Knowledge organiser title	Specification topic	Page numbers
Cell Biology	B1 Cell Biology	**2-6**
Organisation (lungs, heart and health)	B2 Organisation	**7-11**
Organisation (digestive system and enzymes)	B2 Organisation	**12-14**
Infection and response	B3 Infection and response	**15-19**
Bioenergetics (respiration, effects of exercise and metabolism)	B4 Bioenergetics	**20-22**
Bioenergetics (plant structure and photosynthesis)	B4 Bioenergetics	**23-28**

Required practical	Page number
Microscopy	**4**
Food tests	**14**
Effect of pH on an enzyme	**14**
Culturing microorganisms	**19**
Osmosis	**23**
Effect of light intensity on photosynthesis	**25**

2 BIOLOGY Cell Biology – Knowledge Organiser Paper 1: KS4

Animal cells	Plant cells	Plant cell differentiation and specialisation	Cells tissues and organs	Eukaryotes and prokaryotes	Light & electron microscopes	Magnification	Microscopy RP	Chromosomes and mitosis

Key Words

Key Word	definition
Specialised cells	cells designed to carry out a particular role in the body, such as red blood cells
Organelle	Parts of cells with a job
Unicellular	Made of one cell
Respiration	A chemical reaction in mitochondria- releases energy
Prokaryote	Bacteria cells – no nucleus
Plasmid	A circular strand of DNA found in bacteria cells
Differentiation	Cells becoming specialised cells

Misconceptions

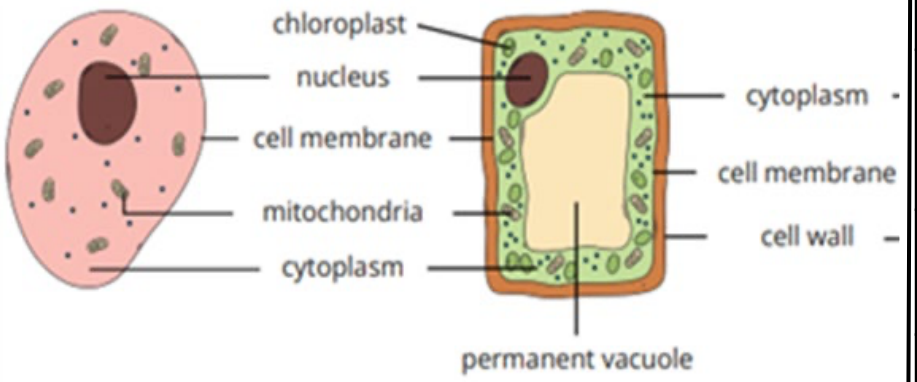
- Zooming in does NOT make the image clear (Focusing using focusing knob)
- Not All bacteria/germs are bad (Bacteria can be useful)
- Mitochondria do not **make** energy (mitochondria -release energy by respiration)
- Cell wall does not **protect** the pant (provides support)
- Nucleus is not the Brain of a cell (Contains DNA)

Key questions

- Describe how to use microscope
- Describe advantages and disadvantages of adult and embryonic stem cells
- Name the parts and functions of plant and animal cell organelles.
- Describe the 3 stages of the cell cycle
- Compare prokaryote and eukaryote cells

3 BIOLOGY Cell Biology - Knowledge Organiser Paper 1: KS4

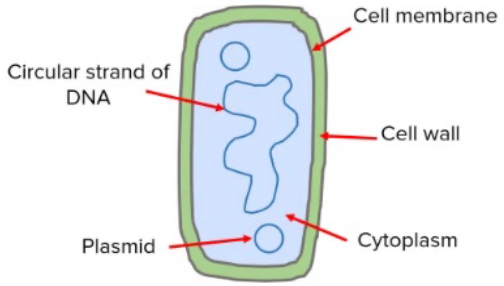
Plant and animal cells



Cell Organelles and functions

Organelle	Function
Nucleus	It contains genetic material (DNA)
Cell membrane	Controls the movement of substances into and out of the cell.
Cytoplasm	Where chemical reactions occur.
mitochondria	aerobic respiration
Ribosomes	Make proteins
Cell wall	provides support for the plant
Chloroplast	Contain a pigment called chlorophyll-photosynthesis
Permanent vacuole	Filled with cell sap

Prokaryote



Specialised cells

Cell	Function	How adapted to carry out function
red blood cell	To transport oxygen	Biconcave shape increases the surface area for the diffusion of oxygen. No nucleus so that there is more room for oxygen
muscle cell	Contract to move bones	Lots of mitochondria to release energy for muscle contraction
sperm cell	To join with an egg cell	Long tail for movement to the egg and lots of mitochondria to release energy
palisade cell	To carry out photosynthesis	Lots of chloroplasts to absorb light energy for photosynthesis. Its tall, long shape gives the cell a large surface area to maximise the absorption of light.
root hair cell	To absorb water and minerals	Long protrusion provides a large surface area for the absorption of water and minerals into the cell.
xylem	carry water and minerals	TRANSPIRATION - dead cells cell walls toughened by lignin flows in one direction
phloem	carry glucose	TRANSLOCATION - living cells cells have end plates with holes flows in both directions

Comparing cells

Sub-Cellular Structure	Animal Cell	Plant Cell	Bacterial Cell
nucleus	✓	✓	×
circular DNA	×	×	✓
mitochondria	✓	✓	×
chloroplasts	×	✓	×
cell wall	×	✓	✓
cell membrane	✓	✓	✓
cytoplasm	✓	✓	✓
flagellum	×	×	✓
permanent vacuole	×	✓	×
plasmids	×	×	✓

Cell differentiation

As an organism develops, cells differentiate to form different types of cells.

- animal cells -differentiate at an early stage.
- plant cells differentiate throughout their life.

4 BIOLOGY Cell Biology - Knowledge Organiser Paper 1: KS4

Organisation

Cell	Function
	A **cell** is the smallest unit of a living organism
	A **tissue** is a group of similar cells of the same type working together to carry out a job.
	An **organ** is a group of different tissues working together to carry out a job.
	An **organ** system is a group of different organs working together to perform a particular function.

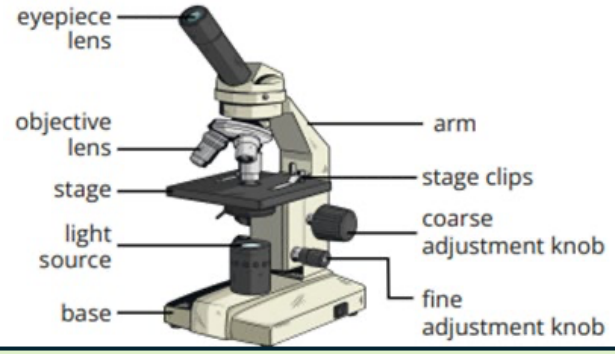
Magnification calculations

$$\text{Magnification} = \frac{\text{Size of image}}{\text{Actual Size}}$$

Comparing microscopes

Feature	Light (optical) microscope	Electron microscope
Radiation used	Light rays	Electron beams
Max magnification	~ 1500 times	~ 2 000 000 times
Resolution	200nm	0.2nm
Size of microscope	Small and portable	Very large and not portable
Cost	~£100 for a school one	Several £100,000 to £1 million plus

Microscopes



Conversion of units

1mm= 1000 micrometers
millimeters --> micrometers X1000

How to use a microscope

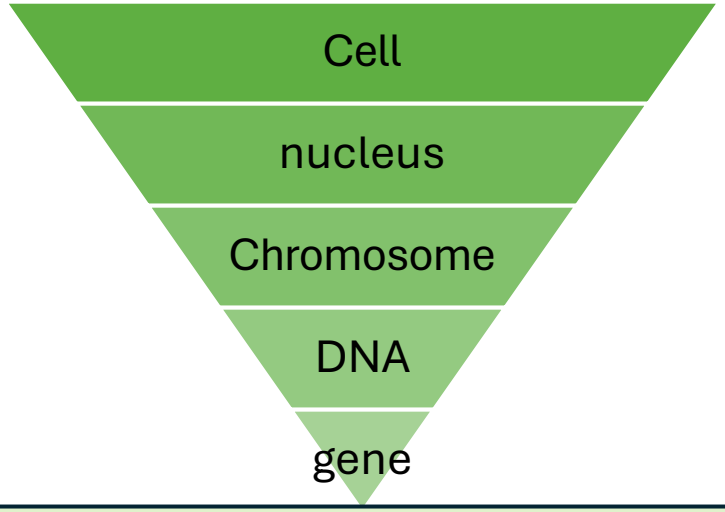
1. Make sure the objective lens with the lowest magnification is in use.
2. Put the slide on the stage.
3. Turn the coarse focus knob upwards to manually focus the image.
4. Use the fine focus knob to focus the image further.
5. Switch to an objective lens with a higher magnification and repeat above steps.

