

AQA Combined Science: **Trilogy**

Year 10
Knowledge organiser booklet
Paper 1

BIOLOGY

B1 Cell Biology

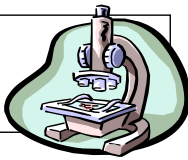
B2 Organisation

B3 Infection and response

B4 Bioenergetics

Name:

Key Words - GCSE Biology unit 1 Cells



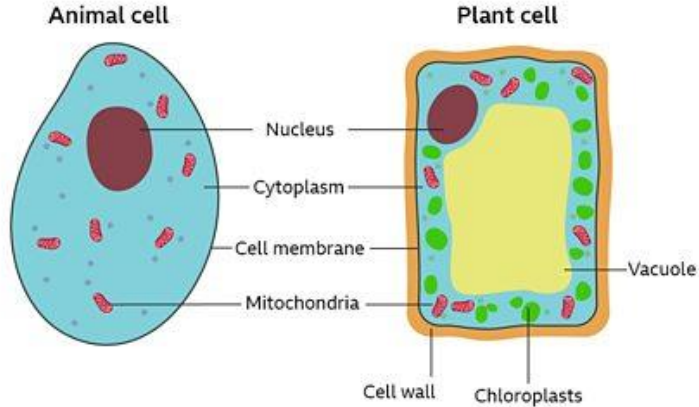
<i>Active Transport</i>	The movement of particles against a concentration gradient, using energy from respiration
<i>Chloroplasts</i>	Where photosynthesis takes place in plant cells
<i>Cytoplasm</i>	Where the chemical reactions that keep the cell alive take place
<i>Diffusion</i>	The movement of particles from a high concentration to a low concentration across the cell membrane.
<i>Nucleus</i>	The control centre of the cell, where the genes are found
<i>Membrane</i>	Controls what passes in and out of a cell
<i>Meristem</i>	Source of stem cells in plants found in the growing parts of the plant.
<i>Mitochondria</i>	Where energy is released during respiration
<i>Osmosis</i>	The movement of water from a dilute solution to a less dilute solution (e.g. from a high water concentration to a low one)
<i>Respiration</i>	Chemical reaction that takes place in living cells, releasing energy for the cell
<i>Ribosomes</i>	Where proteins are made in a cell
<i>Stem cell</i>	Unspecialised cells that can develop into any other type of cell
<i>Vacuole</i>	Where the cell sap is found in plant cells
<u>Numeracy:</u>	

Total Microscope magnification = eyepiece lens x objective lens

B1 – Cell Biology

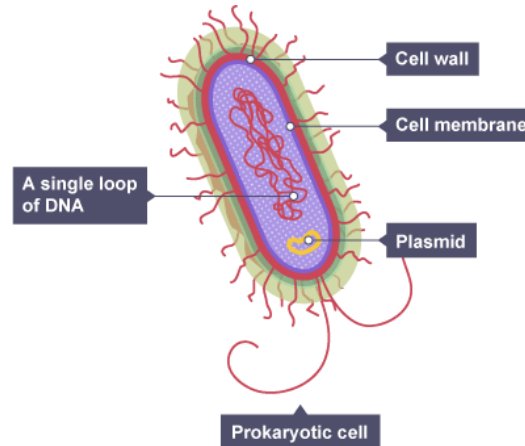
Eukaryotic Cells

They have a nucleus to contain the chromosomes. These can be animal, plant or fungus or protist cells. Animal and plant cells are shown below.

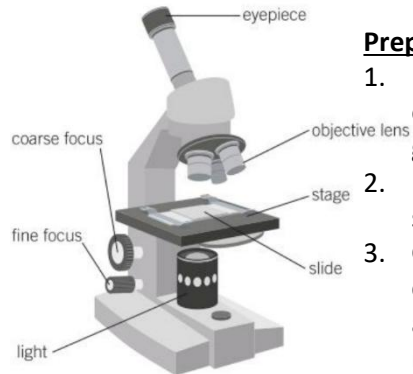


Prokaryotic Cells

They do not have a nucleus, they are usually a lot smaller and may contain plasmids.



RP1 – Microscopy; Observing Plant Cells



Preparing the slide:

1. Place a thin layer of onion membrane on a glass slide with forceps.
2. Use a drop of iodine to stain the cells.
3. Gently place a glass cover slip over the same and tap carefully to remove air bubbles.

Viewing the slide:

1. Place the slide on the stage and turn on the light.
2. Select the lowest magnification objective lens.
3. Look through the eyepiece and turn the coarse focus until the image can be seen.
4. Turn the fine focus until a clear image is formed.
5. Change the objective lens to another with a higher magnification and turn the fine focus re-focus the image.

Microscopes

The development of microscopes of the last 200 years has allowed us to study cells and the structures inside them in more and more detail.

Light Microscope	Electron Microscope
Low resolution Low magnification Cheap	High resolution High magnification Expensive

Calculating Magnification

Units for image and actual size may need to be converted before using the equation below.

