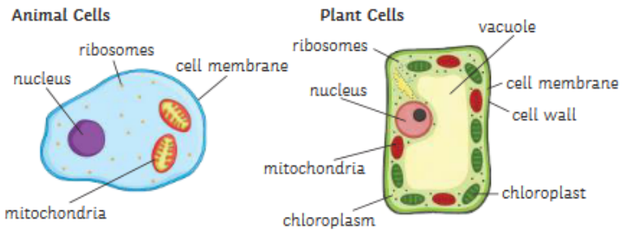
B1 - Cell Biology

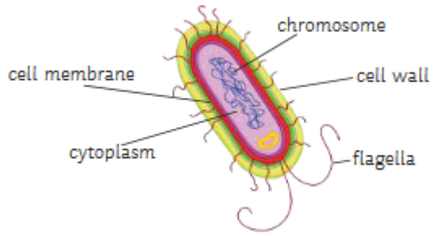
Eukaryotic Cells

These are cells that have a nucleus, such as animal, plant, and fungal cells



Prokaryotic Cells

These are bacterial cells that do not have a nucleus



Similarities between Eukaryotic and Prokaryotic Cells

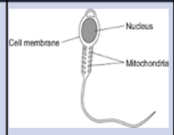
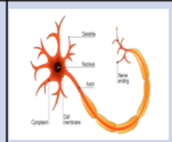
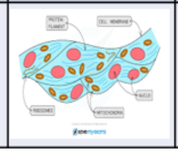
- Both have DNA
- Both have cell membrane and cell wall
- Both have cytoplasm

Differences between Eukaryotic and Prokaryotic Cells

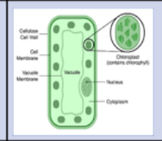
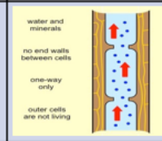
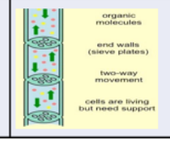
- Eukaryotic cells have a nucleus, prokaryotic do not
- Eukaryotic cells have mitochondria, prokaryotic do not
- Eukaryotic cells have chloroplasts, prokaryotic do not
- Eukaryotic cells are bigger and have bigger ribosomes
- Prokaryotic cells have plasmids, eukaryotic cells do not

Cell Organelle	Function
Nucleus	Contains DNA (genetic information)
Cell Membrane	Allows things in and out of cell
Cytoplasm	Where chemical reactions occur
Mitochondria	Where aerobic respiration takes place to release energy
Ribosomes	Where proteins are made
Chloroplasts	Where photosynthesis occurs
Cell Wall	Supports cell
Vacuole	Contains cell sap
Plasmids	Extra genetic information in bacterial cells

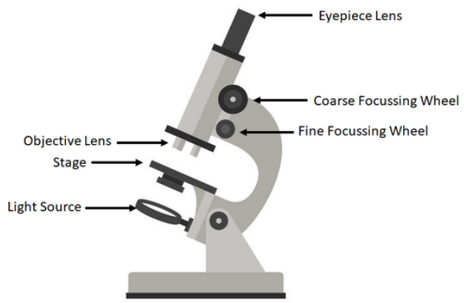
Specialised Animal Cells

Name of Cell	Picture	Function	Adaptations
Sperm Cell		Swim to and fertilise egg cell	• Tail to swim • Lots of mitochondria to provide energy to swim • Enzymes in head to digest outside coating of egg
Red Blood Cell		Carries oxygen around body	• No nucleus to carry more oxygen • Biconcave (dents in middle) shape to increase surface area • Contains haemoglobin to carry oxygen
Nerve Cell		Carry messages around body	• Long to carry impulses further • Branched to make connections with other neurons • Fatty sheath to insulate axon, so message does not get lost
Muscle Cell		Contracts for movement	• Lots of mitochondria to release energy from respiration

Specialised Plant Cells

Name of Cell	Picture	Function	Adaptations
Palisade Cell		Photosynthesis	• Lots of chloroplasts to absorb more light • Tall, block shaped to pack more cells
Root Hair Cell		Absorb water and minerals from soil	• Long to increase surface area • Thin cell wall so shorter diffusion distance
Xylem Cell		Carry water and minerals up plant	• Continuous hollow tube to carry water quicker • Made of dead cells (lignin) that strengthens walls (waterproof)
Phloem Cell		Carry dissolved sugars up and down plant	• Lots of mitochondria to release energy from respiration

Using a Microscope



1. Place the slide on the stage
2. Use the lowest powered objective lens first
3. Using the coarse adjustment wheel, move the stage until the image comes into focus
4. Once the image is focused, increase the magnification of the objective lens to the desired magnification
5. Use the fine adjustment if the image is not fully focused

Magnification of Microscope

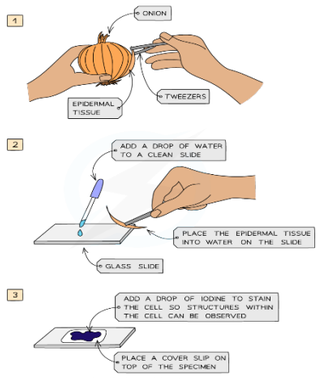
Total magnification = eyepiece magnification x objective magnification

E.g. Calculate the total magnification of a microscope with an eyepiece lens that is x5 and an objective lens that is x10

Total magnification = 10 x 5 = x50

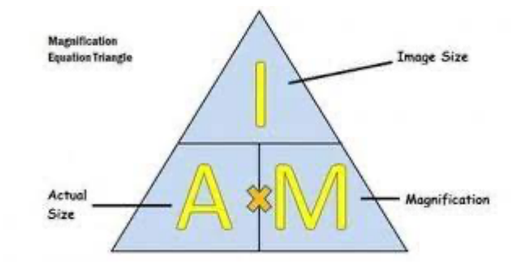
Making a Slide

1. Use forceps to peel a thin layer on onion cells. Has to be thin to allow light to pass through.
2. Place onion layer on slide
3. Add a couple of drops of stain to allow cell organelles to be seen clearly
4. Place a cover slip on top from a 45 degree angle to prevent air bubbles