How to set up a microscope

1. Peel off a thin piece of onion skin.
2. Lay the onion flat on the surface of the slide
3. Add a small drop of iodine solution to the onion.
4. Lower the thin glass coverslip or cover glass onto the slide. Make sure there are no air bubbles.
5. Place the glass slide onto the stage on the microscope

5 BIOLOGY Cell Biology - Knowledge Organiser Paper 1: KS4

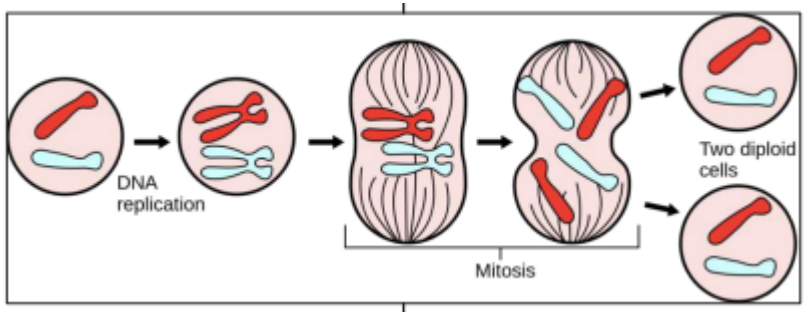
Cells ⟹ Genes



Mitosis and the cell cycle

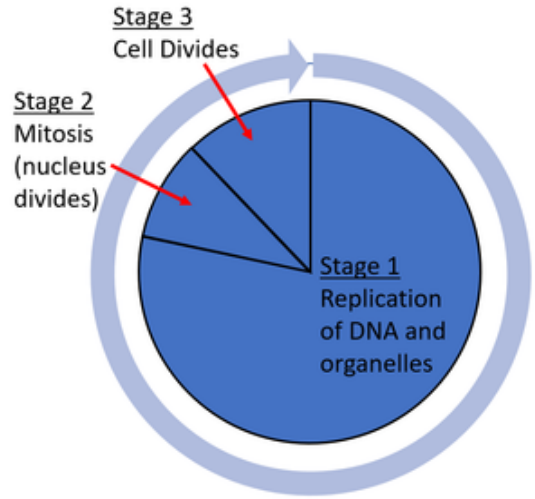
Mitosis occurs during

- growth
- repair
- replacement of cells



Mitosis and the cell cycle

Cells divide in a series of stages. The genetic material is doubled and then divided into two identical cells.



Stage 1	Growth	• Increase the number of sub-cellular structures e.g. ribosomes and mitochondria • DNA replicates • Cell grows
Stage 2	Mitosis	• One set of chromosomes is pulled to each end of the cell • nucleus divides.
Stage 3	Cell divides	• cytoplasm and cell membranes divide • two genetically identical cells produced

Stem Cells

Undifferentiated cell of an organism

Can differentiate to form many other cell types.

2 types in animals:

- Human Embryonic stem cells
- Adult bone marrow stem cells

Therapeutic cloning

- In therapeutic cloning an embryo is produced with the same genes as the patient.
- Stem cells from the embryo are not rejected by the patient's body
- used for medical treatments

Treatment using stem cells

- Treatment with stem cells - diabetes and paralysis.
- Some people object to the use of stem cells on ethical or religious grounds

Human Embryonic stem cells

Advantage

- Can differentiate into many different types of cell
- Can be used to treat many diseases e.g. cancer, diabetes, dementia

Disadvantage

- Embryo is killed/ Embryo can't consent
- Risk if infection
- Rick of cancer

Adult bone marrow stem cells

Advantage

- Can differentiate into some types of cells e.g. red blood cell
- Can be used to treat some diseases
- No ethical issues- adult can consent

Disadvantage

- Can only treat a few diseases
- Risk if infection
- Rick of cancer

Meristems (plants stem cells)

Can differentiate into any plant cell type throughout the life of the pant.

Used to produce clones quickly and economically, e.g. rare species, crop plants with pest /disease resistance

7 BIOLOGY B2 Organisation (Lungs, Heart & Health) - Knowledge Organiser Paper 1: KS4

Lungs and dissection 1	Lungs and dissection 2	Diffusion theory	Diffusion examples 1	Diffusion examples 2	The blood	Blood vessels	The heart and circulatory system 1	The heart and circulatory system 2	Coronary heart disease 1	Coronary heart disease 2	Risk factors for health and cancer

Key Words

Key Word	Definition
Alveoli	Air sacs in the lungs where gas exchange takes place
Trachea	A tube that takes air from the mouth and nose to the bronchi
Bronchi	Where the tracheas splits into to tubes to take air to the lungs
Diffusion	The movement of gas or liquid particles from a high concentration to a low concentration across a partially permeable membrane
Oxygenated	Blood that is carrying oxygen
Deoxygenated	Blood that is carrying carbon dioxide and no oxygen
Capillary	The smallest blood vessel that allows the exchange of substances from the blood to the cells and vice versa
Coronary artery	The heart has a left and right coronary artery that
Malignant	A cancerous tumour
Benign	A non-cancerous tumour

Misconceptions

That the blood carries oxygen and carbon dioxide – it is the red blood cells that carry oxygen and plasma that carries carbon dioxide

That the heart has a double circulatory system because it pumps blood twice – it is the left ventricle that pumps the blood to the body and the right ventricle that pumps the blood to the lungs

That the artery has the widest lumen because it is the 'biggest' blood vessel – veins have wider lumens than arteries and artery's have thicker walls than veins

That the heart receives oxygen from the blood that flows through the chambers – the coronary artery supplies the heart with it's own oxygen supply

That certain lifestyle choices will definitely lead to diseases. They are risk factors e.g. smoking dramatically increases the risk of lung cancer

Key questions

What is the definition of diffusion?

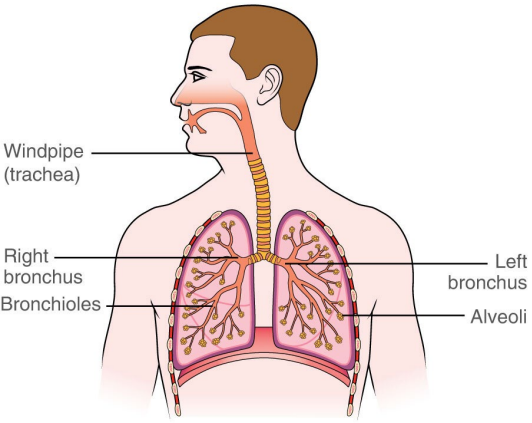
How are the alveoli adapted for gas exchange?

What is meant by the heart having a double circulation system system?

How is coronary heart disease caused and what are the treatments?

How does cancer form and what are the risk factors for cancer?

The Lungs and Gas Exchange

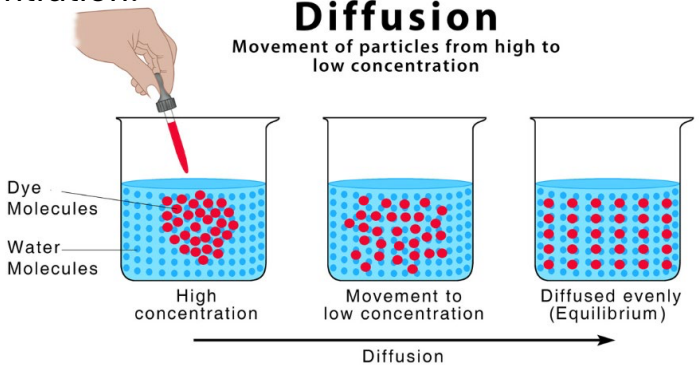


Oxygen diffuses from the alveoli into the blood stream, from a high the low concentration, by diffusion.