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

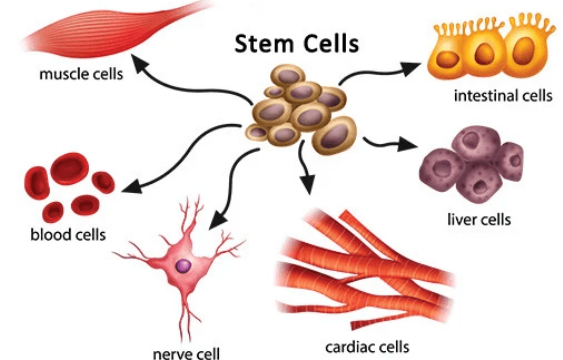
$$\begin{aligned} \text{mm} &\rightarrow \mu\text{m} \\ \mu\text{m} &\rightarrow \text{mm} \end{aligned}$$

$$\begin{aligned} &\times 1000 \\ &\div 1000 \end{aligned}$$

Cell		Features
Animal	Sperm	High number of mitochondria Ribosomes that make enzymes in the head
	Nerve	Long Lots of branches (dendrites)
	Muscle	High number of mitochondria High Number of ribosomes Store glycogen
Plant	Xylem	Walls thickened with lignin to strength the cells into a tube
	Phloem	Sections between cells called sieves to help transport substances like dissolved sugars
	Root hair	Large surface area Lack of chloroplasts Large vacuole

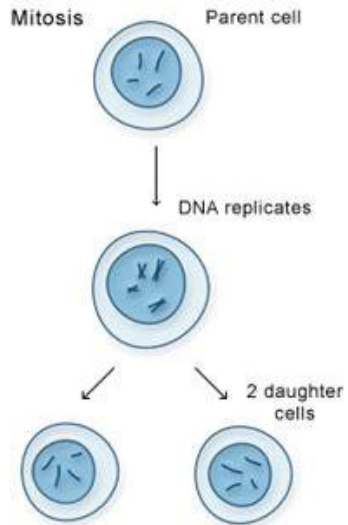
Cell Differentiation

As an organism develops, cells differentiate to form different types of cells. This is an example in animals.



B1 – Cell Biology

Mitosis

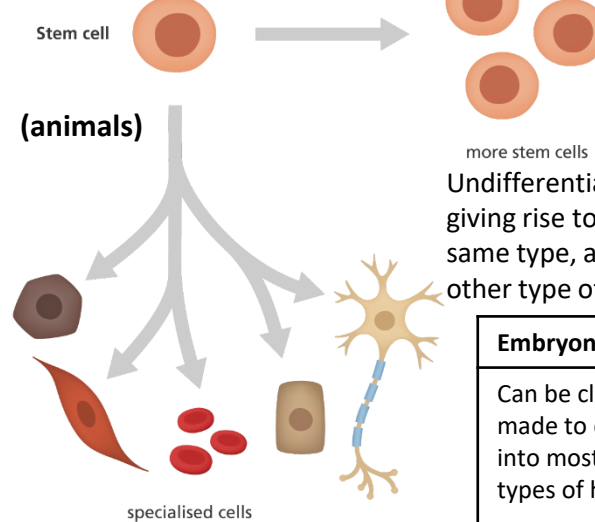


Before a cell can divide it needs to grow and increase the number of sub-cellular structures such as ribosomes and mitochondria. **The DNA replicates** to form two copies of each chromosome.

In mitosis one set of chromosomes is pulled to each end of the cell and the **nucleus divides**.

Finally the **cytoplasm and cell membranes divide** to form two identical cells.

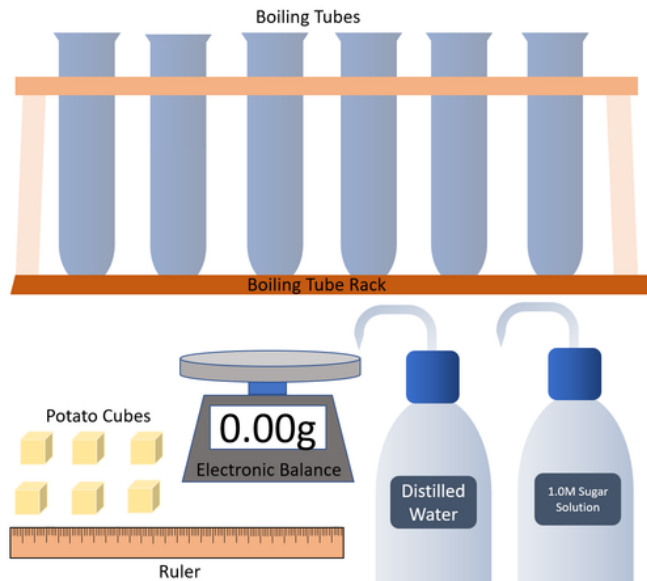
Stem Cells



Undifferentiated cells are capable of giving rise to many more cells of the same type, and can differentiate into other type of cells.

Embryonic	Adult	Meristems
Can be cloned and made to differentiate into most different types of human cells	Bone marrow stem cells can form many types of cells including blood cells.	Can differentiate into any type of plant cell, throughout the life of the plant.

