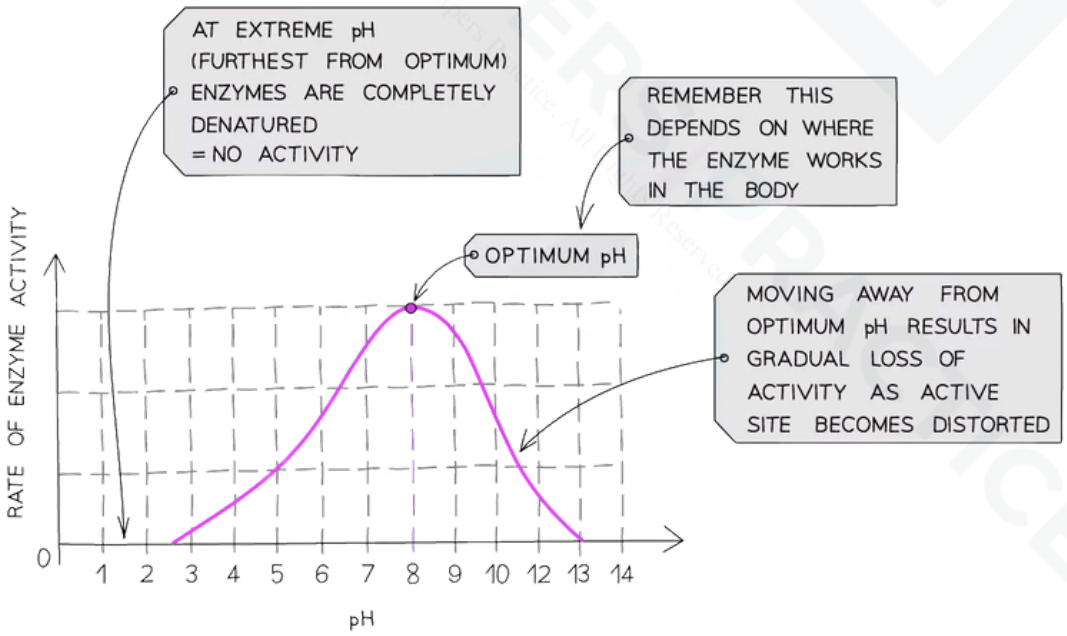
YOUR NOTES

Results and Analysis

- Amylase is an enzyme which breaks downstarch
- When the iodine solution remains orange-brown, all the starch has been digested
- This investigation shows:
  - At the optimum pH, the iodine stopped turning blue-black and remained orange-brown within the shortest amount of time
    - This is because the enzyme is working at its fastest rate and has digested all the s ta rch
- At higher or lower pH's (above or below the optimum) the iodine took a longer time to stop turning blue-black or continued to turn blue-black for the entire investigation
  - This is because on either side of the optimum pH, the enzymes are starting to become denatured and as a result are unable to bind with the starch or break it down

Li mi tati on s

- The starch and amylase solutions that need to be used should be placed in a water bath at optimum temperature before being used
- A colorimeter can be used to measure the progress of the reaction more accurately by measuring the absorbance/transmission of light through the coloured solution
  - A control of iodine solution would be used for comparison

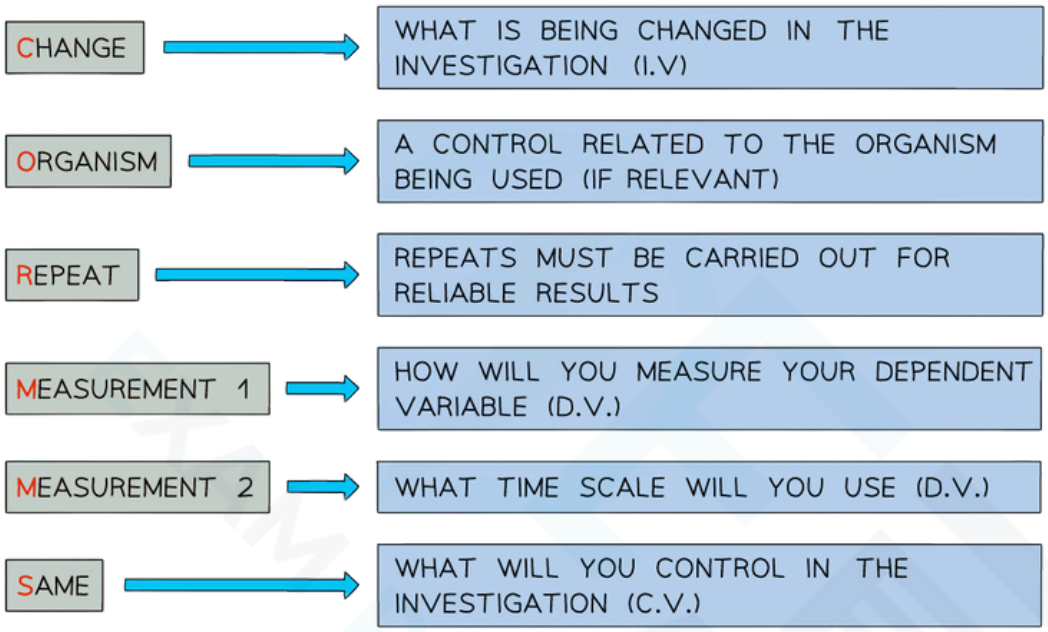


A graph showing the optimum pH for an enzyme from a region of the small intestine

Applying CORMS to practical work

YOUR NOTES

- When working with practical investigations, remember to consider your CORMS evaluation



CORMS Evaluation

- In this investigation, your evaluation should look something like this:
  - C - We are changing the pH of the environment
  - O - This is not relevant to this investigation as we aren't using an organism
  - R - We will repeat the investigation several times to ensure reliability
  - M1 - We will measure the time taken for
  - M2 - the iodine to stop turning black
  - S - We will control the concentration and volume of the amylase, iodine and starch solution used in the investigation

Exam Tip

When describing the e ect of pH on enzyme activity, it is important to remember that any pH outside of the optimum can lead to the enzyme becoming permanently den a tu red.

YOUR NOTES

Rate Calculations for Enzyme Activity

- Rate calculations are important in determining how fast an enzyme is working (i.e. the rate of reaction)
- To perform a rate calculation, use the following formula:

Rate = Change ÷ Time

- 'Change' refers to the change in the substance being measured
  - This could be the amount of substrate used up in the reaction or the amount of product formed
- 'Time' refers to the time taken for that change to occur
- Another way to view the equation is as follows:

Rate = Amount of substrate used or product formed ÷ Time

Worked Example

Amylase catalyses the breakdown of starch into maltose. 15 grams of starch were added to a solution containing amylase. It took 2 hours for all the starch to be broken down. Calculate the rate of reaction.

Step One: Write out the equation for calculating the rate of enzyme activity

Rate = Change ÷ Time

(In this case, Rate = Amount of substrate used ÷ Time)

Step Two: Substitute in the known values and calculate the rate

Rate = 15 g ÷ 2 hours

Rate = 7.5 g / hr or 7.5 g hr^{-1}

- In the example above, the 'change' was the amount of substrate (starch) that is used up in the reaction
- In the example below, the 'change' is the amount of product that is formed in the reaction

Worked Example

The enzyme catalase catalyses the breakdown of hydrogen peroxide into water and oxygen. In one experiment, a student found that 45 cm^3 of oxygen was released in 5 minutes. Calculate the rate of reaction.

Step One: Write out the equation for calculating the rate of enzyme activity

Rate = Change ÷ Time

(In this case, Rate = Amount of product formed ÷ Time)

Step Two: Substitute in the known values and calculate the rate

Rate = 45 cm^3 ÷ 5 minutes

Rate = 9 cm^3 / min or 9 cm^3 min^{-1}

- Alternatively, you may not be told how much something has changed during a reaction (i.e. how much of a substrate has been used up or how much of a product has been formed)
- Instead, you may only be told the time taken for the reaction to occur
- In this case, you can still calculate the rate of reaction by using the following (slightly di erent) formula:

Rate = 1 ÷ Time

Worked Example

A student adds a set volume of starch solution to a set volume of amylase solution at a range of di erent pH values. At each pH, the student times how long it takes for the amylase to break down all of the starch. At pH 6 the time taken for amylase to break down all of the starch was 50 seconds. Calculate the rate of reaction at pH 6.

Step One: Write out the equation for calculating the rate of enzyme activity

Rate = 1 ÷ Time

Step Two: Substitute in the known values and calculate the rate

Rate = 1 ÷ 50 seconds

Rate = 0.02 s^{-1}

Exam Tip

The units for the calculation above are in s^{-1} because rate is given per unit time. In an exam, you could be asked to plot the reaction rates (from an enzyme catalysed reaction) on a graph. However, using the equation 'Rate = 1 ÷ Time' often gives small numbers that are di cult to plot on a graph. In these cases, you can also use the equ a tion :
Rate = 1000 ÷ Time

This equation give you bigger numbers that are easier to plot on a graph. So, for the calculation in the worked example above, you would get:Rate = 1000 ÷ 50 secondsRate = 20 s^{-1}

YOUR NOTES

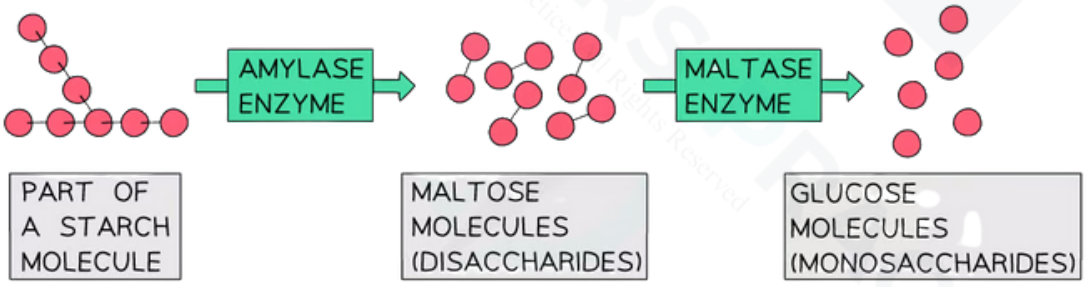
YOUR NOTES

Enzymes as Biological Catalysts

- The purpose of digestion is to break down large, insoluble molecules into smaller, soluble molecules that can be absorbed into the bloodstream
- Food is partially digested mechanically (by chewing, churning and emulsification) in order to break large pieces of food into smaller pieces of food
  - This increases the surface area for enzymes to work on
- Digestion mainly takes place chemically, where bonds holding the large molecules together are broken to make smaller and smaller molecules
- Chemical digestion is controlled by enzymes that are produced in different areas of the digestive system
- Enzymes are biological catalysts – they speed up chemical reactions without themselves being used up or changed in the reaction
- There are three main types of digestive enzymes: carbohydrases, proteases and lipases