Carbon dioxide diffuses from the blood capillaries into the alveoli, from a high to low concentration, by diffusion.

Diffusion

Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of higher concentration to an area of lower concentration.

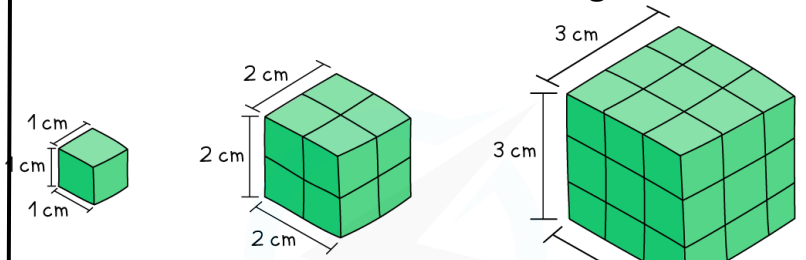


Biological Examples of Diffusion

Some of the substances transported in and out of cells by diffusion are oxygen and carbon dioxide in gas exchange, and of the waste product urea from cells into the blood plasma for excretion in the kidney.

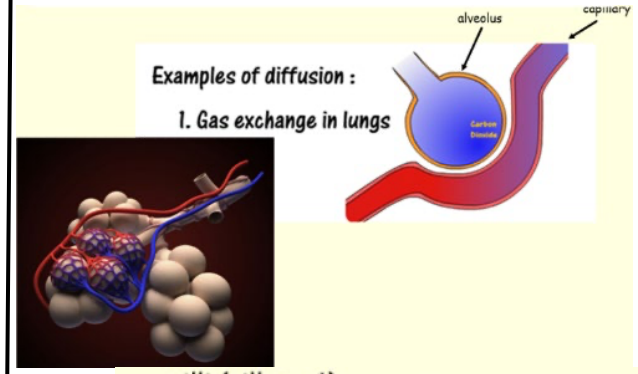
Factors which affect the rate of diffusion are:
- The difference in concentrations (concentration gradient)
- The temperature
- The surface area of the membrane.

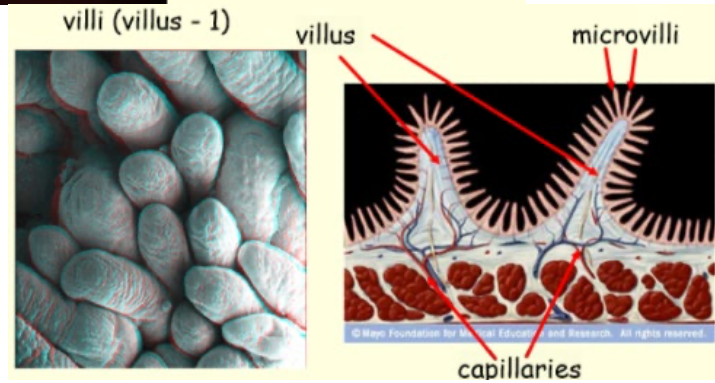
A single-celled organism has a relatively large surface area to volume ratio. This allows sufficient transport of molecules into and out of the cell to meet the needs of the organism.



Surface area	6 cm^2	24 cm^2	54 cm^2
Volume	1 cm^3	8 cm^3	27 cm^3
Surface area: volume	6:1	3:1	2:1

In multicellular organisms, surfaces and organ systems are specialised for exchanging materials. This is to allow sufficient molecules to be transported into and out of cells for the organism's needs.
The effectiveness of an exchange surface is increased by:
- Having a large surface area
- A membrane that is thin, to provide a short diffusion path
- (in animals) having an efficient blood supply
- (in animals, for gaseous exchange) being ventilated.





9 BIOLOGY B2 Organisation (Lungs, Heart & Health) - Knowledge Organiser Paper 1: KS4

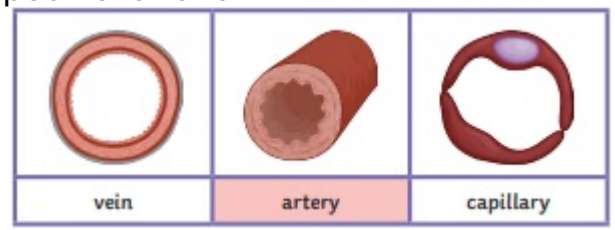
The Blood

Blood is a tissue consisting of plasma, in which the red blood cells, white blood cells and platelets are suspended.

Blood Component	Function/job
Red blood cells	Transports oxygen
White blood cells	Destroy/kill bacteria
Platelets	Clots the blood
Plasma	carries/transports all the cells/digested food/waste products/hormones/carbon dioxide/platelets/dissolved minerals/antibodies/antitoxins/ water

Blood vessels

The three types of blood vessels, shown above, are each adapted to carry out their specific function.



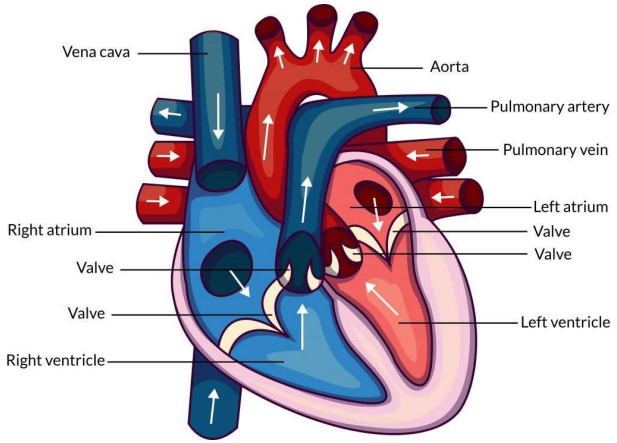
Capillaries are narrow vessels which form networks to closely supply cells. and organs between the veins and arteries. The walls of the capillaries are only one cell thick, which provides a short diffusion pathway to increase the rate at which substances are transferred.

The table below compares the structure and function of arteries and veins.

	Artery	Vein
direction of blood flow	away from the heart	towards the heart
oxygenated or deoxygenated blood?	oxygenated (except the pulmonary artery)	deoxygenated (except the pulmonary vein)
pressure	high	low (negative)
wall structure	thick, elastic, muscular, connective tissue for strength	thin, less muscular, less connective tissue
lumen (channel inside the vessel)	narrow	wide (with valves)

The Heart and Natural/Artificial Pacemakers

The heart is an organ that pumps blood around the body in a double circulatory system. The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body



The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. Artificial pacemakers are electrical devices used to correct irregularities in the heart rate.

10 BIOLOGY B2 Organisation (Lungs, Heart & Health) - Knowledge Organiser Paper 1: KS4

Coronary Heart Disease

In coronary heart disease layers of fatty material build up inside the coronary arteries, narrowing them. This reduces the flow of blood through the coronary arteries, resulting in a lack of oxygen for the heart muscle, which can lead to a heart attack.

Stents are used to keep the coronary arteries open, so blood can flow.

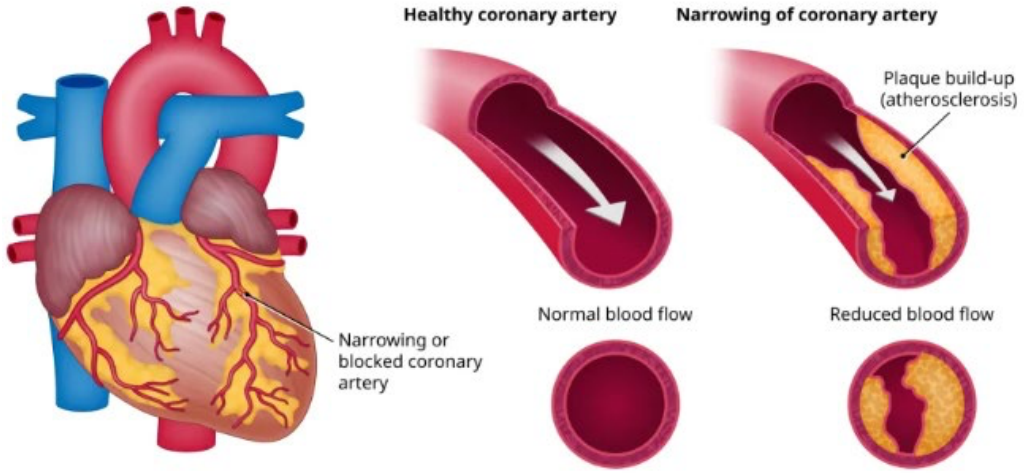
Statins are widely used to reduce blood cholesterol levels which slows down the rate of fatty material deposit.