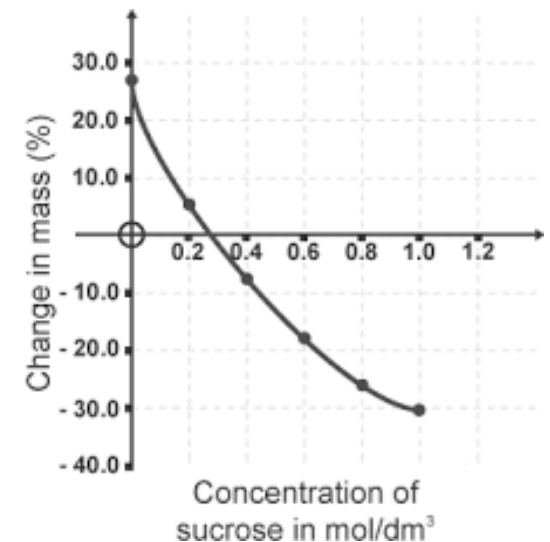
RP2 – Osmosis: The concentration of surrounding solution affects mass of plant tissue



1. Use a cork borer to create 5 cylinders of plant tissue (usually potato) and cut them all to the same length.
2. Measure the mass of each piece using a top pan balance and the length of each piece with a ruler. Record in a table.
3. Measure out 100cm³ of each concentration of salt/sugar solution into labelled boiling tubes.
4. Place each piece of potato into a boiling tube for 24 hours.
5. Remove the pieces and blot with a paper towel.
6. Measure the mass of each piece using a top pan balance and the length of each piece with a ruler. Record in a table.
7. Calculate the percentage change in mass.

$$\% \text{ change in mass} = \frac{\text{change in mass (g)}}{\text{initial mass of potato (g)}}$$

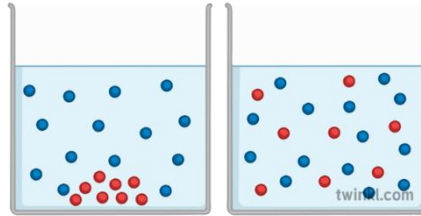
Results Graph



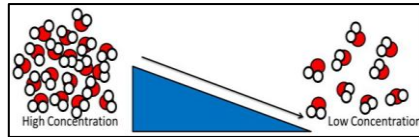
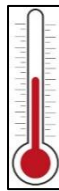
B1 – Cell Biology

Diffusion

- Substances move a higher concentration of that substance (red particles pictured) to where there is a lower concentration of that substance. (High $\rightarrow$ Low)
- This happens because of the random movement of the particles in a fluid (liquid or gas).



- There are ways the rate of diffusion can be changed:
 - the difference in concentrations (concentration gradient)
 - the temperature
 - the surface area of the membrane

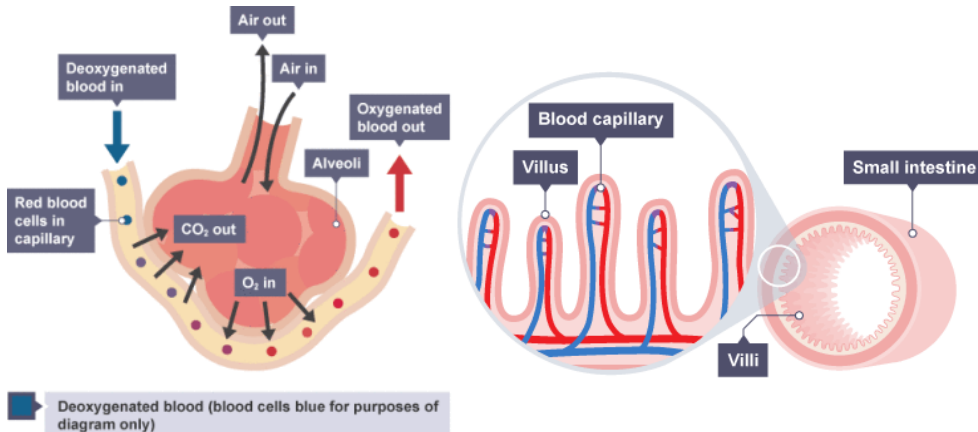


1 cm	2 cm	3 cm
SA = 6 cm ²	SA = 24 cm ²	SA = 54 cm ²
Vol = 1 cm ³	Vol = 8 cm ³	Vol = 27 cm ³
SA:Vol = 6:1	SA:Vol = 3:1	SA:Vol = 2:1

Examples

Alveoli in the lungs and villi in the small intestine are both structured in similar ways so diffusion can happen at a high rate (fast).

- having a large surface area
- a membrane that is thin, to provide a short diffusion path
- (in animals) having an efficient blood supply