Carbohydrases

- Carbohydrases are enzymes that break down carbohydrates into simple sugars such as glucose
  - Amylase is a carbohydrase that is made in the salivary glands, the pancreas and the small intestine
  - Amylase breaks down starch into maltose
  - Maltase then breaks down maltose into glucose

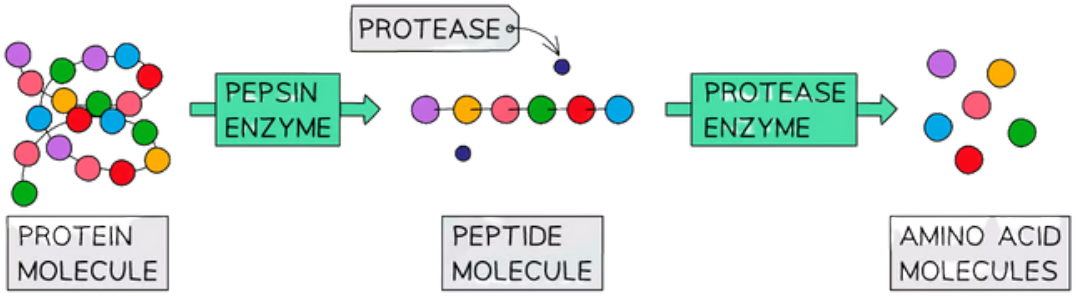


Starch is broken down into glucose using two enzymes: amylase and maltase

Proteases

- Proteases are a group of enzymes that break down proteins into amino acids
  - Pepsin is an enzyme made in the stomach that breaks down proteins into smaller polypeptide chains
  - Proteases are made in the pancreas and small intestine that break the polypeptides into amino acids

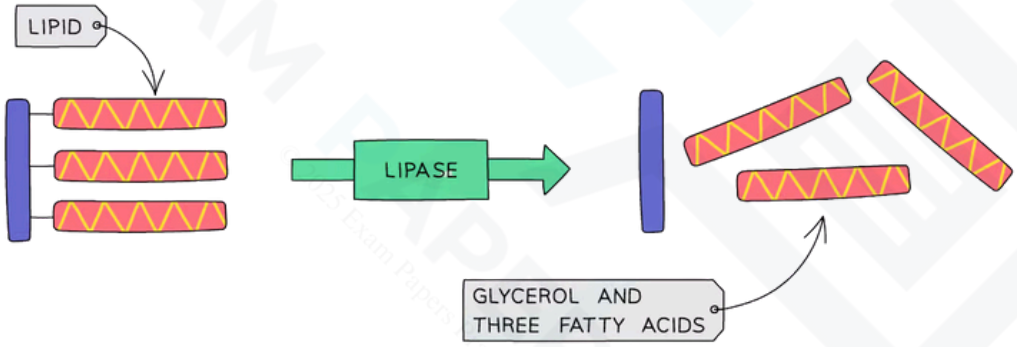
YOUR NOTES



Proteins are broken down using pepsin and other proteases

Lipases

- Lipases are enzymes that break down lipids (fats) to glycerol and fatty acids
  - Lipase enzymes are produced in the pancreas and secreted into the small intestine



Lipids are broken down by lipase enzymes

Synthesis of carbohydrates, proteins and lipids

- Enzymes are not just important in breaking down larger molecules into smaller ones
- They are also required for the synthesis of larger molecules (building small molecules back up into bigger ones)
- Enzymes are required by organisms to synthesise carbohydrates, proteins and lipids
  - Carbohydrates are synthesised by joining simple sugars together
    - For example, glycogen synthase is an enzyme that joins together many chains of glucose molecules to form glycogen (an energy-storage molecule in animals)
  - Proteins are synthesised by joining amino acids together
    - Again, enzymes catalyse the reactions required to do this
  - Many enzymes are involved in the synthesis of lipids from fatty acids and glycerol

YOUR NOTES

Exam Tip

The pancreas is an accessory organ in the digestive system. Food does not pass directly through it, but it has a key role in producing digestive enzymes, as well as the hormones that regulate blood sugar (insulin and glucagon).

YOUR NOTES

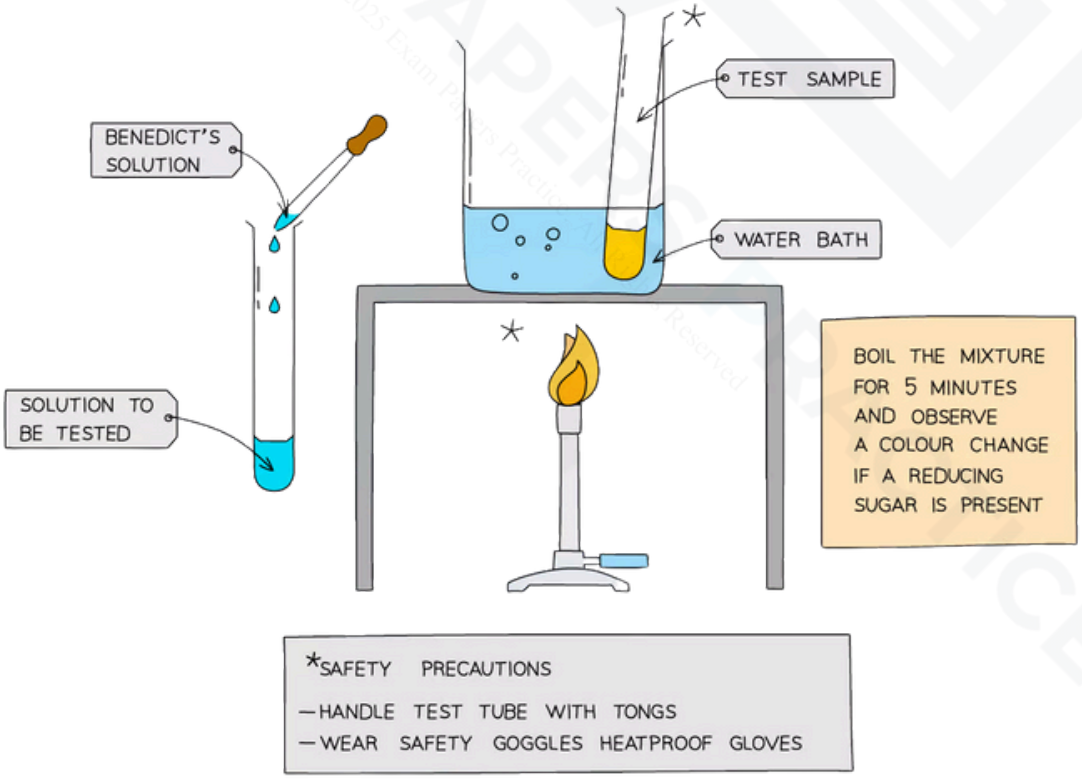
Practical: Food Tests

Preparing a sample

- Before you can carry out any of the food tests described below, you may need to prepare a food sample first (especially for solid foods to be tested)
- To do this:
  - Break up the food using a pestle and mortar
  - Transfer to a test tube and add distilled water
  - Mix the food with the water by stirring with a glass rod
  - Filter the mixture using a funnel and filter paper, collecting the solution
  - Proceed with the food tests

Test for glucose (a reducing sugar)

- Add Benedict's solution to the sample solution in a test tube
- Heat in a boiling water bath for 5 minutes
- Take the test tube out of the water bath and observe the colour
- A positive test will show a colour change from blue to orange / brick red

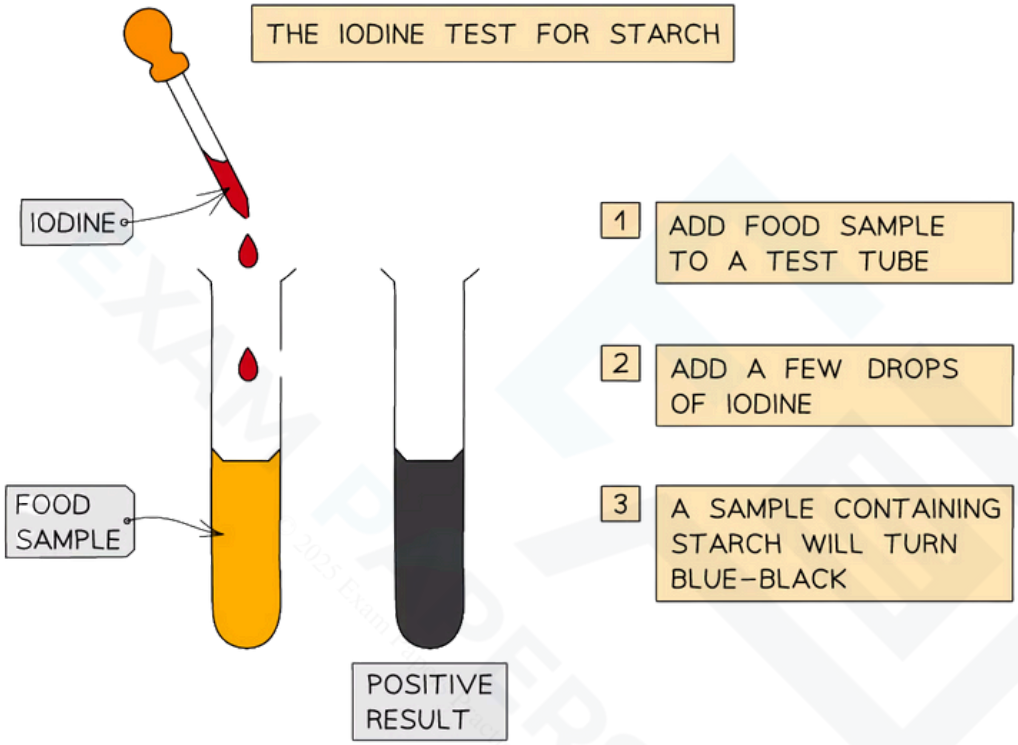


The Benedict's test for glucose

Test for starch using iodine

YOUR NOTES

- We can use iodine to test for the presence or absence of starch in a food sample
- Add drops of iodine solution to the food sample
- A positive test will show a colour change from orange-brown to blue-black