In some people heart valves may become faulty, preventing the valve from opening fully, or the heart valve might develop a leak. Faulty heart valves can be replaced using biological or mechanical valves.

In the case of heart failure a donor heart can be transplanted.

Artificial hearts are occasionally used to keep patients alive whilst waiting for a heart transplant, or to allow the heart to rest as an aid to recovery.

Coronary Artery Disease



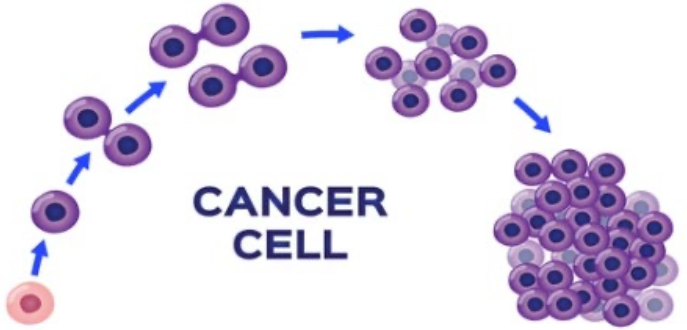
Advantages and Disadvantages of Heart Disease Treatments

There are a range of medical treatments for heart disease.

Treatment	Description	Advantages	Disadvantages
statins	**Drugs** used to lower cholesterol levels in the blood, by reducing the amount produced in the liver.	• Can be used to prevent heart disease developing. • Improved quality of life.	• Long-term treatment. • Possible negative side-effects.
stents	**Mechanical device** which is used to stretch narrow or blocked arteries, restoring blood flow.	• Used for patients where drugs are less effective. • Offers long-term benefits. • Made from metal alloys so will not be rejected by the patients body. • Improved quality of life.	• Requires surgery under general anaesthetic, which carries risk of infection.
heart transplant	The entire organ is replaced with one from an organ **donor** (a person who has died and previously expressed a wish for their organs to be used in this way).	• Can treat complete heart failure in a person. • extended life • Improved quality of life. • Artificial plastic hearts can be used temporarily until a donor is found.	• Requires major surgery under general anaesthetic, which carries risks. • Lack of donors available. • Risk of infection or transplant rejection. • Long recovery times.

Cancer

Cancer is the result of uncontrolled cell growth and division. Scientists have identified lifestyle risk factors for various types of cancer (e.g. smoking, exposure to UV and ionising radiation, excessive alcohol consumption, obesity). Infection with some viruses has been shown to increase the chances of developing certain types of cancer. There are also genetic risk factors for some cancers.



11 BIOLOGY B2 Organisation (Lungs, Heart & Health) - Knowledge Organiser Paper 1: KS4

Benign and Malignant Tumours

The uncontrolled growth of cells is called a tumour.

Benign tumours are growths of abnormal cells which are contained in one area, usually within a membrane. They do not invade other parts of the body.

Malignant tumour cells are cancers. They invade neighbouring tissues and spread to different parts of the body in the blood where they form secondary tumours

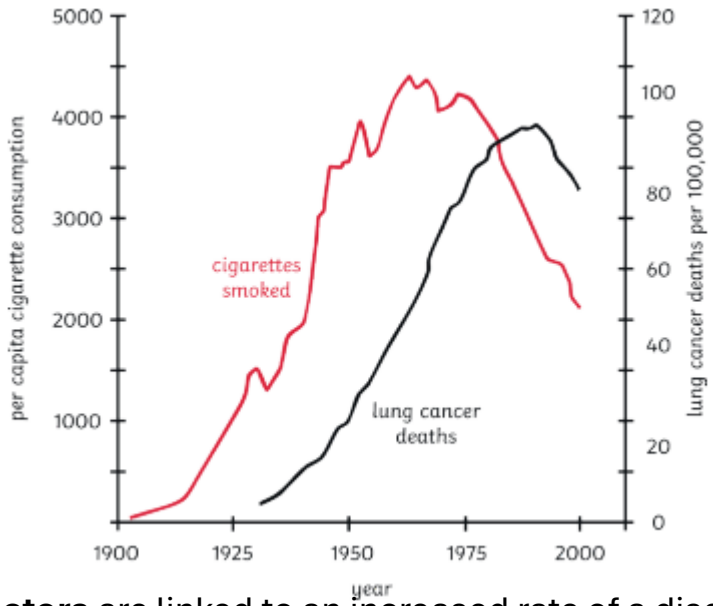
Benign Tumour	Malignant Tumour
• Usually grows slowly. • Usually grows within a membrane and can be easily removed. • Does not normally grow back. • Does not spread around the body. • Can cause damage to organs and be life-threatening.	• cancerous • Usually grows rapidly. • Can spread around the body, via the bloodstream. • Cells can break away and cause secondary tumours to grow in other areas of the body (metastasis).

Health and Risk Factors for Health

Health is the state of physical and mental well-being. Diseases, both communicable and non-communicable, are major causes of ill health. Other factors including diet, stress and life situations may have a profound effect on both physical and mental health.

Different types of disease may interact:

- Defects in the immune system mean that an individual is more likely to suffer from infectious diseases.
- Viruses living in cells can be the trigger for cancers.
- Immune reactions initially caused by a pathogen can trigger allergies such as skin rashes and asthma.
- Severe physical ill health can lead to depression and other mental illness.



Risk factors are linked to an increased rate of a disease. They can be:

- Aspects of a person's lifestyle
- Substances in the person's body or environment.

A link has been proven for some risk factors, but not in others:

- The effects of diet, smoking and exercise on cardiovascular disease.
- Obesity as a risk factor for Type 2 diabetes.
- The effect of alcohol on the liver and brain function.
- The effect of smoking on lung disease and lung cancer.
- The effects of smoking and alcohol on unborn babies.
- Carcinogens, including ionising radiation, as risk factors in cancer.

Many diseases are caused by the interaction of a number of factors.

12 BIOLOGY B2 Organisation (Digestive System & Enzymes) – Knowledge Organiser

Paper 1: KS4

The digestive system structure and function	Absorption and the small intestine	Active transport (diffusion recap)	Food test Required Practical	Enzyme theory and digestive enzymes	Factors affecting enzymes (temperature and pH)	Lipase practical and model gut demo	Effect of pH on enzymes Required Practical 1	Effect of pH on enzymes Required Practical 2

Key Words

Key Word	Definition
Digestive system	A group of organs that digest and absorb food
Digestion	Breaking down large insoluble into small soluble molecules
Enzyme	Biological catalysts- speed up chemical reactions
Denature	Active site changes shape- due to high temperature/ pH
Protease	Enzyme breaks down protein to amino acids.
Lipase	Enzyme breaks down lipids into fatty acids and glycerol
Amylase	Enzyme Breaks down starch into glucose
Diffusion	Movement of particles from a high concentration to a low concentration
Active Transport	Substances move from an area of low concentration to high concentration. Using energy.

Misconceptions

We don't only eat food to give us energy.

(protein needed for growth)

Bile does not digest fats.

(Bile emulsifies fats – increasing surface area)

Enzymes are NOT denatured at low temperature.

(Enzymes work slowly at low temperatures)

Enzymes are Not killed at high temperature.

(Enzymes are proteins - not living)

Key questions

State the role of the 3 digestive enzymes.

Describe the food tests and the positive/negative results.

State the role of the 3 digestive enzymes.