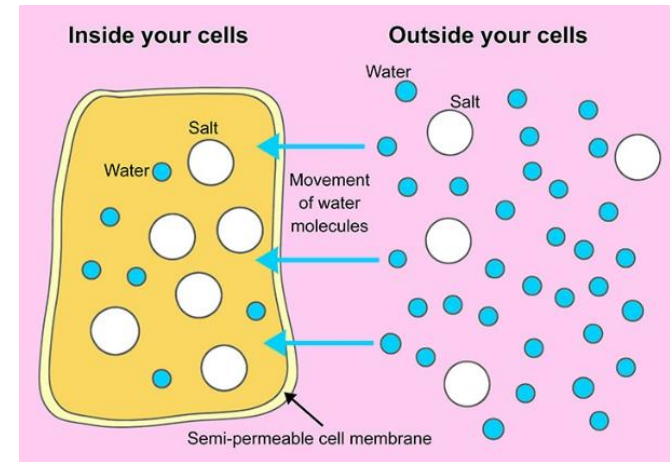


Osmosis

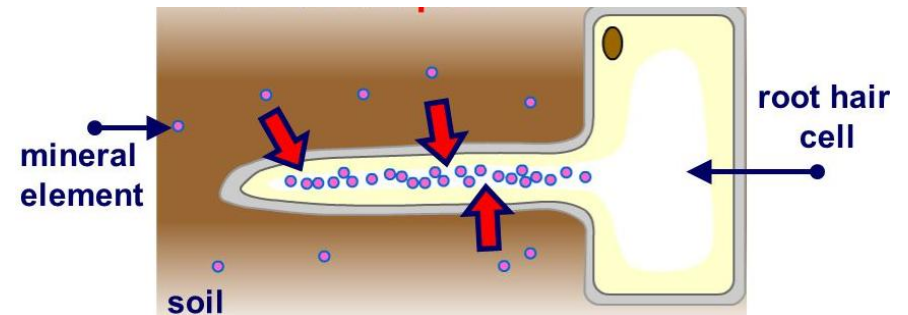
Water may move across cell membranes via osmosis.

Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane (H $\rightarrow$ L).

Partially permeable means small molecules can move through but large molecules cannot.



Active Transport



- Active transport is moving substances against the concentration gradient (L $\rightarrow$ H) so requires energy. This energy comes from respiration.
- This means that cells that carry out a lot of active transport (root hair cells, epithelial cells on villi in the small intestine) contain a lot of mitochondria.

B2 – Organisation

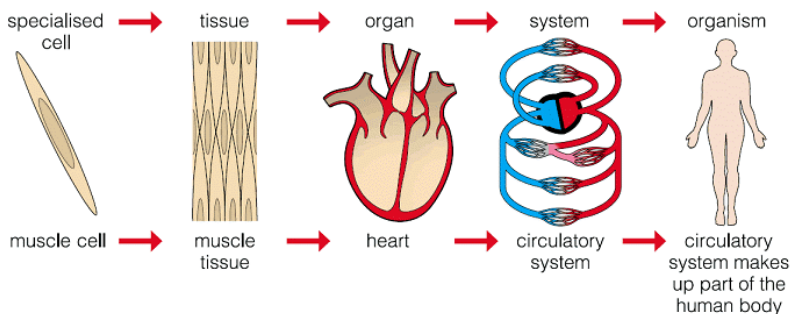
Levels of Organisation

Cells = basic building blocks of all living organisms.

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

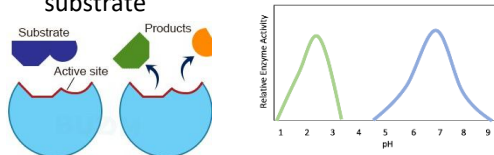
Organs = aggregations of tissues performing specific functions.

Organ systems = organs organised to form organisms.

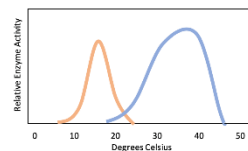


Enzymes

- Biological catalysts
- Digestive enzymes speed up the break down of insoluble food molecules
- Specific shape active site that matches substrate



Enzymes work best at certain temperatures or pH depending on their role.



Bile

The liver makes an **alkaline** solution called bile. Stored by the gall bladder.

Has two jobs:

- Emulsifies fats
- Neutralises stomach acid.



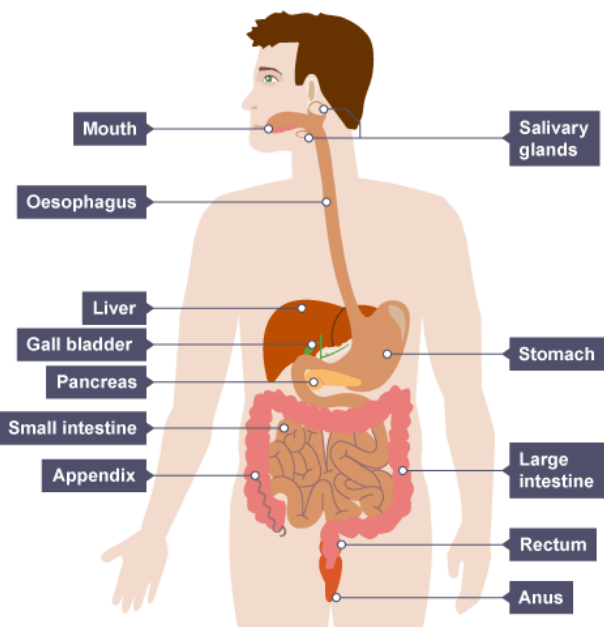
Digestive Enzymes

Starch $\xrightarrow{\text{amylase}}$ Glucose

Protein $\xrightarrow{\text{protease}}$ Amino Acids

Fats $\xrightarrow{\text{lipase}}$ Fatty acids + Glycerol

Digestive System



Organ	Function
Mouth	Teeth and tongue to chew food.
Salivary Glands	Releases saliva containing enzymes.
Oesophagus	Muscle tube to squeeze food along.
Stomach	Contains enzymes and hydrochloric acid. Is made of muscle to churn food. Hydrochloric acid kills bacteria in food
Small Intestine	Where digestion is completed and soluble food particles (glucose, amino acids, fatty acids, glycerol). are absorbed
Large Intestine	Absorbs water.
Liver	Produces bile.
Gall Bladder	Stores bile.
Pancreas	Releases enzymes.