Magnification Equation

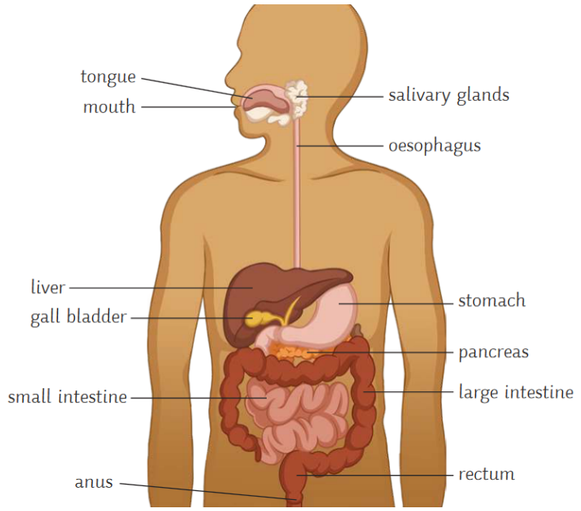
1000µm = 1mm



B2 – Digestive System

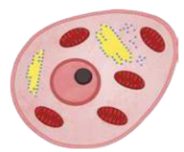
Digestive System

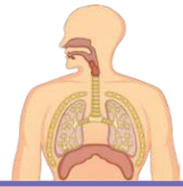
Function of the digestive system is to break down large food molecules into smaller soluble food molecules that can be absorbed into the blood.



Part of Digestive System	Function
Mouth	Teeth for mechanical digestion
Salivary Glands	Saliva to moisten food. Releases amylase to break down starch
Oesophagus	Carries food down to stomach by peristalsis
Stomach	Mechanical digestion by muscles Releases acid to kill bacteria and provide right conditions for protein digestion by protease
Liver	Makes bile
Gall Bladder	Stores bile
Pancreas	Makes digestive enzymes
Small Intestine	Where break down of food finishes then is absorbed into blood
Large Intestine	Where water is absorbed into blood
Rectum	Stores faeces

Principles of Organisation




cell	→ tissue	→ organ	→ organ system	→ organism
Cells are the basic building blocks of all living things.	A group of cells with a similar structure and function is called a tissue.	An organ is a combination of tissues carrying out a specific function.	Organs work together within an organ system.	Organ systems work together to form whole living organisms.

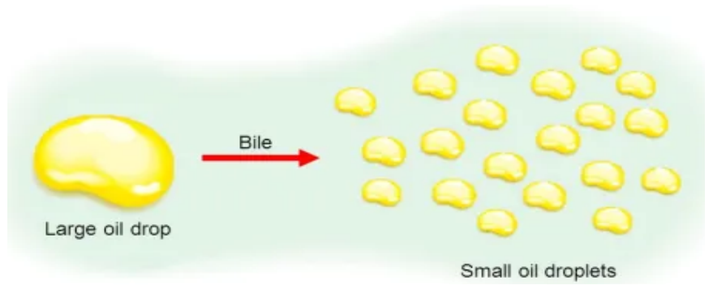
Bile

Bile is produced by the liver and then stored by the gall bladder and released when digestion takes place after a meal.

Bile has 2 jobs:-

Emulsifies Fats

Breaks down large fat droplets into smaller fat droplets to increase surface area for digestion by lipase



Neutralises Stomach Acid

When the stomach acid reaches the small intestine, bile is an alkaline solution so neutralises the stomach acid in the small intestine. Provides the right pH for enzymes in the small intestine.

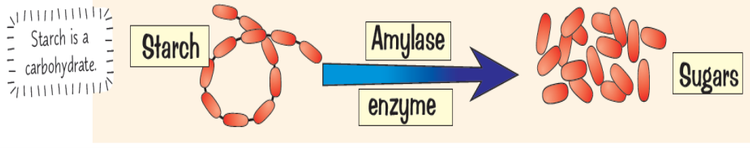
Food Tests

Food Molecule	Name of Test	Observation If Positive
Sugars (Glucose)	Benedict's solution Heated to 75^{0}C in water bath	Blue to green to yellow to brick-red depending on amount of sugar
Starch	Iodine solution	Orange-brown to blue-black
Protein	Biuret Solution	Blue to purple (lilac)
Lipids	Ethanol and Water	With ethanol colourless and then cloudy with water

Digestive Enzymes

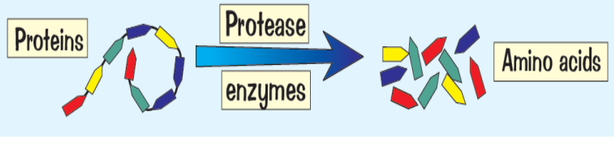
CARBOHYDRASES

- Amylase is an example of a carbohydrase.
- Amylase is made in the salivary glands, pancreas and small intestine.
- It works in the mouth and small intestine.



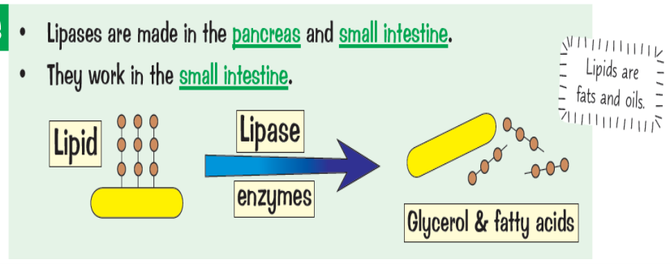
PROTEASES

- Proteases are made in the stomach, pancreas and small intestine.
- They work in the stomach and small intestine.



LIPASES

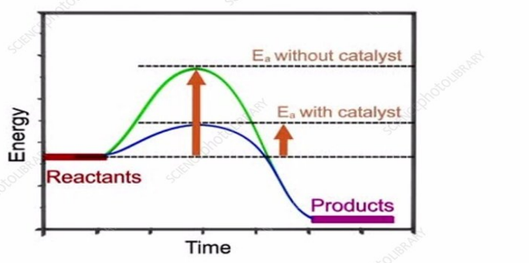
- Lipases are made in the pancreas and small intestine.
- They work in the small intestine.