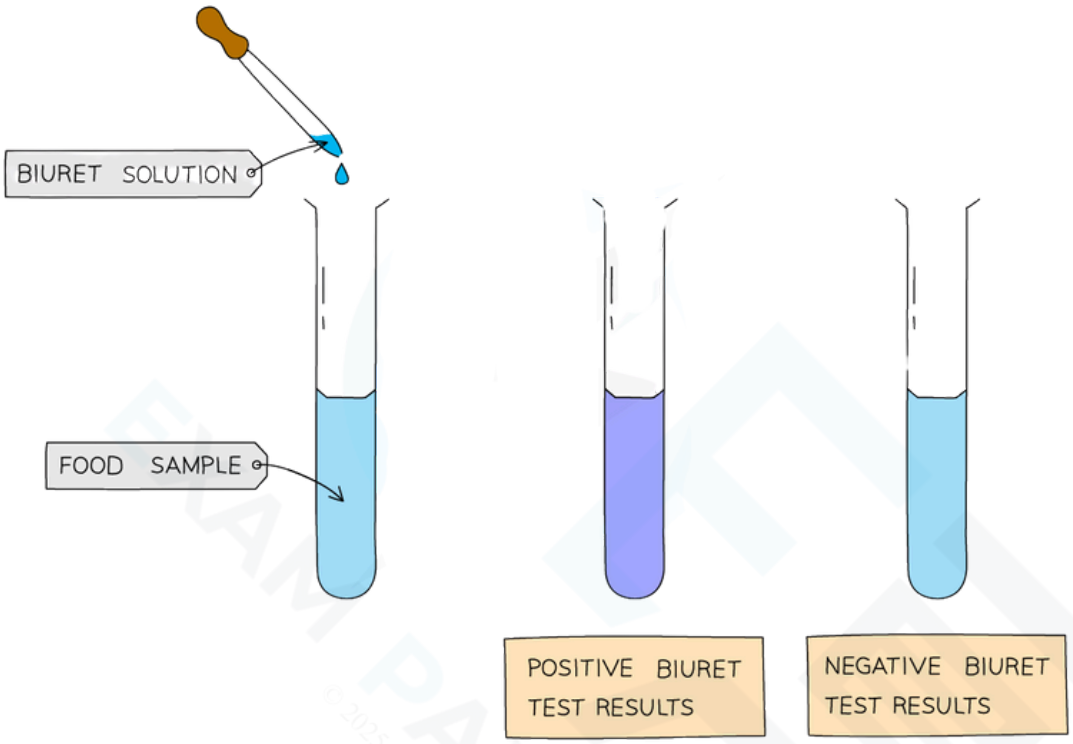


In the presence of starch, iodine will turn from brown to blue-black

Test for protein

- Add drops of Biuret solution to the food sample
- A positive test will show a colour change from blue to violet / purple

YOUR NOTES

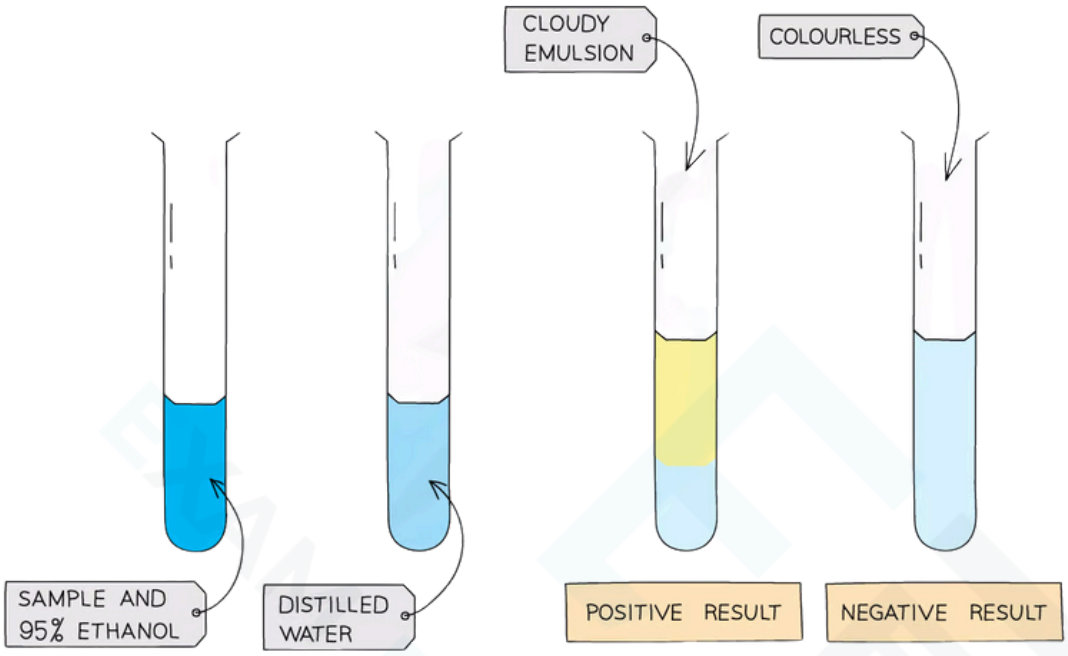


Your paragraph text

The Biuret test for protein

Test for lipids

- Mix the food sample with 4cm3 of ethanol and shake
- Allow time for the sample to dissolve in the ethanol
- Strain the ethanol solution into another test tube
- Add the ethanol solution to an equal volume of cold distilled water (4cm3)
- A positive test will show a cloudy emulsion forming



The ethanol test for lipids

Food Test Results Table

Food Test	Colour of reagent	Positive test result	Negative test result
Iodine for starch	orange–brown	blue–black	orange–brown (no change)
Benedict's for sugar	light blue	green to brick–red	light blue (no change)
Ethanol for lipid	colourless	cloudy emulsion	colourless (no change)
Biuret for protein	blue	lilac–purple	blue (no change)

Important hazards

- Whilst carrying out this practical you should try to identify the main hazards and be thinking of ways to reduce harm
- Biuret solution contains copper (II) sulfate which is dangerous particularly if it gets in the eyes, so always wear goggles

- Iodine is also an irritant to the eyes
- Sodium hydroxide in biuret solution is corrosive, if any chemicals get onto your skin wash your hands immediately
- Ethanol is highly flammable; keep it away from any Bunsen burner
- The Bunsen burner itself is a hazard due to the open flame

YOUR NOTES

Worked Example

Food tests: analysis

Name of food tested	Colour produced with Benedict's solution	Colour produced with iodine solution	Cloudy layer produced with ethanol	Colour produced with Biuret solution
Potato	Blue	Black	✗	Blue
Olive oil	Blue	Orange	✓	Blue
Egg yolk	Blue	Orange	✓	Purple
Apple	Orange	Dark blue	✗	Blue
Tofu	Blue	Orange	✗	Purple
Biscuit	Yellow	Orange	✓	Blue

Write a conclusion to state which food groups are present one of the food samples you tested and an explanation of how you know this.

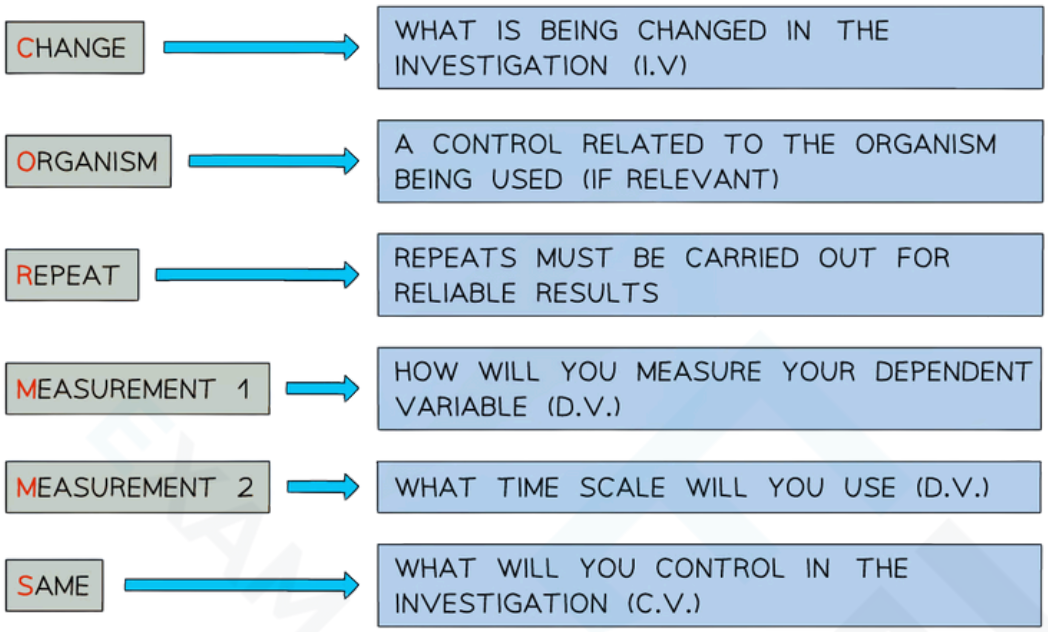
Conclusion:

The apple contained both starch and sugar as it tested positive for both the iodine test (orange → blue - black) and the benedict's test (blue → orange).

The apple did not contain protein or lipid (fat) as the biuret and emulsion tests were both n ega tiv e.

Applying CORMS to practical work

- When working with practical investigations, remember to consider your CORMS ev a lu a tion .



CORMS evaluation

- In this investigation, your evaluation should look something like this:
  - C - We are changing the type of food in the sample
  - O - This is not relevant to this investigation as we aren't using an organism
  - R - We will repeat the investigation several times for each food sample to ensure a reliable result
  - M1 - The presence of the specific biological molecule in each food type by noting the colour change
  - M2 - ....after testing with each specific testing agent
  - S - We will control the volume of each testing agent used, the quantity of the food sample, the concentration of the testing agents, the temperature of the water bath for the Benedicts test. There may be other examples that you can think of

Exam Tip

When describing food tests in exam answers, make sure you give the starting colour of the solution and the colour it changes to for a positive result.