Where are the enzymes?

Enzyme	Salivary glands	Stomach	Pancreas	Small intestine
Amylase	X		X	X
Protease		X	X	X
Lipase			X	X

RP3 – Food Tests

Summaries of the four food tests.

Protein Add Biuret's reagent Positive test; Blue solution turns Purple	Starch Add Iodine Positive test; solution turns from orange to Black
Fats Add Ethanol and water Positive test – solution turns Cloudy	Glucose Add Benedict's and heat Positive test blue solution turns Brick red

Water Bath

B2 – Organisation

The effect of pH on the rate of reaction of amylase

1. Add 2cm³ amylase solution, 2cm³ of starch solution and 2cm³ of pH2 buffer to a water bath (37°) in separate test tubes. Wait 10 minutes.
2. While waiting, add 2 drops of iodine solution to each well on the spotting tile.
3. Once the solutions in the water bath have reached 37° pour the amylase and PH2 buffer into the starch solution.
4. Immediately take a sample with a pipette and add to the first well of the spotting tile.
5. Repeat step 4 every 30 seconds until there is no colour change when testing with iodine solution.
6. Repeat steps 1-5 with pH4, pH6, pH8 and pH10 buffers.



Blood Vessels



Arteries

- Blood carried away from heart
- Thick muscular and elastic walls = withstands high pressure
- Small lumen = maintains high pressure

Capillaries

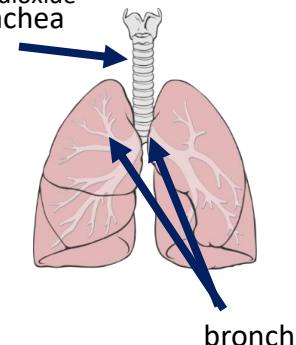
- Walls only one cells thick = shorter diffusion pathway
- Lumen just bigger than red blood cell
- Blood flows very slowly
- Diffusion takes place here

Veins

- Blood carried back to heart
- Thin walls as blood is low pressure
- Large lumen – lower resistance for blood passing through
- Valves prevent back flow

Respiratory System

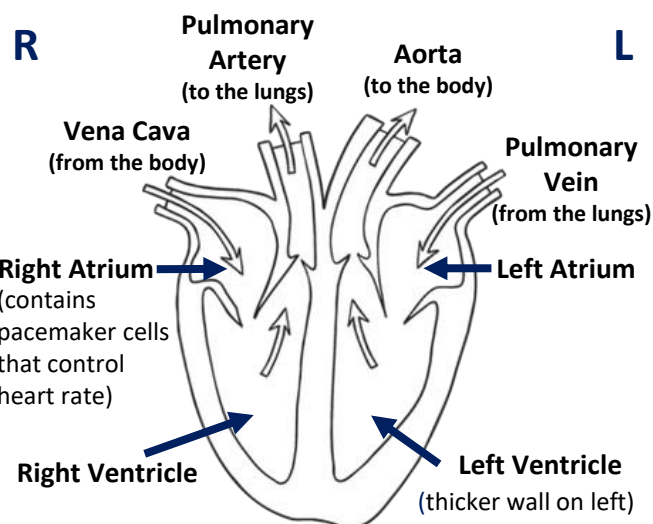
The lungs have two jobs – to get oxygen into the blood and remove carbon dioxide



Structures that cannot be seen on this diagram are the **alveoli** and **capillary network** – see 'unit 1 - diffusion'.

The Human Heart

Double pump because - left side pumps to whole body, right side pumps to the lungs.



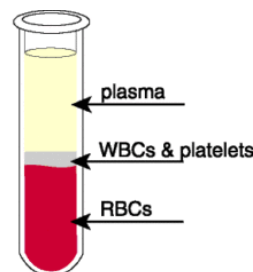
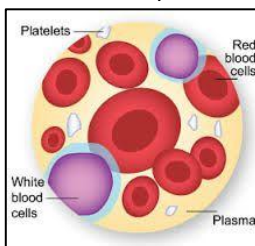
Blood – 4 components

Red blood cells – contain haemoglobin to carry oxygen. More detail...

White blood cells – fight pathogens (see unit 3 – infection and response).

Platelets – cell fragments that clot blood.

Plasma – liquid part that transports cells, cell fragments and dissolved substances (salts, urea, CO₂, hormones...)