B2 – Enzymes

Enzymes

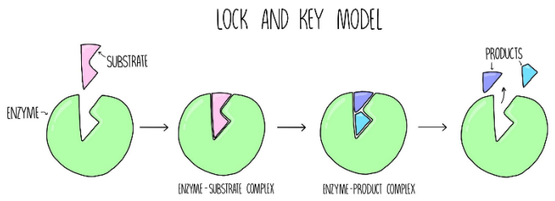
- Enzymes are proteins – made of amino acids.
- Enzymes are biological catalysts. They speed up chemical reactions inside the body.
- As they are catalysts, they provide an alternative route with a lower activation energy.



Name of Enzyme	Substrate (Polymer)	Products (Monomers)	Where is the enzyme made?
Amylase	Starch	Glucose (simple sugars)	Salivary Glands Pancreas Small intestine
Protease	Protein	Amino acids	Stomach Pancreas Small intestine
Lipase	Fats (lipids)	Fatty acids Glycerol	Pancreas Small Intestine

Lock and Key Model

- Each enzyme in the body has its own unique active site (lock)
- A substrate (key) that is complimentary (shapes match) binds to the active site of the enzyme to form an enzyme-substrate complex.
- The substrate is broken down into products by the enzyme.
- The products leave the active site, so more substrates can bind.

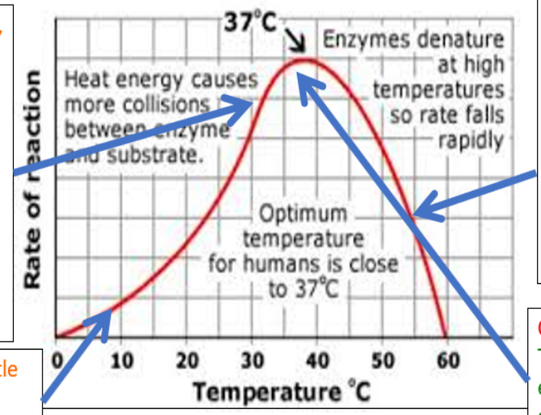


- Some enzymes have 2 substrates binding to the active site and build larger molecules than break substrates down.

Enzymes and Temperature

(H) As temp increases, particles have more energy, move faster, more collisions between enzyme and substrate, more enzyme-substrate complexes, faster reaction

(H) Low temp, very little kinetic energy, fewer collisions, fewer enzyme-substrate complexes, slower reaction



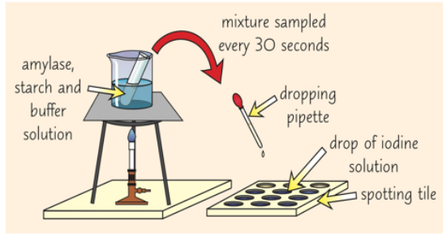
High temp, particles still have more energy, move faster, more collisions **but enzyme denatures permanently**, active site changes shape, substrate cannot fit into active site anymore, reaction stops

Optimum means best. Temp at which most enzyme-substrate complexes are formed

Exam technique
When describing graphs, look at the number of marks available for the question and break down the graph into that many parts. For example, 2 marks will mean 2 parts to the graph

Investigating Effect of pH on Enzyme Activity (RP)

1. Put a drop of iodine solution into each spotting tile
2. As shown in the diagram, heat up a beaker of water to 35°C – monitor the temperature with a thermometer. This temperature used as it is closer to optimum temperature
3. In a boiling tube, add 1cm³ of buffer solution (at a certain pH) and 1cm3 of amylase (breaks down starch into maltose)
4. Put boiling tube into beaker of water for 5mins
5. Then, add 5cm³ of starch solution using a different syringe
6. Mix contents of boiling tube, and start stopwatch
7. Every 30seconds, remove a fresh sample of solution from boiling tube, and add it to the well in the spotting tile – iodine should turn from orange to blue-black
8. Keep repeating until the iodine has no colour change (stays orange-brown) – all starch has been broken down
9. Repeat with different pH buffers

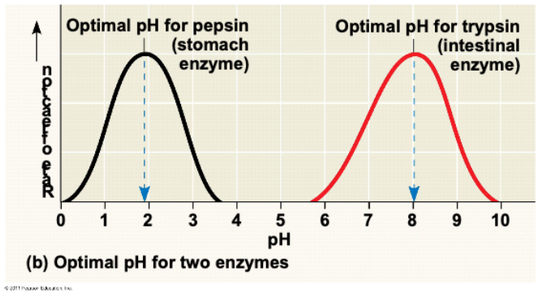


Alternative Equipment
Use water bath to control temperature
pH meter to measure the pH of buffer

Possible Sources of Error
Not controlling temperature
Volumes vary from one pH to the other
Judgement of colour change

Enzymes and pH

- Enzymes can have a different optimum pH depending on their location in the body.
- For example, the stomach is acidic and therefore enzymes in the stomach have an optimum pH of around 2.
- Once the enzymes from the stomach get into the small intestine where the pH is around 7, the enzymes denature and stop working,
- Enzymes in the small intestine will have an optimum pH between 7 and 8.



- If the pH gets too high or too low from the optimum pH, the enzyme denatures.
- This means the active site changes shape.
- Substrate cannot fit.
- Enzyme activity decreases.

B2/B3 – Communicable and Non-Communicable Diseases

Non-Communicable Diseases

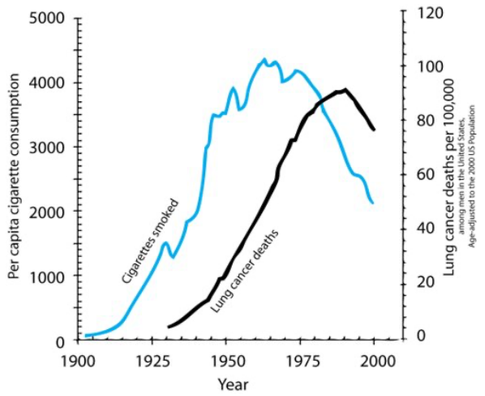
A non-communicable disease is one where the disease cannot be spread from person to person by a pathogen e.g., CHD, lung cancer

Lifestyle risk factors are factors that increase the chance of getting a disease but can be controlled by a change in lifestyle e.g., diet, smoking, drinking alcohol

Medical risk factors are factors of underlying health that influences another disease e.g., diabetes, high blood pressure, genetics.