YOUR NOTES

YOUR NOTES

Practical: Energy Content of a Food Sample

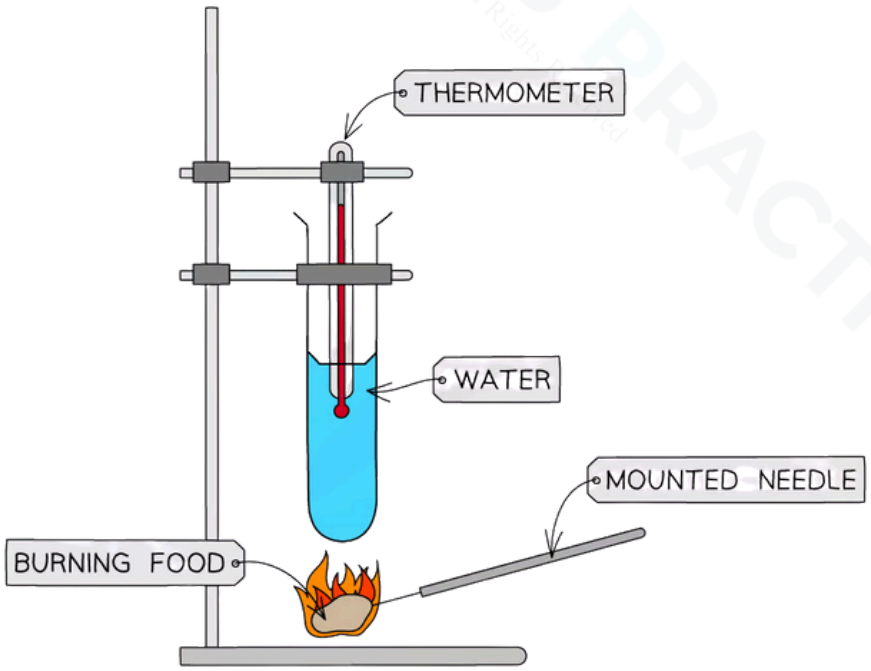
We can investigate the energy content of food in a simple calorimetry experiment

A p p aratu s

- Boiling tube
- Boiling tube holder
- Bunsen burner
- Mounted needle
- Measuring cylinder
- B a la n ce/s ca les
- T h ermometer
- Water
- Food samples

M eth od

- Use the measuring cylinder to measure out 25cm3 of water and pour it into the boiling tube
- Record the starting temperature of the water using the thermometer
- Weigh the initial mass of the food sample
- Set fire to the sample of food using the bunsen burner and hold the sample 2cm from the boiling tube until it has completely burned
- Record the final temperature of the water
- (Once cooled) weigh the mass of any remaining food and record
- Repeat the process with di erent food samples
    - e.g. popcorn, nuts, crisps



Di erent food samples can be burned in a simple calorimetry experiment to compare the energy contents of the samples

YOUR NOTES

Results

- A larger increase in water temperature indicates a larger amount of energy contained by the sample
- We can calculate the energy in each food sample using the following equation:

Energy transferred (J) =

(mass of water (g) x 4.2 x temperature increase (°C)) ÷ (mass of food (g))

The Energy Content of Popcorn and Walnuts Table

Food type	Initial Mass (g)	Final Mass (g)	Change in mass (g)	Initial temperature of water (°C)	Final temperature of water (°C)	Change in temperature (°C)	Energy transferred (J)
Popcorn	8.5	2.4	6.1	20.5	31.2	10.7	184.2 j/g
Walnut	8.1	2.9	5.2	20.4	34.1	13.7	276.6 j/g

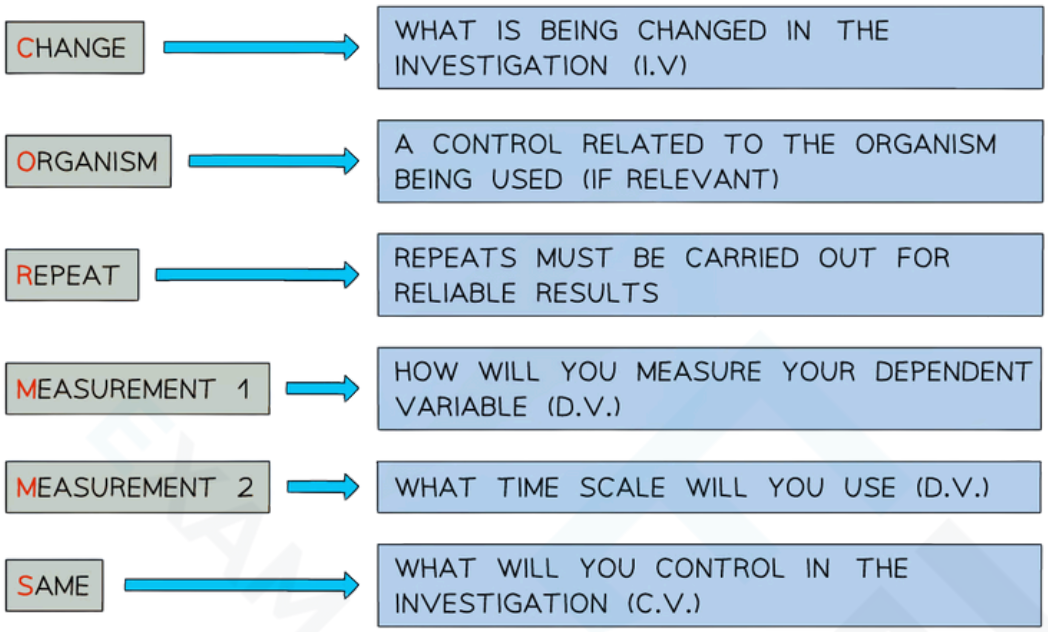
Li mi tati on s

- Incomplete burningof the food sample
  - Solution: Relight the food sample until it no longer lights up
- Heat energy is lostto the surroundings
  - Solution: Whilst heat lost means that the energy calculation is not very accurate, so long as the procedure is carried out in exactly the same way each time (with the same distance between food sample and boiling tube), we can still compare the results

Applying CORMS evaluation to practical work

- When working with practical investigations, remember to consider your CORMS evaluation

YOUR NOTES



Experimental design considerations: CORMS

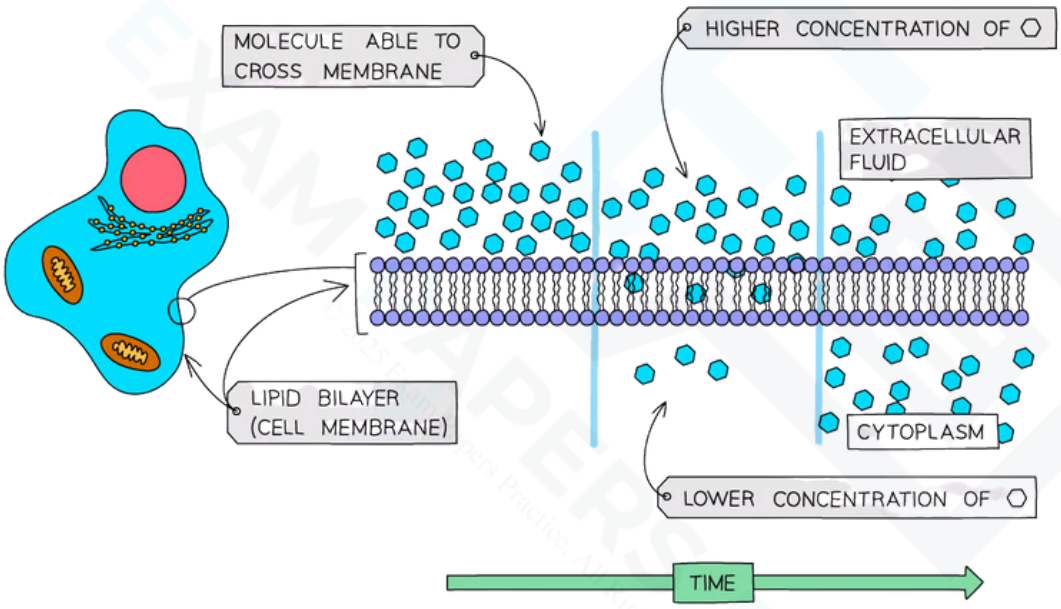
- In this investigation, your evaluation should look something like this:
  - Change - We are changing the type of food in the sample
  - Organisms - This is not relevant to this investigation as we aren't using an organism
  - Repeat - We will repeat the investigation several times for each food sample
  - Measurement 1 - We will measure the change in temperature of the water
  - Measurement 2 - The mass of the food will be measured after the food sample has burned out
  - Same - We will control the volume of water used, the distance between the food sample and the boiling tube during burning, the food will also be relit every time it goes out until it no longer lights

1.3 Movement of Substances Into & Out of Cells

1.3.1 Di usion

Di usion Theory

- Di usion is the movement of molecules from a region of its higher concentration to a region of its lower concentration
- Molecules move down a concentration gradient, as a result of their random movement



Di usion across the cell membrane

Di usion in living organisms

- For living cells, the principle of the movement down a concentration gradient is the same, but the cell is surrounded by a cell membrane, which can restrict the free movement of the molecules
- The cell membrane is a partially permeable membrane - this means it allows some molecules to cross easily, but others with di culty or not at all
  - The simplest sort of selection is based on the size of the molecules (i.e. smaller molecules can di use across the membrane but larger molecules cannot)
- Di usion helps living organisms to:
  - Obtain many of their requirements
  - Get rid of many of their waste products
  - Carry out gas exchange for respiration

Examples of di usion in living organisms

YOUR NOTES

- You will need to learn examples of substances that organisms obtain by di usion

SITE	MOLECULES MOVING	FROM	TO
SMALL INTESTINE	DIGESTED FOOD PRODUCTS – GLUCOSE, AMINO ACIDS, FATTY ACIDS AND GLYCEROL ETC.	LUMEN OF SMALL INTESTINE	BLOOD / LYMPH IN VILLI FOUND COVERING SMALL INTESTINE WALLS
LEAF	OXYGEN	AIR SPACES BETWEEN MESOPHYLL CELLS	MITOCHONDRIA IN ALL CELLS
LEAF	CARBON DIOXIDE	AIR SPACES BETWEEN MESOPHYLL CELLS	CHLOROPLASTS IN MESOPHYLL CELLS
LEAF	WATER VAPOUR	STOMATAL PORES	AIR OUTSIDE STOMATA
LUNGS	OXYGEN	ALVEOLAR AIR SPACE	BLOOD IN CAPILLARIES AROUND ALVEOLI
LUNGS	CARBON DIOXIDE	BLOOD IN CAPILLARIES AROUND ALVEOLI	ALVEOLAR AIR SPACE

Exam Tip

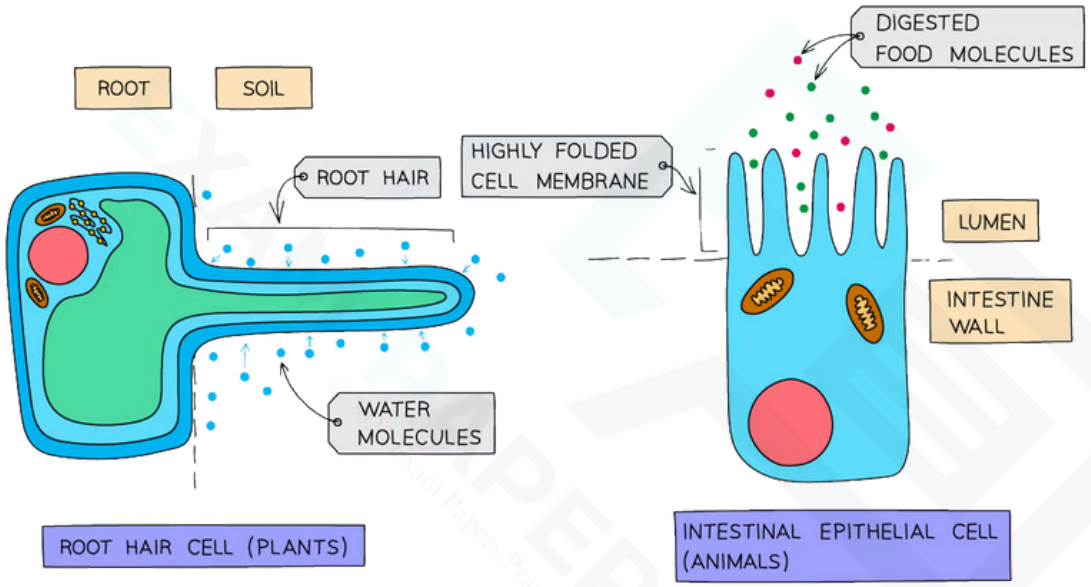
Remember that di usion is a passive process, so when it occurs in a living organism, the cells of that organism do not provide the particles involved with energy to di use. The particles that are moving about randomly have their own kinetic energy.