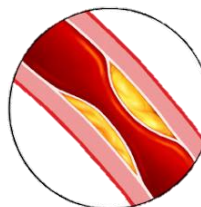


Red Blood Cells (RBCs)

- Contain chemical 'haemoglobin'.
- This reacts/ binds with oxygen to be carried around the body.
- RBCs are ~8µm (relative small animal cell) allows them to fit through capillaries
- Bi-concave disc shape for large SA:V



Coronary Heart Disease (CHD)

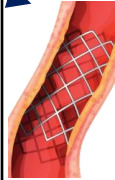


- Coronary arteries supply heart muscle with blood (containing glucose and oxygen for respiration)
- Can become narrowed/blocked by fatty deposits if cholesterol high, reducing blood flow.
- Reduced muscle contraction in heart

B2 – Organisation

Heart Disease Treatment – Statins vs Stents

Statins	Stents
- Medication to be taken everyday - Lowers blood cholesterol - Does not work immediately	- Mesh tube to be inserted into artery to hold it open - Surgery required - Works immediately



Faulty Valves

- Valves in veins and the heart prevent backflow of blood
- Faulty valves = don't open or close fully
- Can be replaced with man-made valves or transplants from donors



faulty



healthy

Cancer

Uncontrolled cell growth

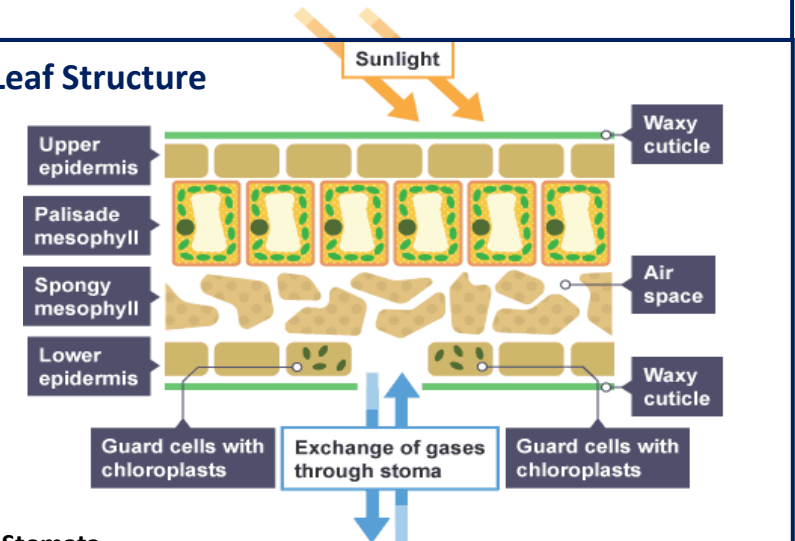
Benign tumours = abnormal cells, contained in one area, in a membrane, do not invade other parts of body.

Malignant tumours = cancer cells, not in a capsule, invade neighbouring tissue, and spread into blood and form secondary tumours.

Risk Factors

Lifestyle factors can have be risk factors for certain diseases. E.g. obesity is a risk factor for type 2 diabetes, or drinking and smoking while pregnant affects the development of the foetus.

Leaf Structure

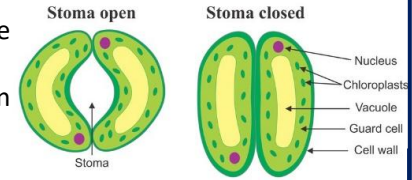


Stomata

Tiny pores on the underside of the leaf.

Allow oxygen and CO₂ to diffuse in and out

Guard cells surround the stomata and can open and close the pore

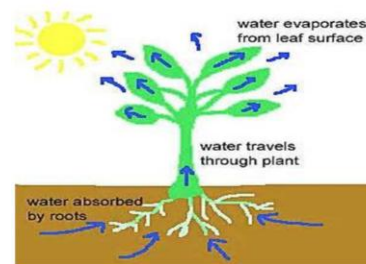


Interaction of Diseases

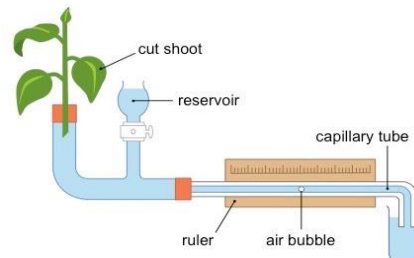
- Defects in the immune system - individual is more likely to suffer from infectious diseases.
- Viruses can trigger cancers, e.g. HPV can trigger cervical cancer.
- Immune reactions caused by pathogens can trigger allergies such as asthma or rashes
- Severe physical ill health can lead to depression and other mental illness.

Transpiration

Movement of water through plant from roots to leaves, driven by evaporation through the stomata



Measuring transpiration



Record the distance the bubble of air moves along the scale during set amount of time to calculate volume of water uptake per minute.

Transpiration	Translocation
Movement of water from roots to leaves	Movement of dissolved sugars from leaves all round the plant
Xylem - hollow tubes strengthened by lignin.	Phloem – tubes of elongated cells.
One way system – roots to leaves.	Two way system – sugars taken to wherever they are needed.