Correlation and Causes

Correlation is a link between 2 factors. It can be a positive correlation or a negative correlation. The graph below shows a positive correlation between cigarette smoking and incidence of lung cancer. However, a correlation does not mean that one thing causes the other. For this, scientific evidence is needed and here the scientific evidence is of cigarette smoke containing carcinogens that cause mutations and cancer.

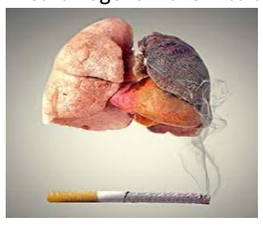


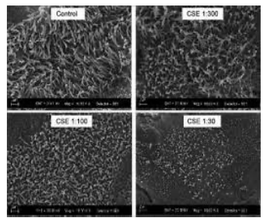
On the other hand, there is a also a positive correlation between number of ice cream sales and people getting hay fever. However, eating ice cream does not cause hay fever. A third factor of increasing temperatures (summer) causes both to rise

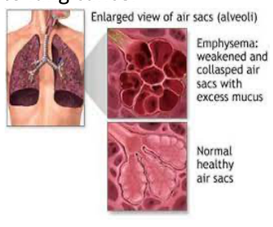
Effects of Smoking

Smoking contains the following chemicals with the effects they have on the body

- Nicotine – stimulant causing high blood pressure and higher heart rate
- Tar – black thicky substance deposited in lungs/alveoli and reduces gas exchange
- Carbon monoxide – stops red blood cells carrying oxygen
- Particulates – small particles deposited in airways and causes asthma/difficulty breathing
- Carcinogens – chemicals that cause mutations leading to lung cancer







Other effects of smoking include loss of alveoli, so less gas exchange and oxygen into blood causing breathlessness
Paralyses cilia, so mucus that traps pathogens is not removed causing infections to be more likely

Disease Interactions

Having one type of illness can often make a person more susceptible to another type of illness:

- immune disorders → increased risk of infectious disease
- viral infection of cells → increased risk of cancer
- immune reactions → can trigger allergies
- very poor physical health → increased risk of depression or other mental illness

Health and Disease

Health is the state of being free from **illness** or **disease**. It refers to **physical** and **mental** wellbeing.

Disease and lifestyle factors, such as diet, stress, smoking, alcohol consumption and the use of illegal drugs, can all impact the health of a person.

Some conditions are associated with certain lifestyle choices:

- Liver conditions are associated with poor **diet** and prolonged excessive **alcohol** consumption.
- Lung cancer is associated with **smoking**.
- Memory loss, poor physical health and hygiene are associated with the use of illegal or recreational **drugs**.
- Obesity and diabetes are associated with poor diet.
- Anxiety and depression are associated with **stress** and prolonged excessive alcohol consumption.

Communicable Diseases

Communicable diseases can be spread from on person to another by a pathogen.
A pathogen is a micro-organism that causes a disease.
The 4 types of pathogens are:-

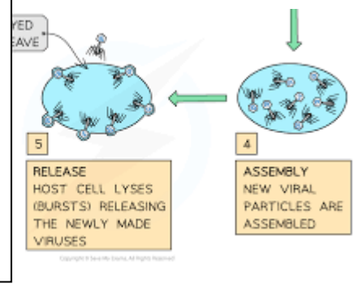
- Bacteria
- Virus
- Protists
- Fungi

Causing Symptoms

Bacteria cause symptoms by producing toxins and reproducing rapidly (once every 20mins) if conditions are optimal

Viruses cause symptoms by replicating inside living host cells and then damaging them on their way out.

Bacteria can be treated with antibiotics, but viruses cannot as the antibiotic cannot get into host cells to kill



Name of Disease	Type of Pathogen	How it Spreads	Symptoms	Treatment (T)/Prevention (P)
Salmonella	Bacteria	Uncooked food (usually poultry/eggs)	Fever, stomach cramps, vomiting, diarrhoea	Cooking food properly (P) Vaccinations of poultry (P)
Gonorrhoea	Bacteria	Sexually transmitted	Pain when urinating and thick yellow/green discharge from penis or vagina	Antibiotics (T)
HIV	Virus	Exchange of bodily fluids (sex or blood)	Flu-like symptoms but leads to AIDS where virus kills body's white blood cells (more infections)	Antiretroviral drugs (T) Condoms (P)
Measles	Virus	Through the air (sneezing or coughing)	Fever, red skin rash	Vaccinations (P) Face masks (P), Isolation (P)
TMV	Virus	Contact from infected leaves	Leaves discoloured, less chlorophyll, less photosynthesis to make less glucose	Burn infected leaves (P) Sterilising gardening equipment (P)
Rose Black Spot	Fungus	Wind or water	Black spots on leaves, less chlorophyll, less photosynthesis to make less glucose	Fungicides (T) Burning/taking off infected leaves (P)
Malaria	Protist	Mosquitoes	Fever, headache, tiredness	Insecticides (P), insect repellent sprays (P), mosquito nets (P), drugs (T/P)

B3 – Fighting Disease

Body's Natural Defences

These are mechanisms by which the body prevents pathogens from entering the blood/lungs/body.

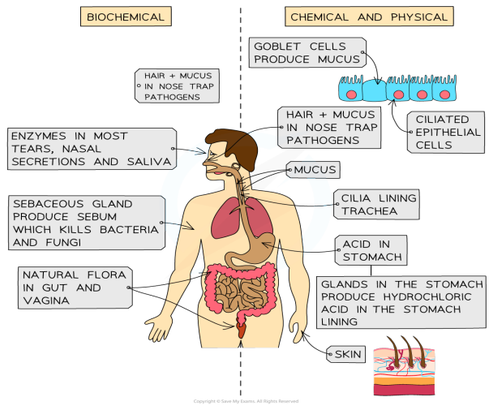
Skin – physical barrier that prevents entry of most pathogen. Skin also secretes chemicals that have antimicrobial properties.