YOUR NOTES

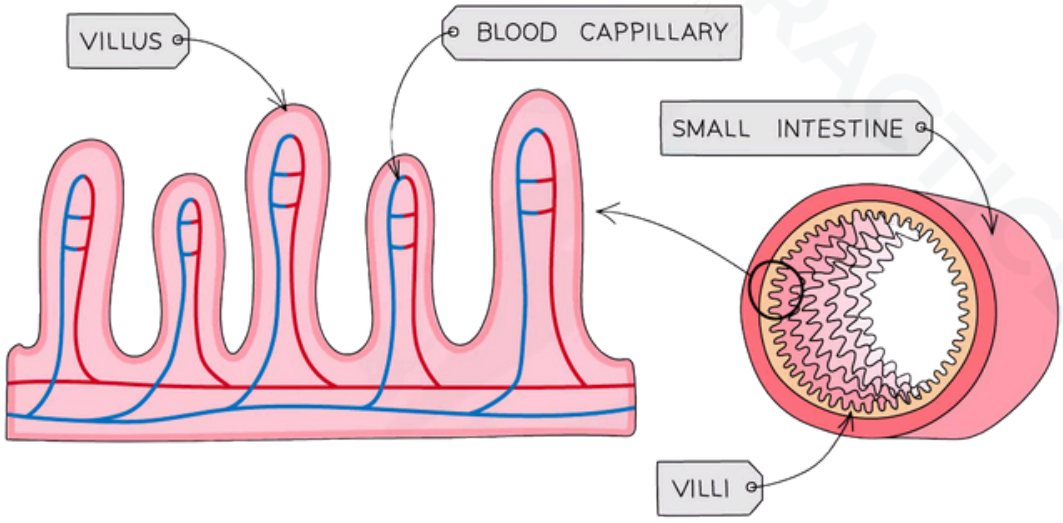
YOUR NOTES

Surface area to volume ratio

- The bigger a cell or structure is, the smaller its surface area to volume ratio is, slowing down the rate at which substances can move across its surface
- Many cells which are adapted for di usion have increased surface area in some way - e.g. root hair cells in plants (which absorb water and mineral ions) and cells lining the ileum in animals (which absorb the products of digestion)



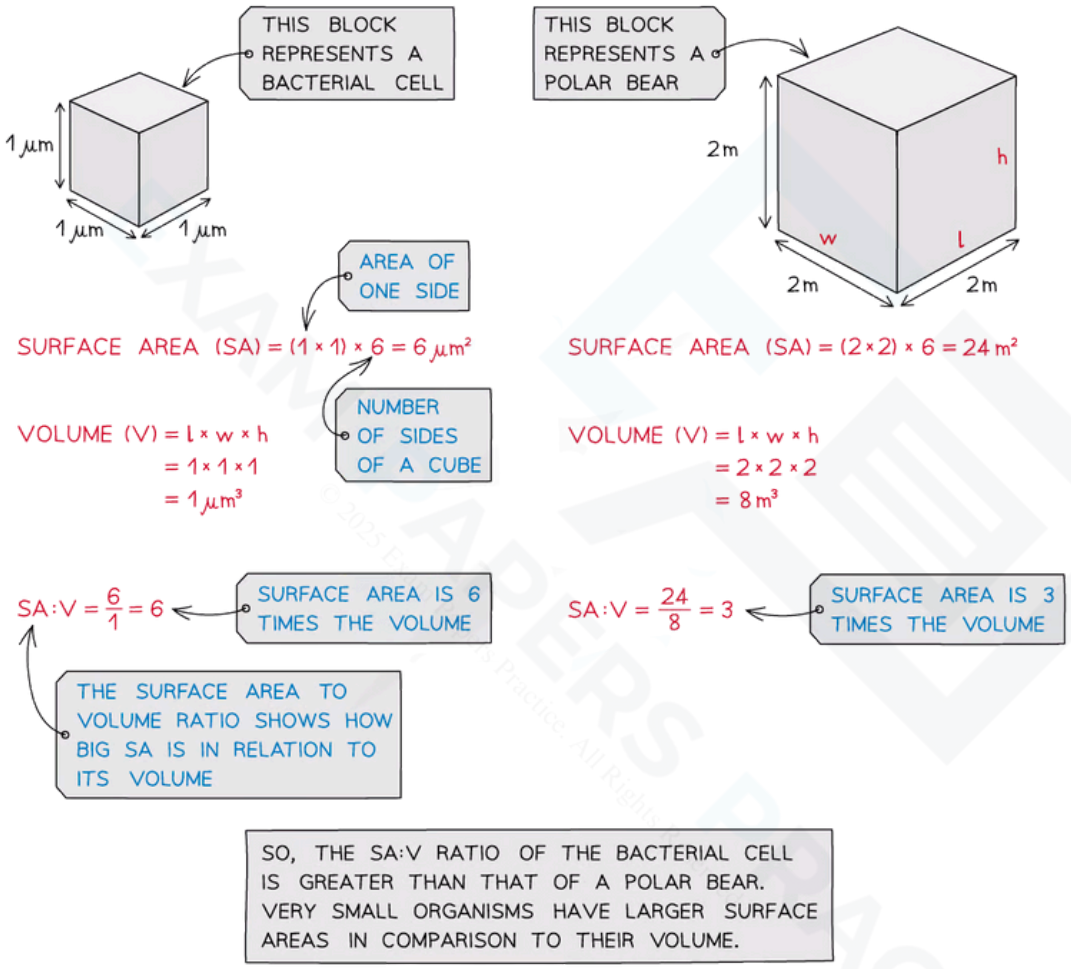
Cell adaptations for di usion



YOUR NOTES

The highly folded surface of the small intestine increases its surface area

- You should be able to calculate and compare surface area to volume ratios
- You can model the e ect of how increasing size a ects surface area to volume ratio using simple cubes:



Calculating the surface area to volume ratio

Di usion distance

- The smaller the distance molecules have to travel the faster transport will occur
- This is why blood capillaries and alveoli have walls which are only one cell thick, ensure the rate of di usion across them is as fast as possible

Temperature

- The higher the temperature, the faster molecules move as they have more energy
- This results in more collisions against the cell membrane and therefore a faster rate of movement across them

Concentration gradient

- The greater the di erence in concentration on either side of the membrane, the faster movement across it will occur
- This is because on the side with the higher concentration, more random collisions against the membrane will occur

YOUR NOTES

Summary of Di usion Factors Table

Factor	How it affects diffusion
Difference in concentrations (concentration gradient)	The greater the difference in concentration between two regions, the faster the overall rate of diffusion.
Temperature	The higher the temperature, the more kinetic (movement) energy the particles of that substance will have. They will move / spread faster compared to when at a lower temperature when they have less kinetic energy
Surface area of a membrane separating two regions	A membrane with a greater surface area will have a greater rate of diffusion across it (think of there being more 'entry or exit points' for particles to cross).

Exam Tip

You should have carried out investigations into the factors that influence the rate of di usion and as so should be able to use the information above to explain experimental results in an exam. You should also be able to plan and carry out an experiment which can investigate the e ect of one of these factors.

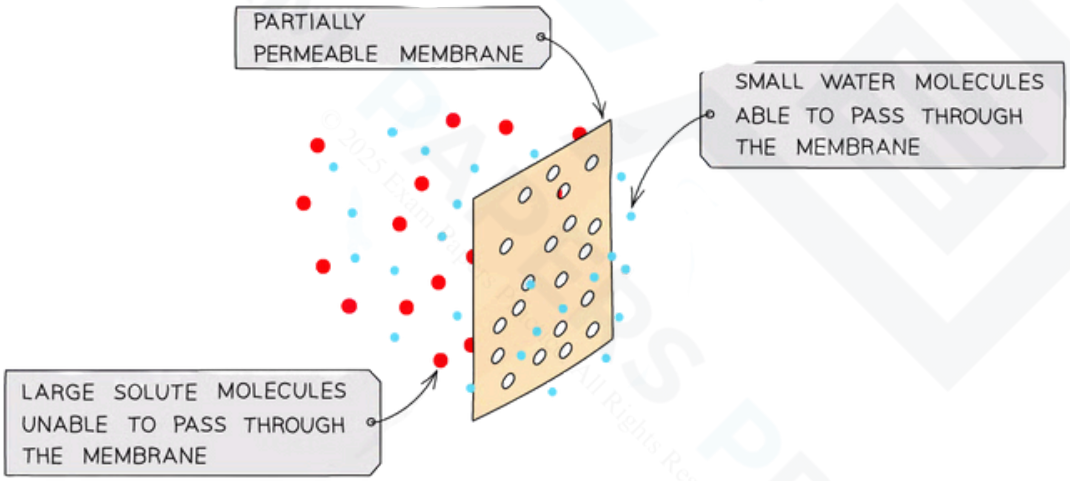
YOUR NOTES

Osmosis Theory

- Osmosis is:

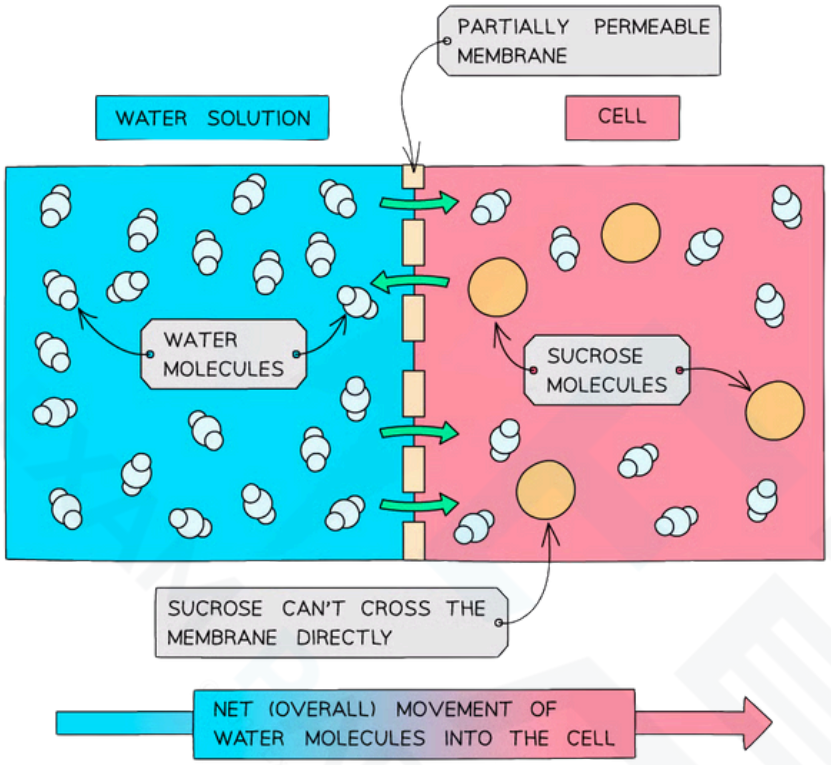
The net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution) through a partially permeable membrane

- Like, di usion, osmosis is a form of passive transport (does not require energy) but it only applies to water
- The cell membrane is partially permeable which means it allows small molecules (like water) through but not larger molecules (like solute molecules)
- Water can move in and out of cells by osmosis
- It will move down its concentration gradient



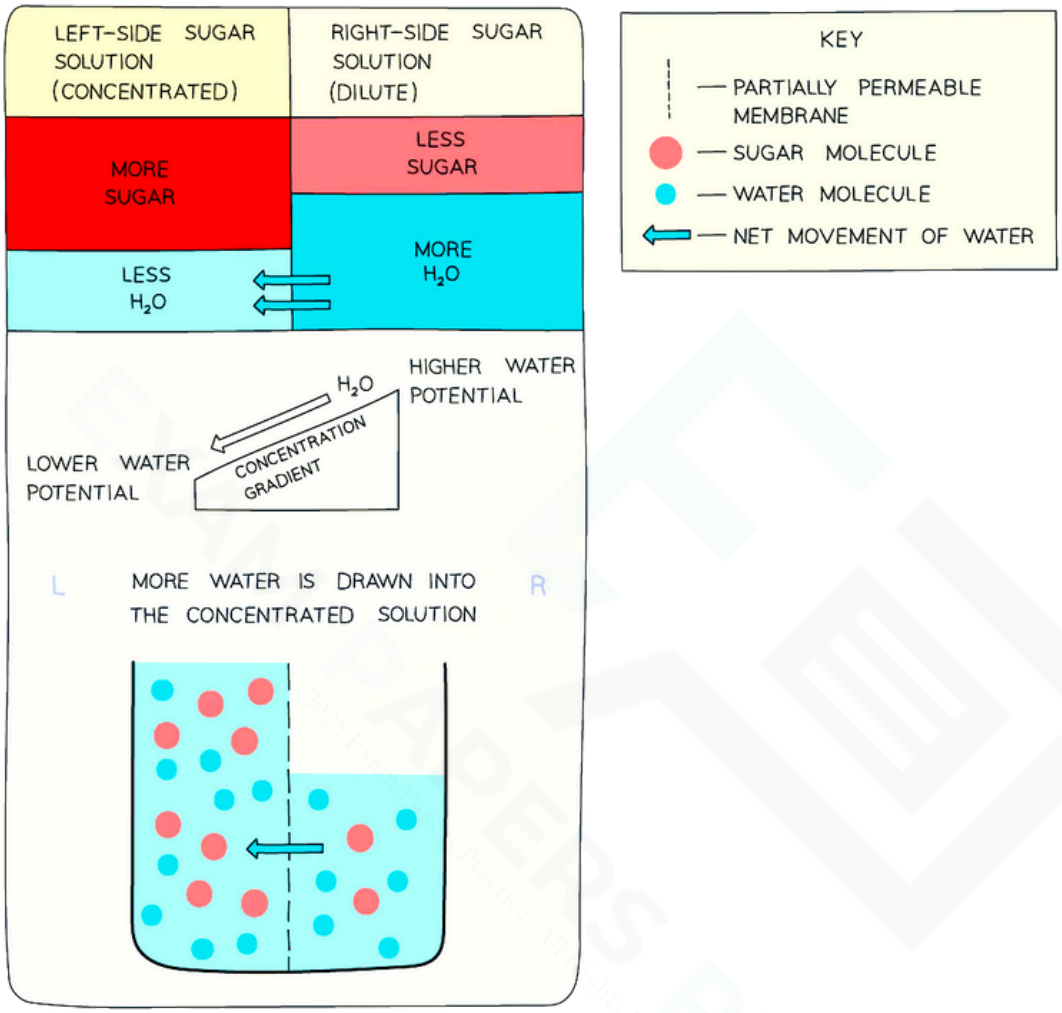
Osmosis and the partially permeable membrane

YOUR NOTES



Osmosis in cells

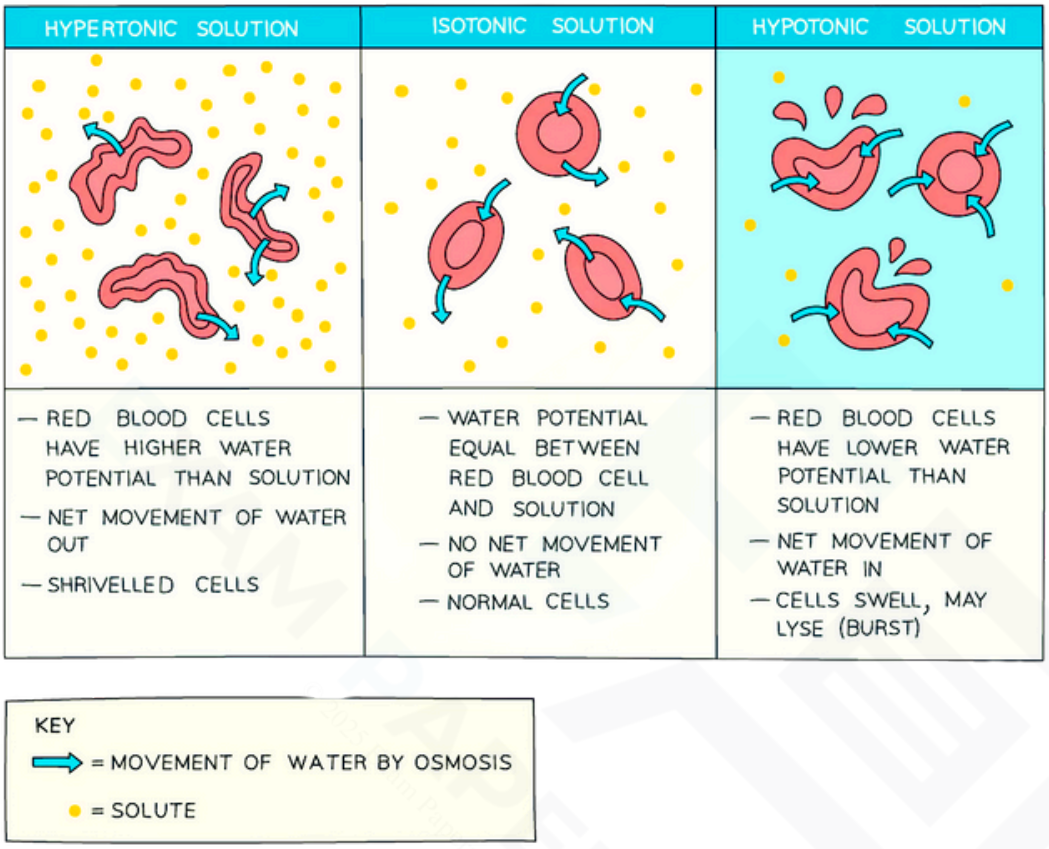
- It can get a little confusing to talk about the 'concentration of water' when we also talk about solutions being 'concentrated' (having a lot of solute in them)
- Instead, we can say that a concentrated solution has a low water potential (the left-hand side of the diagram below) and a dilute solution has a high water potential (the right-hand side of the diagram below)



How osmosis works

Osmosis in animal cells

- Animal cellslose and gain water as a result of osmosis
- As animal cells do not have a supporting cell wall, the results of osmosis can be severe
- If an animal cell is placed into a strong sugar solution (with a lower water potential than the cell), it will lose water by osmosis and become crenated (shrivelled up)
- If an animal cell is placed into distilled water (with a higher water potential than the cell), it will gain water by osmosis as it has no cell wall to create turgor pressure
- It will continue to gain water until the cell membrane is stretched too far and it bursts



E ect of osmosis on animal cells

Osmosis in plant cells

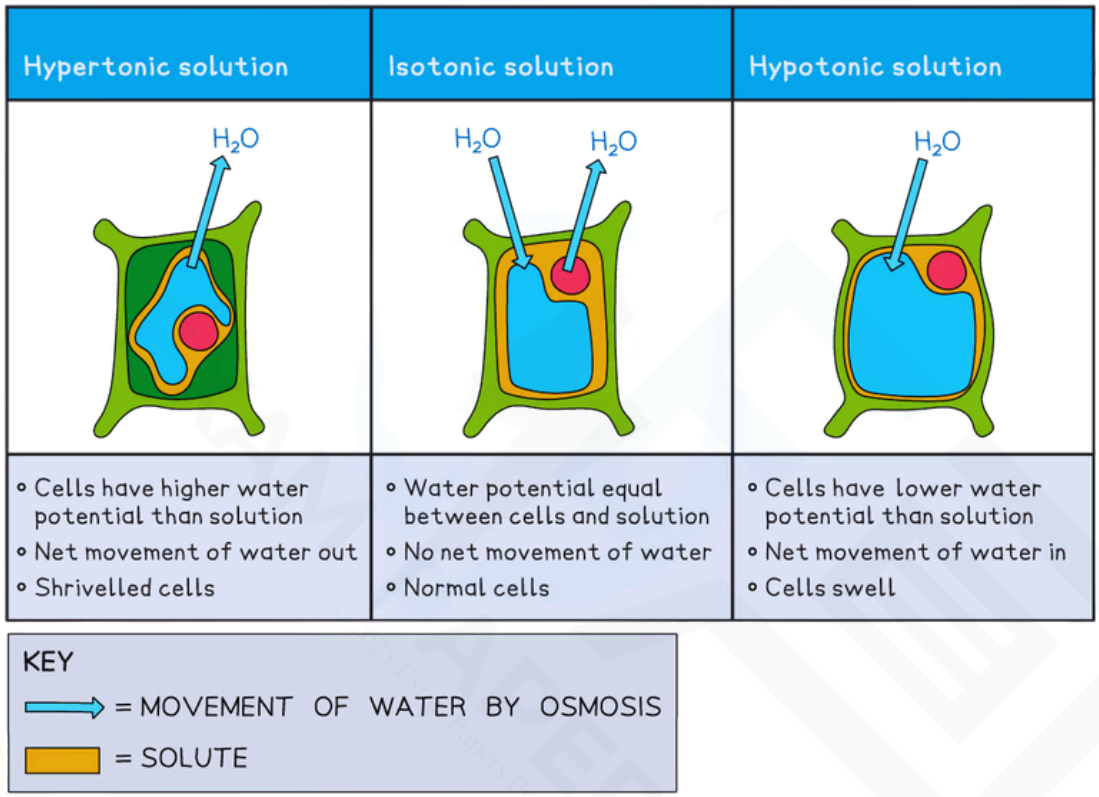
- Plant cells lose or gain water as a result of osmosis
  - Water entering the cell by osmosis makes the cell rigid and firm
  - This is important for plants as the e ect of all the cells in a plant being firm is to provide support and strength for the plant - making the plant stand upright with its leaves held out to catch sunlight
  - If plants do not receive enough water the cells cannot remain rigid and firm (turgid) and the plant wilts