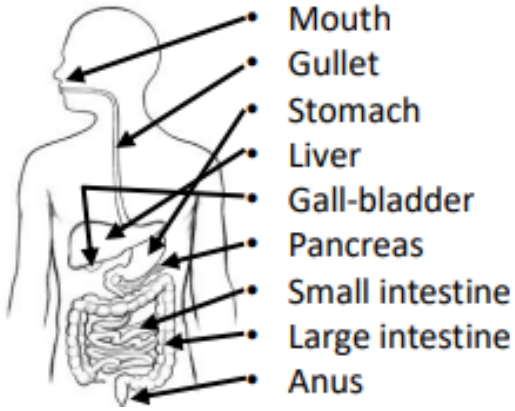
Describe the role of the organs in the digestive system.

State the role of the 3 digestive enzymes.

13 BIOLOGY B2 Organisation (Digestive System & Enzymes) – Knowledge Organiser

Paper 1: KS4

Human digestive system



Definition of digestion

- Breaking down large insoluble into small soluble molecules
- So, food can be absorbed into the blood by diffusion.

Enzymes

Enzymes are Biological catalysts that speed up chemical reactions .

Enzymes are made from proteins

Digestive enzymes

Digestive enzyme	Site of production	Site of action	Substrate	Product
Carbohydrase - e.g. amylase	Salivary glands, pancreas and small intestine wall	Mouth, small intestine	Complex carbohydrates - e.g. starch	Simple sugars - e.g. glucose
Protease	Stomach, pancreas, small intestine wall	Stomach, small intestine	Proteins	Amino acids
Lipase	Pancreas, small intestine wall	Small intestine	Lipids	Glycerol and fatty acids

Enzymes-Lock and key theory

Substrates fit into the enzyme active site, then react, turning into products.

Denature

Active site changes shape so substrate no longer fits.

Factors affecting enzymes.

Temperature

- too cold too slow - optimum = 37°C
- too hot = denatures

pH

- enzymes only work at specific pH.
- Too high or too low enzymes denature.

14 BIOLOGY B2 Organisation (Digestive System & Enzymes) – Knowledge Organiser

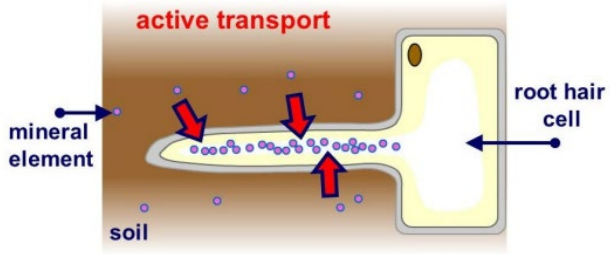
Paper 1: KS4

Active Transport

Substances move from an area of low concentration to high concentration, against the concentration gradient. Using energy from respiration.

Examples of active transport

Root hair cells have more minerals than the soil. Active transport is used for uptake of these minerals. Root hair cells therefore have lots of mitochondria to provide the energy by respiration.



Adaptations of small intestine

- Villi- large surface area
- Folded- large surface area.
- Good blood supply- maintains gradient.
- Thin walls- short diffusion distance

Food Tests Required Practical

Type of Food	Name of Test	Positive Result	Negative Result
Starch	Iodine	Blue/Black	Brown
Glucose	Benedict's (must be heated)	Green → Yellow → Brick red	Blue
Protein	Biuret	Lilac	Blue
Lipids	Emulsion	Cloudy precipitate	Clear

Bile

Alkaline to neutralise stomach acid
Emulsifies fat into small droplets.

Enzymes Required Practical

Iodine is used to test for the presence of starch. If starch is present, the colour will change to blue/black.

IV: pH of the buffer solution
DV: time taken to completely digest starch
CV: Concentration of enzyme, concentration of starch, temperature,

15 BIOLOGY B3 Triple Infection and Response - Knowledge Organiser Paper 1: KS4

Pathogens	Plant diseases and detection of plant disease (SOME TRIPLE)	Plant defences and mineral ion deficiencies (TRIPLE)	Culturing microbes required practical 1 (TRIPLE)	Culturing microbes required practical 2 (TRIPLE)	Disease examples	Body's fist line of defence	Body's second line of defence	Vaccination	Monoclonal antibodies and their uses 1	Monoclonal antibodies and their uses 2	Drugs against disease	Discovery and development of drugs 1	Discovery and development of drugs 2

Key Words

Key Word	Definition
Pathogens	Disease causing microbes
Vectors	An organism that carries the pathogen
Salmonella	A bacteria that causes food poisoning
Gonorrhoea	A bacteria that causes a sexually transmitted infection
Vaccination	People/animals can't develop the infection and pass it on
Antiretroviral	Drugs given to treat HIV
Antigens	Special proteins on the surface of a pathogen
Antibodies	Produced by white blood cells to destroy pathogens
Antitoxins	Produced by white blood cells to neutralise toxins

Misconceptions

- Micro-organisms that cause disease are called 'germs'.
- Plants CAN'T be infected with pathogens and become diseased.
- We have 'hairs' lining our airways.
- White blood cells produce antigens.
- Vaccines contain the pathogen that causes the disease.

Key questions

- What is a pathogen?
- How do bacteria and viruses make us ill?
- What are the ways pathogens spread and how can this be prevented?
- What is the body's first and second line of defence against pathogens?
- How does a vaccination make a person immune to a disease?

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Communicable Disease

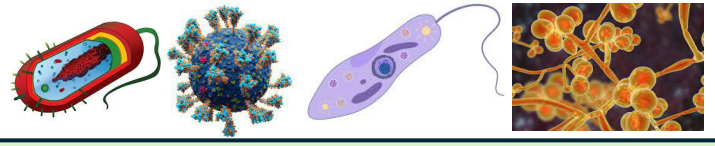
Pathogens are microorganisms that enter the body and cause communicable disease (infectious). Plants and animals can be infected by them.

Bacteria are small cells that can reproduce very quickly in the body. They produce toxins that make you feel ill, damaging your cells and tissues.

Viruses are much smaller than bacteria; they can also reproduce quickly in the body. Viruses live inside your cell where they replicate. They then burst out of the cell, releasing new viruses.

Protists are eukaryotes (multicellular). Some are parasites which live on or inside other organisms, often carried by a vector.

Fungi are sometimes single celled, others grow and penetrate human skin and the surface of plants. They can produce spores which can spread to other plants.



How Pathogens are Spread

Pathogens can be spread in many ways, for example:

Water - by drinking dirty water, e.g. cholera.

Air - carried by air and breathed in, e.g. influenza.

Direct contact - touching contaminated surfaces including the skin, e.g. athlete's foot.

How To Prevent The Spread of Diseases

Being hygienic - washing hands thoroughly.

Destroying vectors - killing vectors by using insecticides or destroying their habitat.

Isolation - isolating an infected person will prevent the spread.

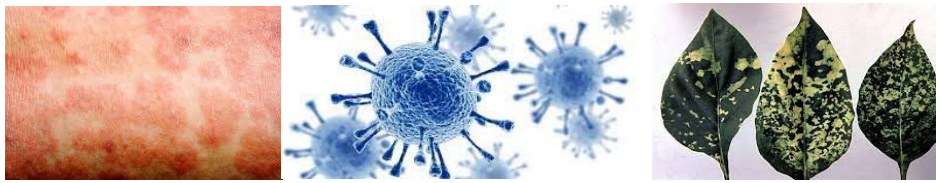
Vaccination - people cannot develop the infection and then pass it on.

Viral Diseases in Animals and Plants

Measles is spread by droplets of liquid from sneezes and coughs etc., symptoms include a red rash on the skin and a fever. Measles can be serious or even fatal. Most people are vaccinated against measles when they are very young.

HIV is spread by sexual contact or exchanging body fluids. HIV can be controlled be antiretroviral drugs, this stops the viruses replicating. The virus attacks the cells in the immune system. If the immune system is badly damaged, the body cannot cope with other infections.

Tobacco mosaic virus affects plants, parts of the leaves become discoloured. This means plants cannot carry out photosynthesis; this will affect the plants growth.