Scabs – prevents entry of pathogen through cuts and wounds.

Mucus and Cilia – in the airways, such as trachea and nose (as well as other tubes in the body). Mucus traps pathogens and dirt, whilst cilia sweep mucus towards the top of the oesophagus to be swallowed.

Stomach acid – stomach releases hydrochloric acid to kill pathogens that are ingested via food.

Tears – contain lysozymes (enzymes which kill pathogens)

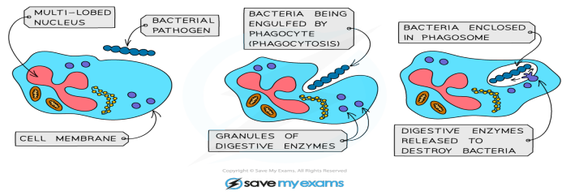


White Blood Cells

There are 3 ways by which white blood cells fight infections.

Phagocytosis

This is when white blood cells engulf and surround the pathogen. They then ingest the pathogen and break it down using enzymes.

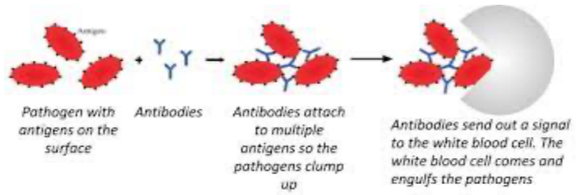


Produce Antitoxins

These are released to neutralise toxins that are released by pathogens.

Produce Antibodies

Antibodies stick to antigens on the surface of pathogens, causing them to clump together. This makes it easier to kill pathogens by phagocytosis.

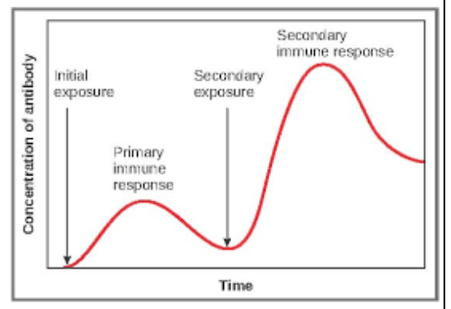


Different pathogens have different antigens on their surface and therefore require different antibodies that are complimentary to their shape. This means antibodies against measles will not work against the flu virus.

Primary vs Secondary Immune Response

In the primary immune response, it takes time for the white blood cells to recognise the antigens on the pathogen. So, there is a lag phase before it produces a small number of antibodies slowly.

If the person is infected again with the same pathogen, memory cells in the blood remember the antigens on the pathogen and produce a large number of antibodies quickly.



Vaccinations

- Vaccine contains a dead, weak, or inactive form of the pathogen.
- This causes the white blood cells to produce antibodies.
- Memory cells stay in the blood.
- If infected with the live pathogen, the memory cells produce a large number of antibodies very quickly.
- Antibodies help kill pathogens before symptoms appear.

Herd Immunity

This is when a large percentage of the population is vaccinated. This means it is very unlikely for an infected person to come across a person that is unvaccinated. This means it is very difficult for the disease to be spread.

Pros

Herd Immunity, eradicate infectious diseases and cheaper in long run for NHS

Cons

Not all people react the same – can have side-effects.

Stages in Drug Testing

1st Stage
Chemical synthesis in the lab. Computer modelling to see the structure of the drug, and its interactions with substances in the body. **Tested for toxicity**

2nd Stage
Testing in the lab on live human cells and animals. **Tested for toxicity**

Small doses at the start of the clinical trial. If drug is safe, further trials carried out to find optimum dose

3rd Stage (Phase 1 of clinical trials)
Testing on human volunteers that are healthy. **Tested for toxicity**

4th Stage (phases 2 and 3 of clinical trials)
Tested on small number patients that have the disease. Then, tested on a large number of patients. **Tested for efficacy (how well it works) and safe doses**

Different Types of Clinical Trials

Blind Trial – only the doctor knows whether the patient has been given a placebo or the real drug

Double Blind Trial – both the patient and doctor do not know whether the patient has been given the placebo or the real drug

Open Label – both the patient and doctor know whether the patient has been given the placebo or the real drug

Placebo – substance that has the appearance of the real drug but has no biological effect

Antibiotics and Painkillers

- Painkillers, such as paracetamol and ibuprofen, are used to treat symptoms of disease, such as pain and fever.
- Antibiotics kill only bacterial infections.
- Cannot be used to treat viral diseases, such as measles and HIV, as viruses replicate inside cells and antibiotics cannot access cells.
- Over the last 20/30 years, there has been an increase in antibiotic resistant bacteria. These are bacteria that cannot be killed by antibiotics, due to a mutation in their DNA which gives them a survival advantage.
- Antibiotic resistant bacteria have increased because…
  - Overprescribing antibiotics for minor infections or viral diseases.
  - People not finishing their courses.
  - Use of antibiotics in agriculture (chickens).

Drugs from Plants/Microorganisms

Aspirin

- From the bark of a willow tree.
- Used as a blood thinner or pain relief.

Digitalis

- From the foxglove plant.
- Used to treat heart arrhythmias.

Penicillin

- Discovered by Alexander Fleming and released by the mould Penicillium.
- Antibiotic used to kill bacteria.