- As plant cells have a supporting cell wall, they are protected from cell lysis
- If a plant cell is placed into a strong sugar solution (with a lower water potential than the cell), it will lose water by osmosis
  - The vacuole gets smaller and the cell membrane shrivels away from the cell wall
  - It becomes flaccid or plasmolysed (shrivelled up)

- If a plant cell is placed into distilled water (with a higher water potential than the cell), it will gain water by osmosis
  - The vacuole gets bigger, pushing the cell membrane against the cell wall

- The plant cell is described as being turgid or as containing a high turgor pressure (the pressure of the cytoplasm pushing against the cell wall)

YOUR NOTES



The e ect of osmosis on plant cells

Exam Tip

Osmosis refers only to the movement of water molecules, so if in an exam you are talking about the movement of water, make sure you mention osmosis as this will often earn you a mark.The best explanations to do with osmosis will refer to water potential, so if you are aiming for a 7, 8 or 9 you will need to understand this concept and use it in your explanations.

Practical: Factors that Influence Osmosis

YOUR NOTES

- We can investigate osmosis by using cylinders of potato and placing them into distilled water and sucrose solutions of increasing concentration

Apparatus

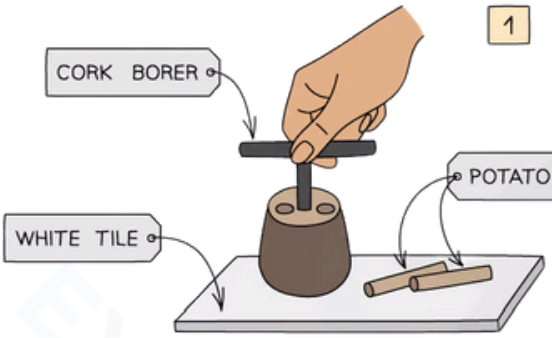
- Potatoes
- Cork borer
- Knife
- Sucrose solutions (from 0 Mol/dm3 to 1 mol/dm3)
- Test tubes
- Balance
- Paper towels
- Ruler
- Test tube rack

Method

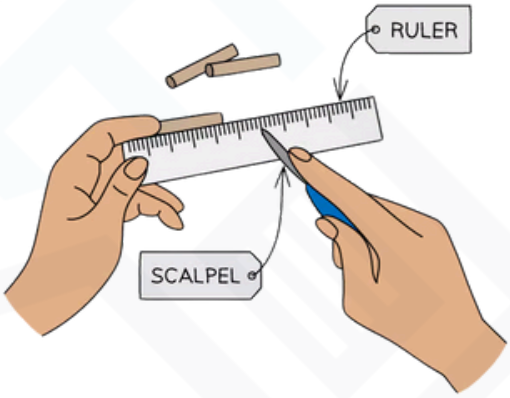
- Prepare a range of sucrose (sugar) solutions ranging from 0 mol dm^{-3} (distilled water) to 1 mol dm^{-3}
- Set up 6 labelled test tubes with 10cm^3 of each of the sucrose solutions
- Using the knife, cork borer and ruler, cut 6 equally-sized cylinders of potato
- Blot each one with a paper towel and weigh on the balance
- Put 1 piece into each concentration of sucrose solution
- After 4 hours, remove them, blot with paper towels and reweigh them

YOUR NOTES

OSMOSIS METHOD

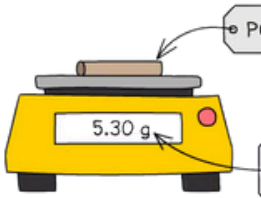


1 USE A CORK BORER TO CUT 5 POTATO CYLINDERS OF THE SAME DIAMETER



2 USE A SCALPEL AND RULER TO TRIM EACH POTATO CYLINDER SO THEY ARE ALL THE SAME LENGTH

3 MEASURE THE MASS OF EACH POTATO CYLINDER AND RECORD IN A TABLE OF RESULTS

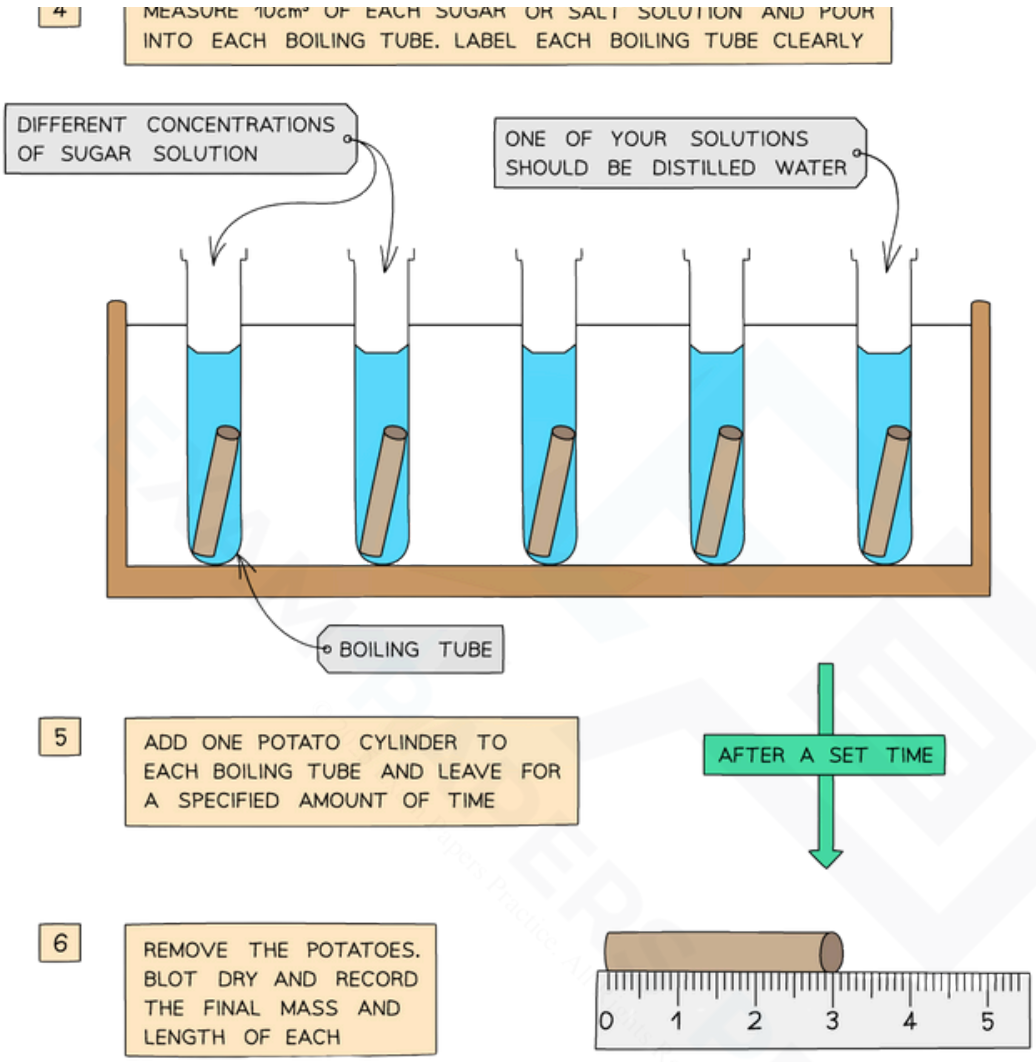


YOU WILL ALSO WANT TO RECORD THE INITIAL LENGTH (mm) IN A SIMILAR TABLE

Concentration of sucrose solution mol/dm³	Initial mass (g)	Final mass (g)	Change in mass (g)	% change in mass
0 (distilled water)	5.30			
0.25	5.32			
0.50	5.29			
0.75	5.31			
1.00	5.29			