Bacterial Diseases in Animals

Salmonella bacteria causes food poisoning. Symptoms include fever, stomach cramps, vomiting and diarrhoea. Food contaminated with salmonella can give you food poisoning. Most poultry in the UK will have had a vaccination against salmonella.

Gonorrhoea is a sexually transmitted bacterial disease, passed on by sexual contact. Symptoms include pain when urinating and thick yellow/green discharge from the vagina or penis. To prevent the spread, people should be treated with antibiotics and use a condom.

Fungal and Protist Diseases in Plants and Animals

Rose black spot fungus shows as black spots on the leaves of the plant, this means less photosynthesis occurs. As a result, the plant does not grow as well. It is spread by the wind or the water. They can be treated by using fungicides and taking the leaves off the infected plant.

Malaria is caused by a protist, mosquitoes are the vectors. They become infected when they feed on an infected animal. Malaria can cause fever, it can also be fatal.

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The Body's First Line of Defence

1. **The skin** acts as a barrier to pathogens.

2. **Hair and mucus** in your nose trap particles.

3. **The trachea and bronchi** release mucus to trap pathogens. They also have cilia which move backwards and forwards to transport the mucus towards the throat. This traps any pathogens and the mucus is usually swallowed.

4. **The stomach** contains hydrochloric acid to kill any pathogens that enter the body via the mouth.

The Body's Second Line of Defence (The Immune System)

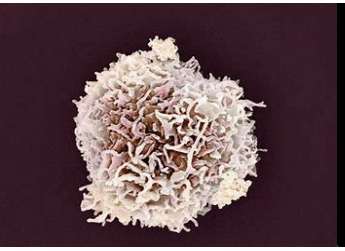
This kills any pathogens that enter the body.

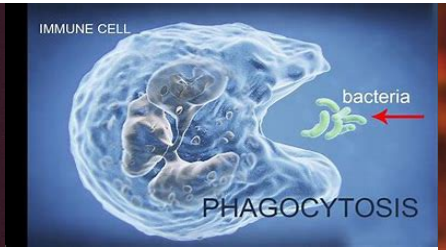
White blood cells:

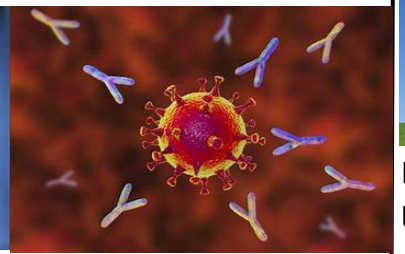
Phagocytosis is when white blood cells engulf pathogens and then digest them.

They produce **antitoxins** to neutralise the toxins.

They also produce antibodies. Pathogens have antigens on their surface, antibodies produced by the white blood cells lock on to the antigen on the outside of the pathogen. White blood cells can then destroy the pathogens. Antibodies are specific to one antigen and will only work on that pathogen.







Vaccinations

Vaccinations have been developed to protect us from future infections. A vaccination involves an injection of a dead or weakened version of the pathogen. They carry antigens which cause your body to produce antibodies which will attack the pathogen. If you are infected again, the white blood cells can produce antibodies quickly.

Pros	Cons
Helps to control communicable diseases that used to be very common.	Some people can have a bad reaction to a vaccine - however, that is very rare.
Epidemics can be prevented.	They don't always work.

Drugs Against Disease

Painkillers relive the pain and symptoms, but do not tackle the cause.

Antibiotics kill the bacteria causing the problem, but do not work on viruses. Viruses are very difficult to kill because they live inside the body cells.

Discovery of Drugs from Plants

Chemicals produced by plants, or micro-organisms to defend themselves can be used to treat human diseases or help with symptoms.

Drug	Plant/Micro-organism
Aspirin	Willow tree
Digitalis	Foxglove
Penicillin	Mould Penicillium

New drugs are now made by chemists, who work for the pharmaceutical industry, in laboratories.

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Development of Drugs

There are three main stages in drug testing:

Pre-clinical testing:

1. Drugs are tested on human cells and tissues.

2. Testing carried out on living animals.

Clinical testing:

3. Tested on healthy human volunteers in clinical trials. Starts with a very low dose, then tested on people with the illness to find the optimum dose.

Placebo is a substance that is like the drug, but does not do anything.

Placebo effect is when the patient thinks the treatment will work even though their treatment isn't doing anything.

Blind trial is when the patient does not know whether they are getting the drug or the placebo.

Double-blind trial is when both the doctor and the patient do not know whether they are getting the drug

TRIPLE ONLY CONTENT

Plant Diseases and Defences

Plants need ions from the soil. If there isn't enough, then the plants suffer deficiency symptoms.

Ion	Symptoms
Nitrates	Stunted growth
Magnesium	Yellow leaves

Plant Diseases common signs include stunted growth, spots on the leaves, patches of decay, abnormal growth, malformed stems or leaves and discolouration.

Plants have physical, chemical and mechanical defences to stop pathogens.

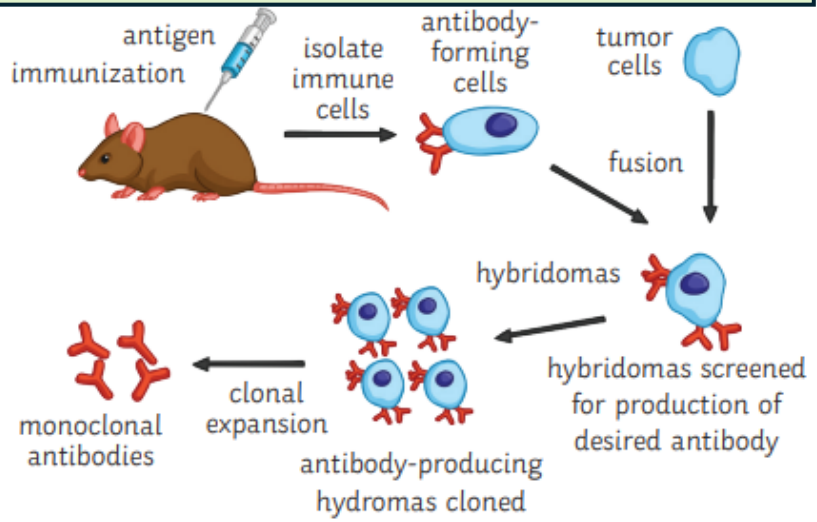
Physical waxy cuticle, cell walls, layer of dead cells.

Mechanical - thorns, hairs, leaves that droop or curl and some plants can mimic other organisms.

Monoclonal Antibodies

Monoclonal antibodies are identical antibodies. Antibodies are produced by B lymphocytes.

It is possible to fuse a B lymphocyte from a mouse with a tumour cell to create a cell called a hybridoma these can be cloned. They will all produce the same antibodies; the antibodies can be collected and purified.



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Uses of Monoclonal Antibodies

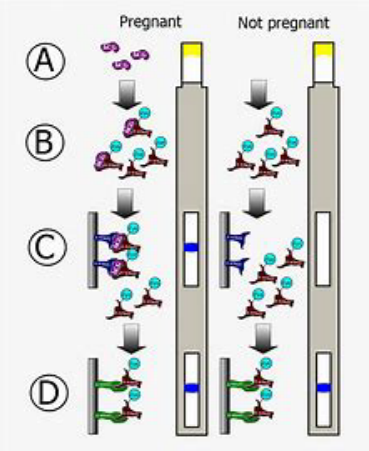
There are many uses of monoclonal antibodies. For example:

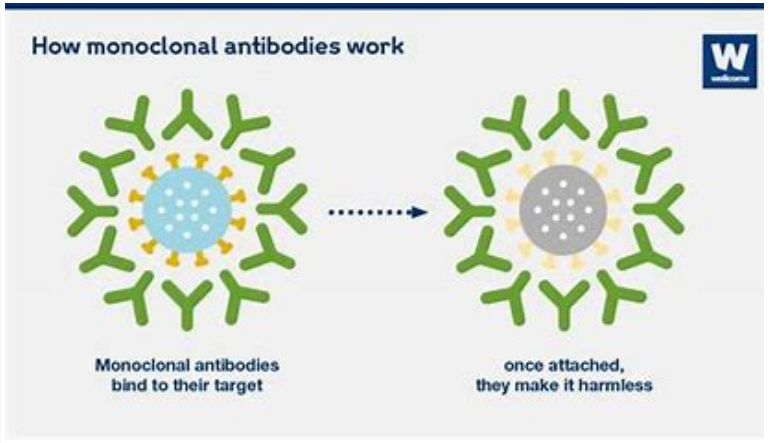
Pregnancy testing: HCG hormone is found in the urine of women when pregnant. Pregnancy testing sticks detect this hormone. The HGC binds to the antibodies on the stick and changes the colour if you are pregnant. If the woman is not pregnant, there is no HCG. This means there is nothing to stick to the blue beads on the test strip, so it does not go blue

Treating diseases: anti-cancer drugs can be attached to monoclonal antibodies. They can target specific cells (cancer cells) by binding to the cancer marker. This kills the cancer cells, but not the normal body cells.