B2/B4 – Plant Leaf Structure and Photosynthesis

Tissues, Organs and Systems

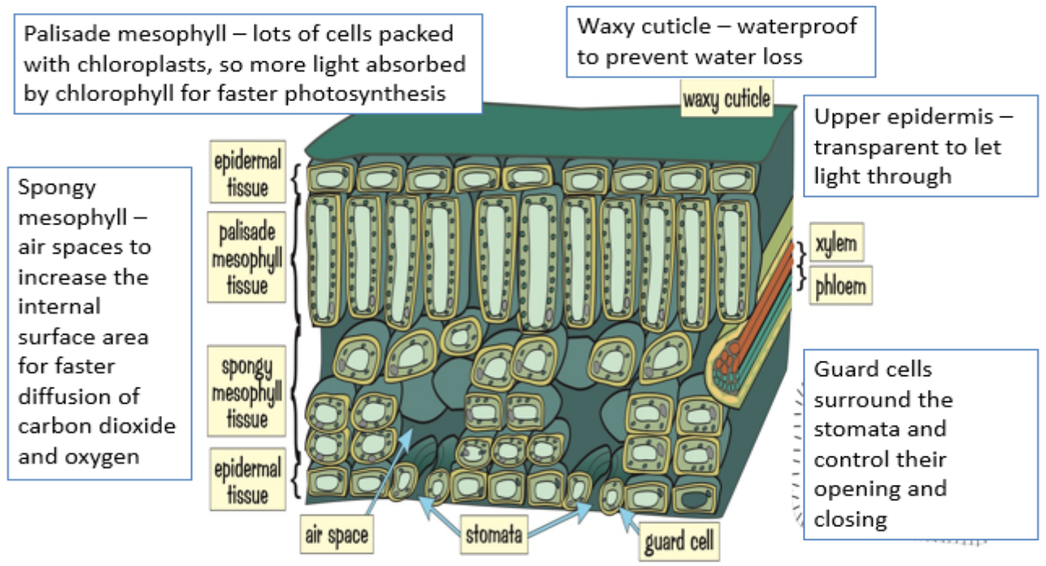
A tissue is a group of specialised cells working together to perform a particular function

An organ is a group of different tissues working together to perform a particular function

A system is a group of different organs working together to perform a particular function

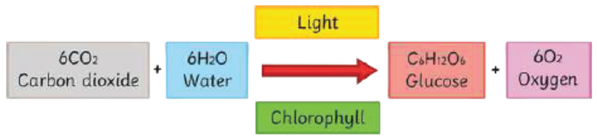
Cell	Tissue	Organ
Root hair	Spongy mesophyll	Leaf
Guard cell	Palisade mesophyll	Roots
	Xylem	Stem
	Epidermal tissue	
	Meristem	
	Phloem	

Plant Leaf Structure



Stomata – tiny holes found mainly on the underside of the leaf. Allows carbon dioxide to enter and oxygen to leave. Also, will close at night and at other times to prevent water loss.

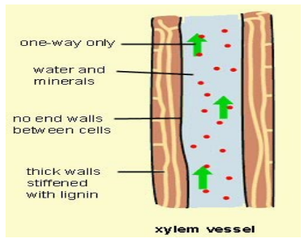
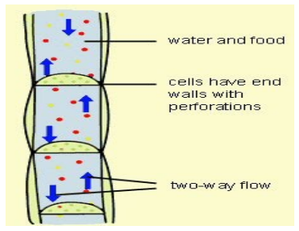
Photosynthesis



- Carbon dioxide enters from the air into the leaves through the stomata
- Water enters from the soil through the roots
- Light is absorbed by a green pigment found inside chloroplasts called chlorophyll
- Photosynthesis is an endothermic reaction as it absorbs (light) energy from the surroundings
- Photosynthesis takes place inside chloroplasts in order for plants to make their own food (glucose)

Uses of Glucose

- Respiration to release energy
- Store as insoluble starch
- Make cellulose for cell walls
- Make fats/oils
- Make amino acids to turn into proteins for growth

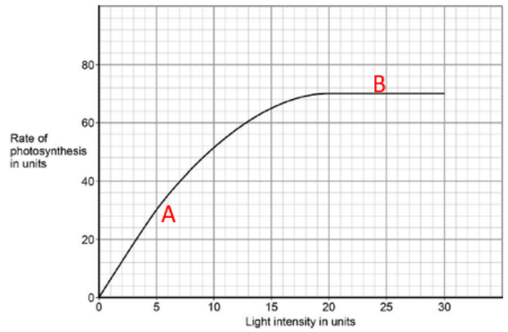
	Xylem	Phloem
Picture		
Function	Carries water and minerals	Carries dissolved sugar
One way or two-way movement?	One way up the plant	Two-way movement up and down the plant
Living or dead cells?	Dead	Living
Composition of cell wall	Made of lignin to strengthen the cell to withstand pressure	Made of cellulose
Other Adaptations	Hollow continuous tube so easier to carry water	Sieve plates at end of cells to allow movement of sugars Lots of mitochondria to provide energy

Limiting Factors of Photosynthesis

A limiting factor is a factor that if the plant does not have enough of, it slows down the rate of photosynthesis. There are 4 limiting factors of photosynthesis…

- Light intensity
- Carbon dioxide concentration
- Temperature
- Amount of chlorophyll

Exam Style Questions



At point A, what is the limiting factor? Explain your answer (use the sentence copi your book to structure your answer)

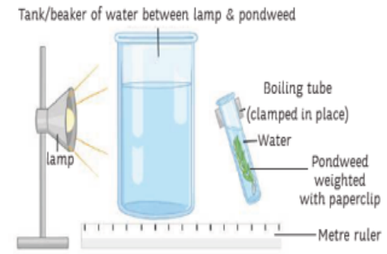
Light intensity is the limiting factor because when light intensity is increased, rate photosynthesis also increases

What is the limiting factor at point B?

Carbon dioxide concentration or temperature

Photosynthesis (RP)

1. Set up the equipment as shown in the diagram
2. Put sodium hydrogencarbonate into the boiling tube with the pondweed. This makes sure that carbon dioxide is not the limiting factor
3. Place the light source 10cm away from the pondweed, and measure the volume of oxygen given off in 1min
4. Repeat by moving the light 20cm away from the pondweed. Increasing the distance decreases the light intensity
5. Repeat each length 3 times to identify anomalous results and reduce effect of random errors



This is the 'proportional to' symbol.