Increasing the rate of transpiration

- Higher temperature
- Lower humidity
- Higher light intensity
- Higher air movement

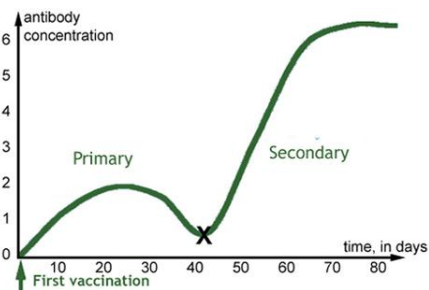
B3 – Infection and Response

Communicable Diseases – diseases caused by a pathogen

Disease	Pathogen	Symptoms	Spread by	Prevent spread	Treatment
Salmonella	Bacteria	Fever, cramps, vomiting, diarrhoea	Contaminated food	Vaccinating poultry, cooking food thoroughly	Antibiotics or management of symptoms
Gonorrhoea	Bacteria	Yellow/green discharge, pain when urinating	Sexual Contact	Using barrier protection, e.g. condoms	Antibiotics
Measles	Virus	Red rash and fever	Breathing in droplets from coughs/sneezes	Vaccination	No cure – only management of symptoms
HIV	Virus	Flu-like symptoms, develops into AIDS	Sexual contact	Using barrier protection, e.g. condoms	Antiretroviral drugs
Tobacco Mosaic Virus (plants)	Virus	'Mosaic' pattern of discolouration on the leaves	Soil	Destroy infected plants	No treatment
Rose Black Spot (plants)	Fungus	Black spots on leaves	Wind or water	Remove and destroy infected leaves	Fungicides
Malaria	Protist	Recurrent episodes of fever	Insect bites (mosquitoes)	Mosquito nets, insect repellent	Antimalarial drugs

Vaccination

- Introducing small quantities of dead or inactive forms of pathogen into the body.
- Stimulates WBCs to produce antibodies.



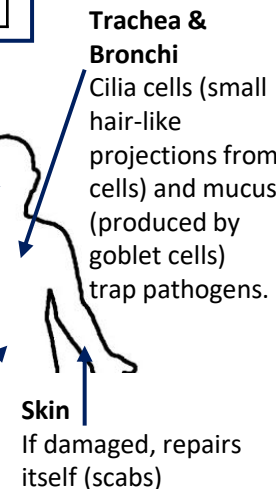
- If same pathogen returns (X), WBCs remember how to make the right antibodies.
- They make MORE antibodies, MORE QUICKLY, and they stay in body for LONGER.

Nose

Hairs and mucus trap pathogens before entering lungs.

Stomach

Contains hydrochloric acid to kill pathogens that have been eaten.



Antibiotics & Painkillers

Antibiotics = kill bacteria (specific antibiotic for specific bacteria) **THEY DO NOT KILL VIRUSES** e.g. penicillin

Antibiotics cannot kill viruses because viruses live inside cells

Painkillers = stop pain (don't kill microbes, just help with symptoms) e.g. paracetamol

Development of Drugs

Testing for:

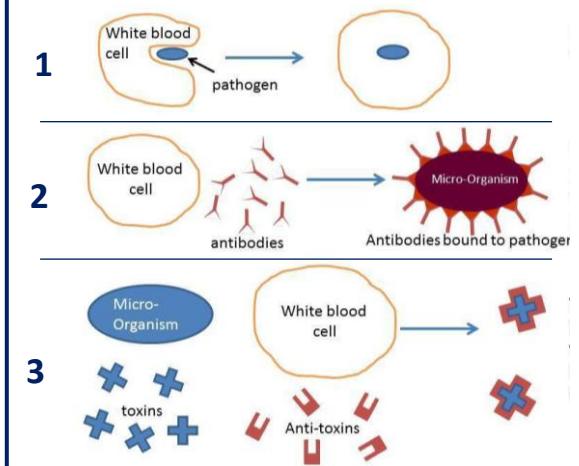
- Safety
- Efficacy (does it work)
- Dosage (how much is needed)

Stage	Description
1	Tested on cells and tissues. Side effects? Efficacy?
2	Tested on animals. Side effects?
3	Clinical trials = tested on humans. 1 st health volunteers, 2 nd patients with the illness. Dosage gradually increased to optimum.

Non-specific Defence Systems

White Blood Cells (WBCs)

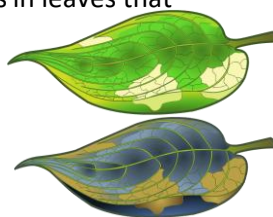
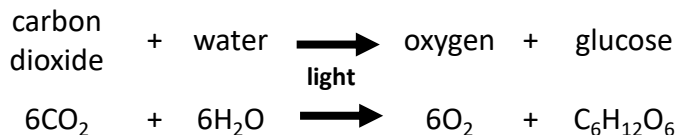
- Phagocytosis – engulfing the pathogen
- Producing antibodies – specific to the antigen
- Producing antitoxins – to neutralise toxins



B4 – Bioenergetics

Photosynthesis

Endothermic chemical reaction that takes place in chloroplasts in leaves that produces glucose and oxygen from carbon dioxide and water



What do plants do with the glucose?