4

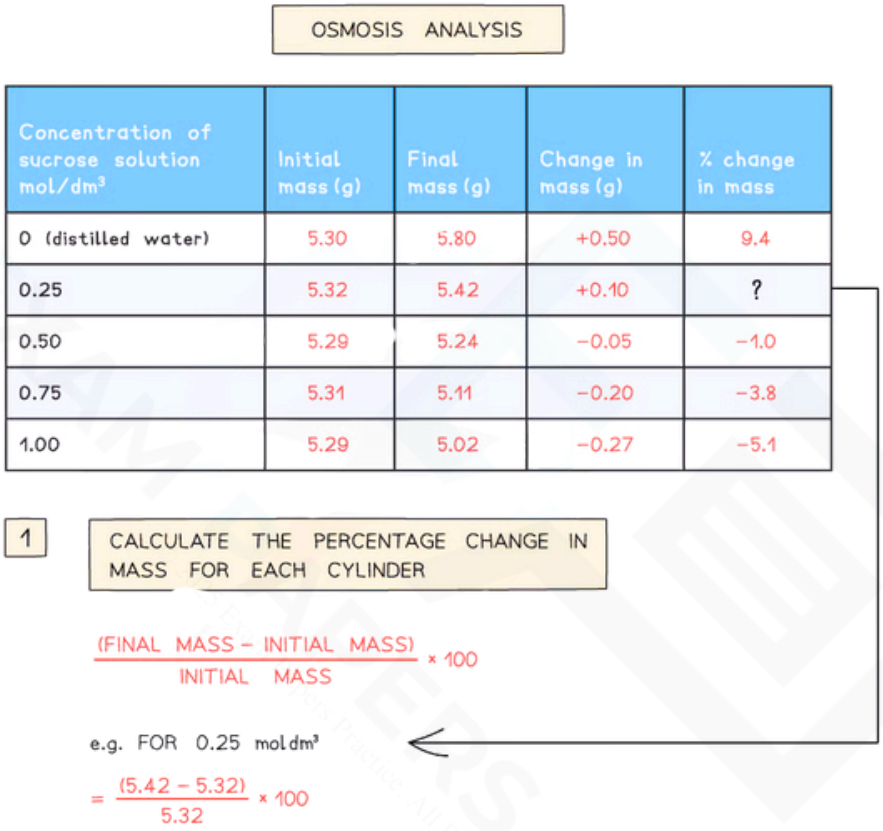
YOUR NOTES



Experimental method for investigating osmosis in potato cylinders

Results and analysis

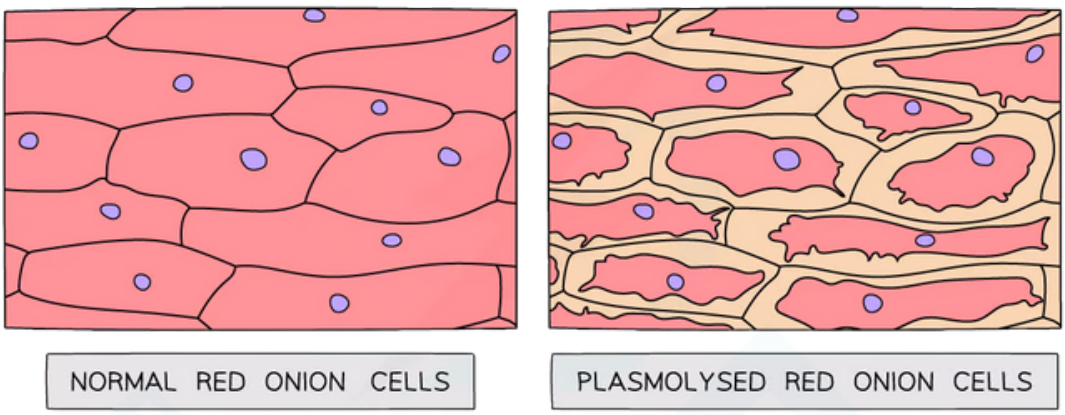
- The percentage change in mass can be calculated for each piece of potato



Calculating percentage change in mass

- The potato cylinder in the distilled water will have increased its mass the most as there is a greater concentration gradient in this tube between the distilled water (high water potential) and the potato cells (lower water potential) This means more water molecules
- will move into the potato cells by osmosis, pushing the cell membrane against the cell wall and so increasing the turgor pressure in the cells which makes them turgid - the potato cylinders will feel hard The potato cylinder in the strongest sucrose concentration
- will have decreased its mass the most as there is a greater concentration gradient in this tube between the potato cells (higher water potential) and the sucrose solution (lower water potential) This means more water molecules will move out of the potato cells by
- osmosis, making them flaccid and decreasing the mass of the cylinder - the potato cylinders will feel floppy If looked at underneath the microscope, cells from this potato
- cylinder might be plasmolysed, meaning the cell membrane has pulled away from the cell wall

YOUR NOTES



Plasmolysed red onion cells

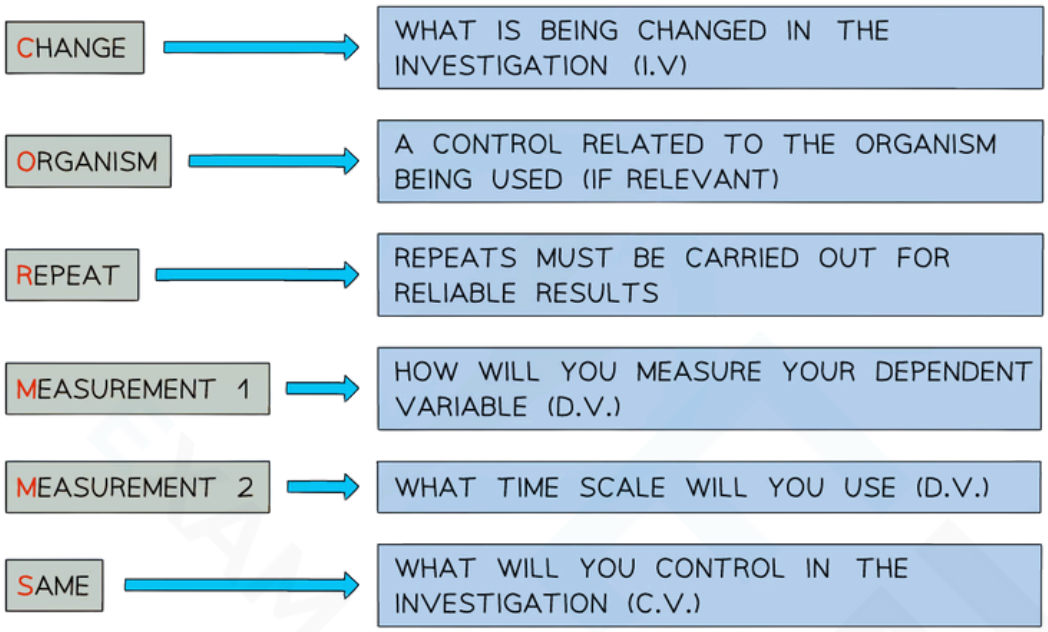
- If there is a potato cylinder that has not increased or decreased in mass, it means there was no overall net movement of water into or out of the potato cells
- This is because the solution that the cylinder was in was the same concentration as the solution found in the cytoplasm of the potato cells, so there was no concentration gra d i ent

Li mi tati on s

- Slight di erences in the potato cylinders may mean that the results aren't reliable or comparable. A possible solution to this limitation could be:
  - For each sucrose concentration, repeat the investigation with several potato cylinders. Making a series of repeat experiments means that any anomalous results can be identified and ignored when a mean is calculated

Applying CORMS evaluation to practical work

- When working with practical investigations, remember to consider your CORMS evaluation



CORMS evaluation

- In this investigation, your evaluation should look something like this:
  C - We are changing the concentration of sucrose solution
  O - The potato cylinders will all be taken from the same potato or potatoes of the same age
  R - We will repeat the investigation several times to ensure our results are reliable
  M1 - We will measure the change in mass of the potato cylinders
  M2 - ...after 4 hours
  S - We will control the volume of sucrose solution used, the dimensions of the potato cylinders and each cylinder must be blotted before it is weighed each time

Exam Tip

Questions involving osmosis experiments are common and you should be able to use your knowledge of these processes to explain the results.Don't worry if it is an experiment you haven't done. Simply figure out where the higher concentration of water molecules is (this is the solution with the higher water potential) and explain which way the molecules move due to the di erences in water potential.

YOUR NOTES

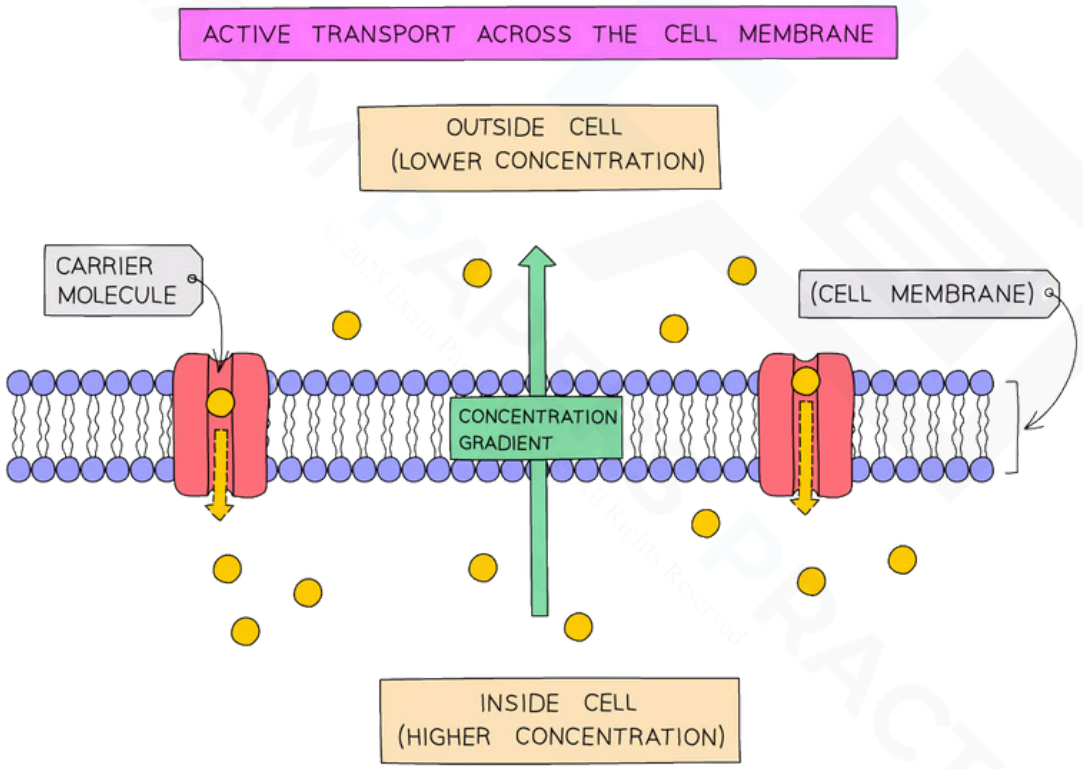
YOUR NOTES

Active Transport Theory

- Active transport is:

The movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration

- Energy is needed because particles are being moved against a concentration gradient, in the opposite direction from which they would naturally move (by di usion)
- Active transport across the cell membrane involves protein carrier molecules embedded in the cell membrane



Active transport across the cell membrane - the molecules here are being transported against the concentration gradient, from a region of lower concentration (outside the cell) to a region of higher concentration (inside the cell)

Active Transport in Organisms

YOUR NOTES

Animals

- Food molecules (such as the sugar glucose) can be absorbed across the wall of the small intestine by di usion, but this is dependent on a concentration gradient existing between the lumen of the intestine and the bloodstream
- Active transport allows molecules such as glucose to be transported into the bloodstream from the lumen of the small intestine (the gut) when the concentration of sugar molecules in the blood is higher
- The active uptake of glucose by epithelial cells in kidney tubules in the kidney nephron allows for the reabsorption of glucose back into the blood so that none is lost in the urine
- Sugar molecules are used in respiration to release energy for cells to function

Pl an ts

- Root hair cells lining the surface of plant roots need to move minerals such as magnesium ions from a region of lower concentration (the very dilute solution of minerals in the soil surrounding the roots) to a region of higher concentration (inside the cytoplasm of the cell)
- Mineral ions are needed by plants to function
  - Magnesium ions are required to make chlorophyll
  - Nitrate ions are needed to make amino acids for protein synthesis (and subsequently grow th)