Research to find specific substances: used to bind to hormones and chemicals in the blood to measure levels. Also used in blood tests for pathogens and locating molecules on a cell or in tissue.

Problems: they have more side-effects than originally thought. For example: fever, vomiting, low blood pressure. They are not used by doctors as much as was first thought.



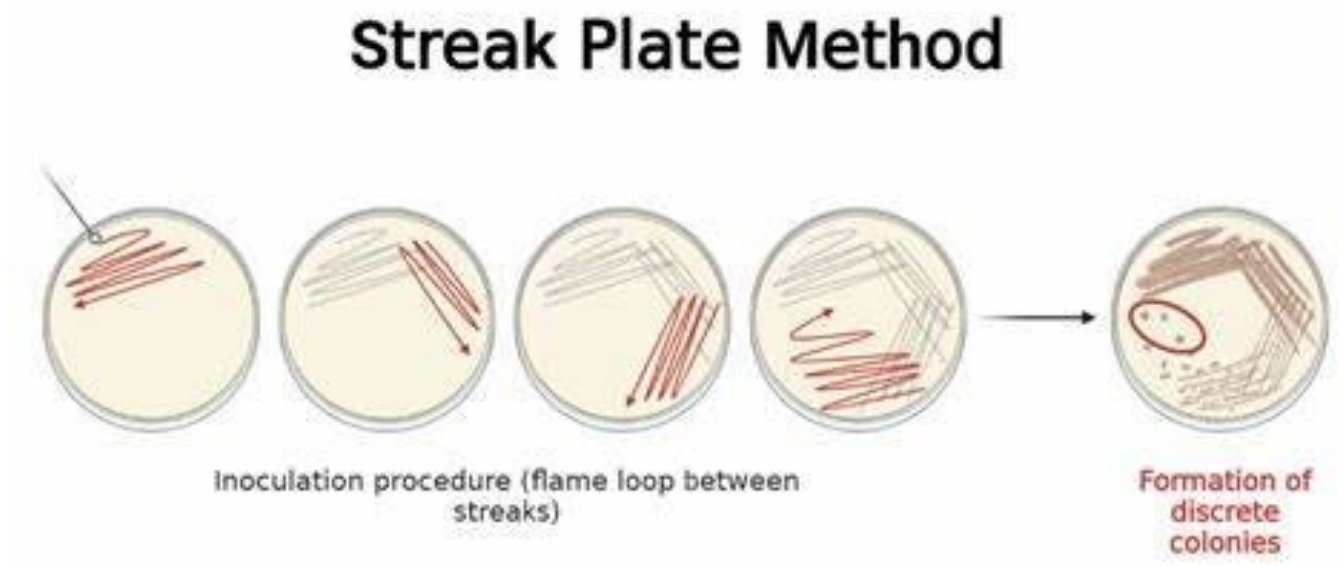


Culturing Microorganisms Required Practical

Culturing Microorganisms in the Lab: Use agar jelly which contains nutrients. The bacteria will form colonies on the agar.

Use inoculating loops to add the bacteria to the agar jelly. In a school la the microorganisms are kept at 25°C to prevent the growth of any harmful bacteria.

Investigating the Effect of Antibiotics on Bacterial Growth: Place paper disks that have been soaked with different antibiotics on an agar plate that has bacteria on it. The antibiotics should diffuse on to the agar. The most effective antibiotic at killing the bacteria will have the largest inhibition zone. Be sure to use a control that has sterile water on the disk (to compare to). Leave in an incubator for 48 hours at 25°C



Aerobic respiration	Anaerobic respiration	Effects of exercise	Metabolism

Key Words

Key Word	Definition
Respiration	A chemical reaction that releases energy from glucose
Mitochondria	The part of a cell where respiration occurs
Aerobic	Respiration involving oxygen
Anaerobic	Respiration without oxygen
Exothermic	The transfer of thermal energy to the surroundings
Fatigue	When muscles have been respiring anaerobically and can no longer contract efficiently
Fermentation	Another name for anaerobic respiration in plant and yeast cells. It produces carbon dioxide and ethanol
Metabolism	The sum of ALL the chemical reactions in an organism

Misconceptions

That respiration and breathing are the same thing – they're not. Respiration is a chemical reaction, in cells, that releases energy.

That the energy is respiration is made – it isn't. It is TRANSFERRED or RELEASED.

That heart rate increases during exercise to carry more blood – it is the oxygen and glucose in the blood that needs to be transported to cells.

That muscle fatigue means muscles are 'tired'. The lactic acid that builds up in anerobic respiration causes them to contract less efficiently.

That metabolism means to digest food. It means the sum of ALL the chemical reactions in an organism.

Key questions

What is respiration and where does it happen in a cell?

What is the definition of aerobic respiration?

What is the definition of anaerobic respiration?

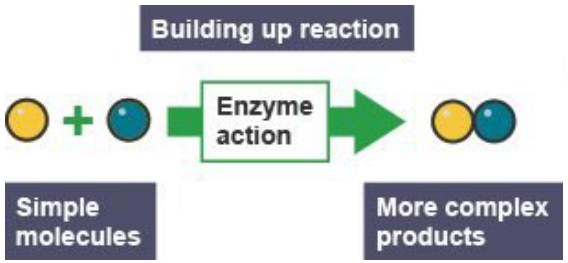
How does exercise effect breathing rate and heart rate and why?

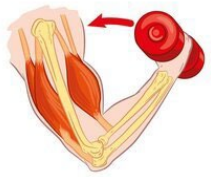
What is the definition of metabolism and what are some examples of metabolic reactions?

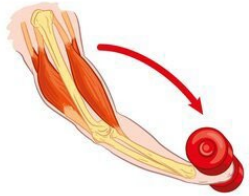
Respiration

Cellular respiration is an exothermic reaction which is continuously occurring in living cells.
The energy transferred supplies all the energy needed for living processes.
Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen), to transfer energy.
Organisms need energy for:

- Chemical reactions to build larger molecules
- Muscle contraction for movement
- Maintaining body temperature (keeping warm)







Aerobic respiration

Aerobic respiration is represented by the word equation:
glucose + oxygen → carbon dioxide + water
Aerobic respiration is represented by the balanced symbol equation:
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Anaerobic respiration

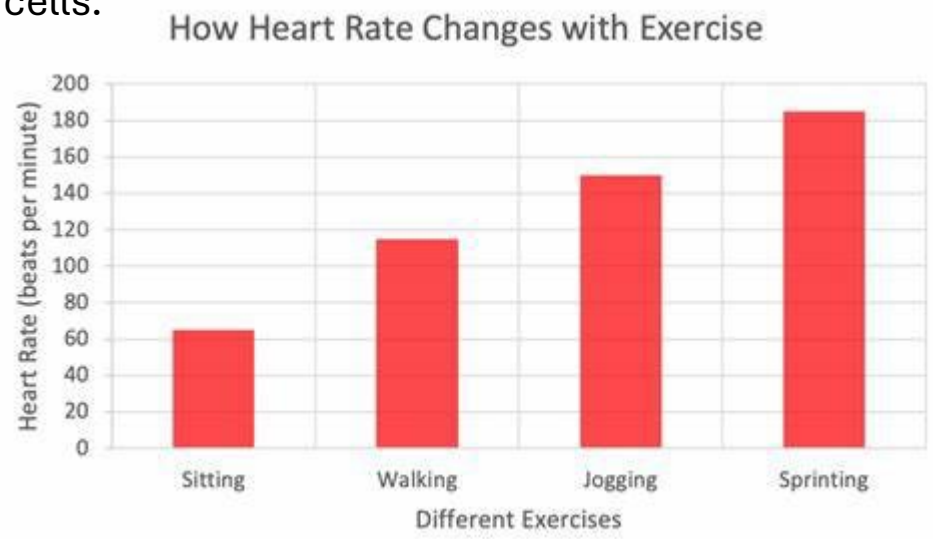
Anaerobic respiration in muscles is represented by the equation:
glucose → lactic acid
As the oxidation of glucose is incomplete in anaerobic respiration much less energy is transferred than in aerobic respiration.
Anaerobic respiration in plant and yeast cells is represented by the equation:
glucose → ethanol + carbon dioxide
Anaerobic respiration in yeast cells is called fermentation and has economic importance in the manufacture of bread and alcoholic drinks.
Compare the processes of aerobic and anaerobic respiration with regard to the need for oxygen, the differing products and the relative amounts of energy transferred.