- Stored as starch
- Stored as fats and oils
- For making cellulose (for cell walls)
- For respiration
- For making amino acids (along with nitrates from soil)

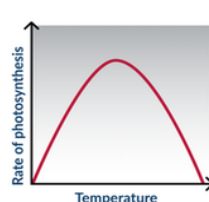
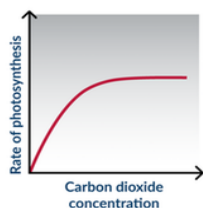
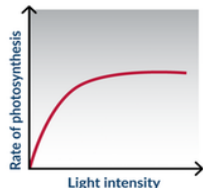
Testing the leaf for starch:

- Boil the leaf for 5 minutes to soften
- Put into heated ethanol to remove chlorophyll (turn off Bunsen burner!)
- Spread leaf on a white tile
- Add iodine
- In the places that contain starch the iodine will turn blue/black
- In a variegated leaf, only the parts containing chlorophyll turn blue black
- This shows chlorophyll is essential for photosynthesis

Factors the affect rate of photosynthesis

- Light
- Temperature
- CO₂ concentration

Whichever one is in the shortest supply is called the **limiting factor** – as it is the one limiting the rate of photosynthesis

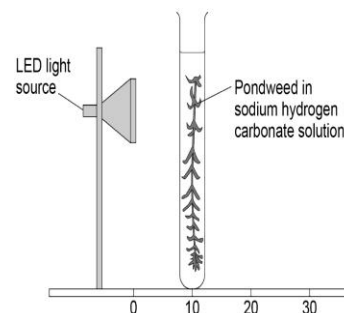


Increased light intensity increases the rate, but only up to a point, when CO₂ or temperature become limiting

Increased CO₂ conc increases the rate, but only up to a point, when light or temperature become limiting

Increased temperature increases the rate, but only up to a point, then the enzymes are denatured & rate drops

RP5 – Effect of light intensity on rate of photosynthesis



Independent variable: distance between lamp and plant (or light intensity)

Dependent variable – number of bubbles per second / rate of photosynthesis

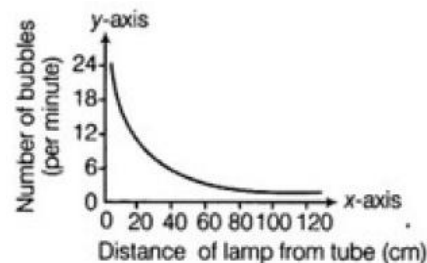
Controls – temperature of solution, piece of pondweed

1. Measure 10cm length of pondweed and cut with scissors.
2. Place into beaker of 250ml NaHCO₃ solution. (this provides CO₂)
3. Place lamp 10cm away from pondweed – turn on lamp and leave for 2 minutes to adjust to light intensity.
4. Count number of bubbles produced in 60 seconds and record in table.
5. Repeat steps 3 and 4 for lamp distances of 20cm – 50cm at 10cm intervals.
6. Keep the temperature of the solution the same (LED light is used to not give off heat)

Inverse Square Law (HT only)

As distance of the lamp doubles the light intensity of the plant quarters $I = \frac{1}{d^2}$

Typical results:



As the **distance** between the lamp and the pondweed **increases**, the **number of bubbles per minute decreases**

B4 – Bioenergetics

Respiration

Respiration is a chemical reaction that happens in the mitochondria of cells to release energy from glucose.

There are two types – Aerobic and Anaerobic.

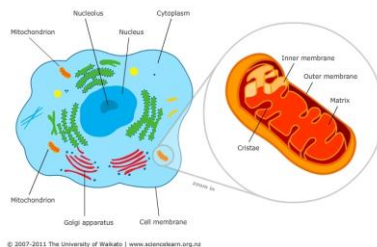
Aerobic: - with oxygen

oxygen + glucose → carbon dioxide + water



Organisms need energy for:

- chemical reactions to build larger molecules
- movement
- keeping warm.



Exercise

During exercise, more energy is needed so that muscles can keep contracting. This means more respiration is needed.

Increased breath depth -

Get more oxygen into blood per breath and remove CO₂

Increased heart rate -

Get more oxygenated blood to muscles.

Increased breathing rate -

Get oxygen into blood quickly.

Heart beats harder - more blood is pumped with every beat.



During intense exercise, there is just not enough oxygen getting into the body. The muscles start to respire anaerobically.

The build up of lactic acid can cause cramp/stitch.

(HT ONLY) When exercise is over, the lactic acid has to be oxidised to CO₂ and H₂O. The amount of oxygen needed to do this is called the oxygen debt

Anaerobic respiration

Respiration without oxygen

In animal cells = **glucose → lactic acid**

In plant/yeast cells = **glucose → ethanol + carbon dioxide**

In yeast, this is fermentation and is used in brewing and baking



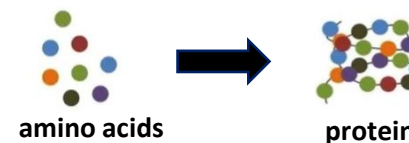
	Aerobic	Anaerobic
Oxygen used?	Yes	No
Waste products	CO ₂ and H ₂ O	Lactic acid (animals) Ethanol + CO ₂ (plants/yeast)
Energy released	Lots	Much less

Metabolism

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

The 'metabolic rate' is the rate at which all of these reactions take place.

An example of a reaction = making proteins using amino acids from digestion.



More examples:

- glucose → glycogen (in muscles/liver)
- respiration
- protein → urea
- glycerol and fatty acids → fats