$$\text{light intensity} \propto \frac{1}{\text{distance (d)}^2}$$

Errors

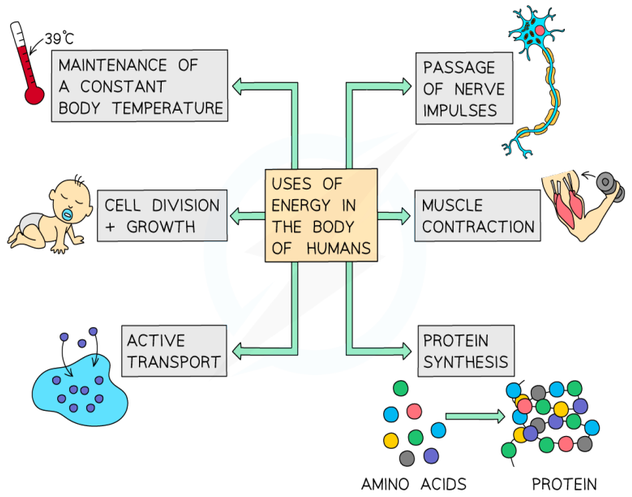
- Counting the number of bubbles would be less accurate, due to miscounting and the bubbles not being the same size
- The light source can increase the temperature of the water. To reduce this, use a more efficient light bulb, or place the boiling tube inside a beaker of water (absorbs heat)

B4 – Respiration and Metabolism

Purpose of Respiration

Chemical reaction in every cell of every living organism designed to release energy from glucose.

The energy released from respiration is used for….



Aerobic Respiration

The equation for aerobic respiration in all organisms is below,

GLUCOSE + OXYGEN ⟶ CARBON DIOXIDE + WATER

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

Also, releases energy to the surroundings, so is an exothermic reaction.

Happens in the mitochondria of Eukaryotic cells.

Changes in the Body During Exercise

During exercise, the following changes take place.

Increase breathing rate – increase oxygen into the body for aerobic respiration to release more energy.

Increase heart rate – increase oxygen and glucose around the body for aerobic respiration to release more energy.

Exercise causes respiration to increase

Cells need more oxygen

Breathing rate and volume increases

Heart rate increases

Anaerobic Respiration in Animals

This is the incomplete breakdown of glucose. Anaerobic means 'without oxygen'. The equation for anaerobic respiration in animals is below,

glucose → lactic acid (+ energy)

Animals use anaerobic respiration to release extra energy they may need during vigorous exercise. This means that they still continue with aerobic respiration but top up the energy with anaerobic respiration.

Disadvantages of Anaerobic Respiration

- Releases less energy.
- Produces lactic acid, which is poisonous and causes enzymes in muscle to denature.

Similarities between Aerobic and Anaerobic Respiration in Animals

- Both use glucose
- Both release energy

Differences between Aerobic and Anaerobic Respiration in Animals

- Aerobic uses oxygen, anaerobic does not.
- Aerobic releases lots of energy, anaerobic releases very little.
- Aerobic produces carbon dioxide, anaerobic produces lactic acid.
- Aerobic takes place in the mitochondria, anaerobic takes place in the cytoplasm.

Anaerobic Respiration in Plants/Yeast

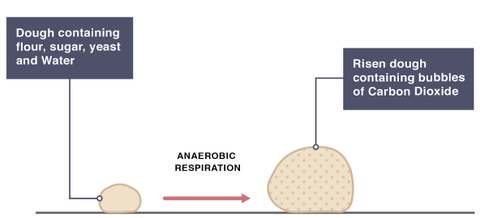
The equation for anaerobic respiration in plants/yeast is below,

glucose –> ethanol + carbon dioxide

In plants, anaerobic respiration often takes places in the roots of plants in waterlogged soils. The soil has very few air pockets, so little oxygen. This means the roots have less energy for active transport of minerals into the soil.

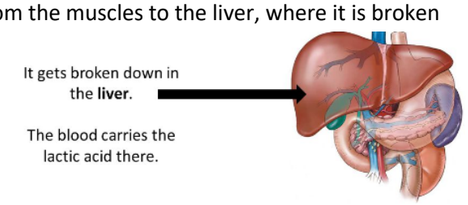
Fermentation

Anaerobic respiration in yeast is called fermentation. This process is used by humans to make beer (ethanol) and make bread (carbon dioxide causes the bread to rise).



Oxygen Debt (HT only)

- This is the amount of oxygen needed after exercise to completely break down the lactic acid.
- This is the reason, the breathing rate (and heart rate) remains high after exercise.
- Recover period is the time taken for breathing rate (and heart rate) to return to normal. Fitter people have a quicker recovery period.
- The lactic acid is taken in the blood from the muscles to the liver, where it is broken down into carbon dioxide and water.



Cardiac Output (HT only)

- Cardiac output → total volume of blood pumped by the heart in one minute.
- Heart rate → number of heart beats per minute
- Stroke volume → volume of blood per heart beat

Cardiac output = heart rate x stroke volume

People that are healthier and fitter, have a lower heart rate but a greater stroke volume. This means their heart is more efficienct and stronger and still maintains the same (or even higher cardiact output)

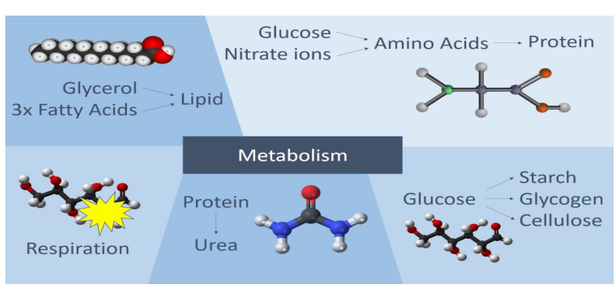
Metabolism

Metabolism is the sum of all the chemical reactions inside the body.

Example of reactions include: -

- Respiration
- Converting glucose to starch, cellulose, and glycogen
- Use of nitrates and glucose to make amino acids, which are joined together to make proteins,
- Making fat (lipid) molecules from 1 glycerol molecule and 3 fatty acids.
- Breakdown of excess proteins to make urea for excretion via urine.

Metabolism can be affected by age, gender, health, genetics, and ethnicity amongst other factors.



B5 – Homeostasis and Nervous System

Homeostasis

Homeostasis is keeping conditions inside the body constant. This is so….

- Enzymes work at their optimum
- Cells function properly.

Conditions that need to be kept constant include….

- Body temperature
- Blood glucose levels
- Body water levels

The 2 control systems involved in homeostasis include…

- Endocrine
- Nervous

Comparison of Nervous and Endocrine System

	Nervous	Endocrine
Fast or slow?	Faster	Slower
Short or long-lived?	Short-lived	Long-lived
Type of message	Electrical impulse	Hormones
Transmission via…	Neurons	Blood
Generalised or localised?	Localised	Generalised

Response pathway

All responses to stimuli that involve the nervous system include the following pathway.

- Stimulus – change in environment.
- Receptor – detects stimulus.
- Sensory neuron – carries impulse from receptor to CNS
- Co-ordination centre – receives and processes information (includes relay neurons)
- Motor neuron – carries impulse from CNS to effector.
- Effector – a muscle or gland that brings about response.
- Response – action from body due to stimulus

Example

- Stimulus – body temperature increases
- Receptor – receptors in skin/brain detect increase in body temperature.
- Sensory neuron – carries impulse from receptors to the brain.
- Co-ordination centre – hypothalamus in brain processes information
- Motor neuron – carries impulse from CNS to sweat glands.
- Effector – sweat glands.
- Response – sweat glands produce sweat.

Organisation of the Nervous System

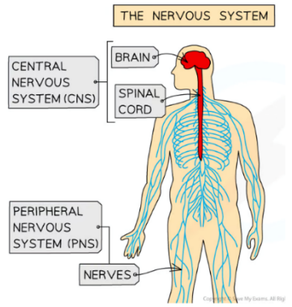
The nervous system includes the central nervous system and the peripheral nervous system.

The central nervous system includes the….

- Brain
- Spinal cord

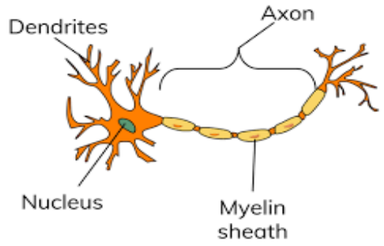
The peripheral nervous system includes the…

- Sensory neurons
- Motor neurons



Nerve Cells

Nerve cells (neurons) carry electrical impulses from one part of the body to another. They have the general structure as shown on the right.

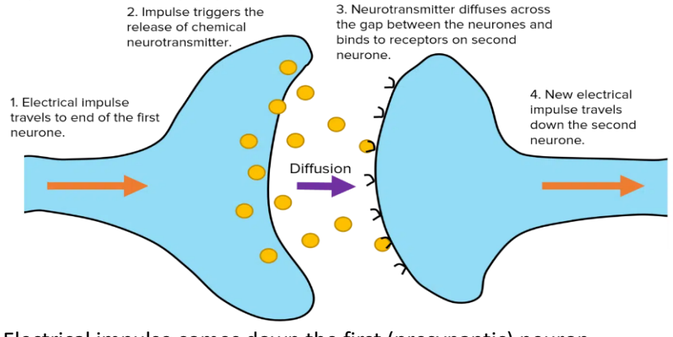


Adaptations

Long axon – carries electrical impulses a long distance with fewer synapses, so transmission is faster.
Fatty myelin sheath – insulates axon, so electrical impulse is not lost and transmitted faster.
Dendrites/Nerve Endings – makes connections with other neurons, as well as receptors and effectors.

Synapses

A synapse is a very tiny gap (junction) between 2 neurons.



1. Electrical impulse comes down the first (presynaptic) neuron.
2. Chemicals called neurotransmitters are released into the synapse.
3. Neurotransmitters diffuse across the gap.
4. They bind to receptors on second (postsynaptic) neuron.
5. This causes an electrical impulse in the second neuron.

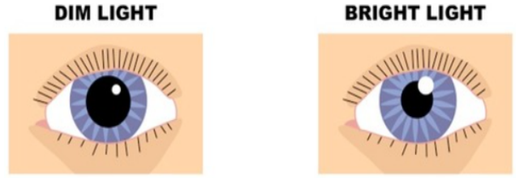
Reflexes

Reflexes are rapid, involuntary responses that do not require conscious thought.

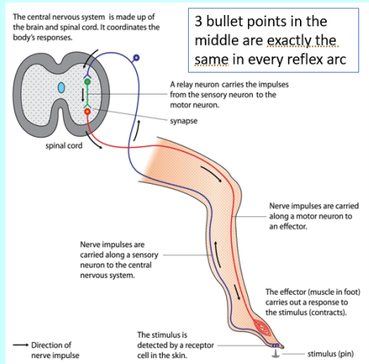
Reflexes ensure that organisms do not come to any harm, and they survive.

Human reflexes include…

- Pupil reflex in eye
- Knee jerk reflex
- Grasping reflex in babies
- Sucking reflex in babies



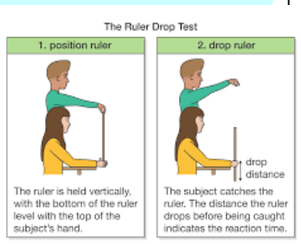
General Structure of a Reflex Arc



- The stimulus is the pin, which is detected by touch receptors in the skin.
- ***Sensory neuron carries the impulse from the receptor to the spinal cord***
- ***Relay neuron carries the impulse from the sensory neuron to the motor neuron within the spinal cord***
- ***Motor neuron carries the impulse from the spinal cord to the effector***
- The effectors, muscles in the legs contract to move the foot away

Reaction Time Practical

This is done in school using the ruler drop test.



1. Place the forearm with elbow resting on the table.
2. Ensure 0cm on ruler is between the thumb and first finger.
3. Another student drops ruler and student catches ruler.
4. Measure length on ruler.
5. Convert distance to reaction time using conversion table.
6. Repeat test to obtain mean reaction time.
7. Repeat by changing independent variable.

Important Notes

The average reaction time of a person is 0.7s, with reactions times generally being between 0.2s and 0.9s. In the ruler drop test, the reaction time will generally be quicker than normal as people can predict when ruler will be dropped, and due to practice.

Another method to measure reaction time would be to use a computer test. This would be more accurate as it measures reaction time directly, has a higher resolution and cannot be predicted.

Independent variables that could be tested are caffeine concentration, gender, age, hand tested, and different distractions (sound/light). Only one factor would be changed and other factors would be kept constant.