Similarities	Differences
Both use glucose	Aerobic respiration uses oxygen, anaerobic does not
Both release energy (although in different amounts)	Aerobic respiration transfers more energy than anaerobic respiration
Both reactions are exothermic	Aerobic produces carbon dioxide and water
	Anaerobic produces lactic acid

Effects of exercise

- During exercise the human body reacts to the increased demand for energy.
- The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood.
- If insufficient oxygen is supplied anaerobic respiration takes place in muscles. The incomplete oxidation of glucose causes a build up of lactic acid and creates an oxygen debt. During long periods of vigorous activity muscles become fatigued and stop contracting efficiently.

(HIGHER TIER ONLY) Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.



Metabolism

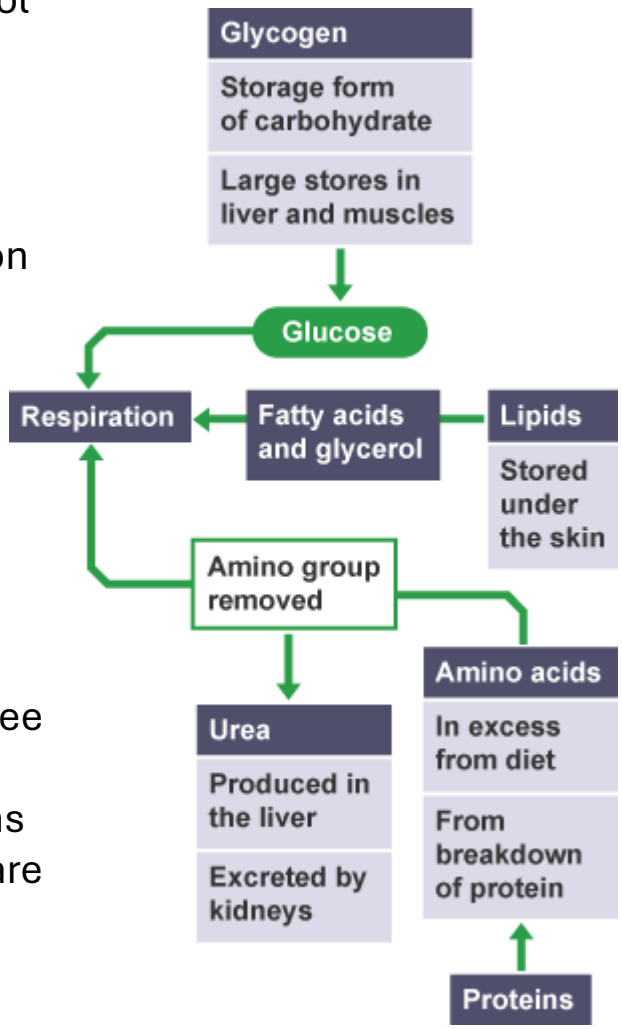
Explain the importance of sugars, amino acids, fatty acids and glycerol in the synthesis and breakdown of carbohydrates, proteins and lipids.

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

The energy transferred by respiration in cells is used by the organism for the continual enzyme controlled processes of metabolism that synthesise new molecules.

Metabolism includes:

- Conversion of glucose to starch, glycogen and cellulose
- The formation of lipid molecules from a molecule of glycerol and three molecules of fatty acids
- The use of glucose and nitrate ions to form amino acids which in turn are used to synthesise proteins
- Respiration
- Breakdown of excess proteins to form urea for excretion.



23 BIOLOGY B4 Bioenergetics (Plant structure and Photosynthesis) - Knowledge Organiser Paper 1: KS4

Photosynthesis	Plant tissues and organs	Osmosis theory (diffusion and active transport recap) 1	Osmosis theory (diffusion and active transport recap) 2	Osmosis required practical 1	Osmosis required practical 2	Limiting factors (some Higher Only)	Greenhouse economics (Higher Only)	Photosynthesis required practical 1	Photosynthesis required practical 2	Transpiration theory 1	Transpiration theory 2	Factors affecting transpiration

Key Words

Key Word	Definition
Photosynthesis	A chemical reaction that uses light energy to produce glucose
Stomata	Pores on the underside of the leaf used for gas exchange
Osmosis	The movement of water from a dilute solution to a concentrated solution through a partially permeable membrane
Limiting factor	A factor that is too low and therefore limits the rate of photosynthesis
Transpiration	The movement of water and minerals through the xylem
Phloem	Living cells that transport glucose/sugars
Xylem	Dead cells that transport water/minerals
Translocation	The movement of glucose/sugars through the phloem

Misconceptions

That plants only photosynthesise and don't respire (plants still need to respire to release the energy from the glucose they make)

That osmosis is the movement of a liquid (it is the movement of **water** from a dilute to a concentrated solution)

That solutes (salts and sugars) move across the partially permeable membrane in osmosis. **ONLY water** moves, the solute particles are too large

That rate of photosynthesis can be measured by the amount of carbon dioxide a plant releases. It's the amount of **oxygen**.

That the factors that limit the rate of photosynthesis (light, CO_2 conc., temp. & chlorophyll) are the same as the factors that affect transpiration (humidity, wind, light & temp.)

Key questions

What is photosynthesis and what type of reaction is it?

How is the structure of leaf adapted to allow photosynthesis to happen?

What is the definition of osmosis?

What are the four limiting factors for photosynthesis and how do they affect photosynthesis?

What is the definition of transpiration and what factors affect transpiration?

Photosynthesis

Photosynthesis is represented by the word equation:

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

And the balanced symbol equation:

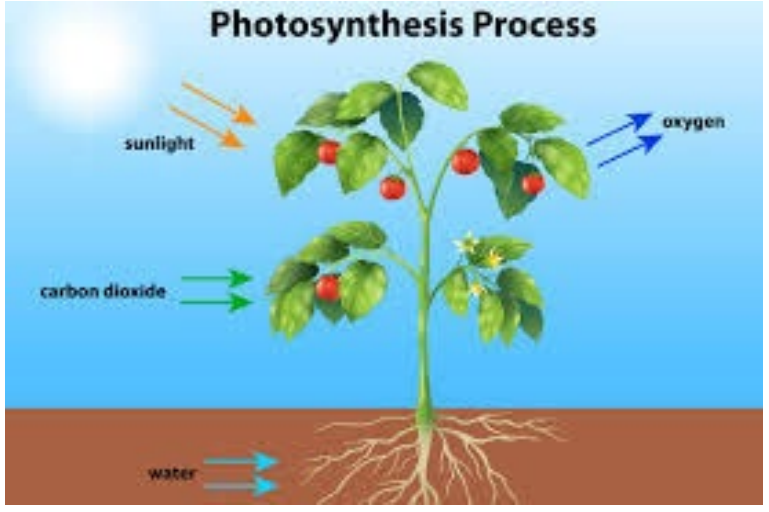
$6CO_2 + 6H_2O \rightarrow + C_6H_{12}O_6 + 6O_2$

Photosynthesis as an endothermic reaction in which energy is transferred from the environment to the chloroplasts by light.

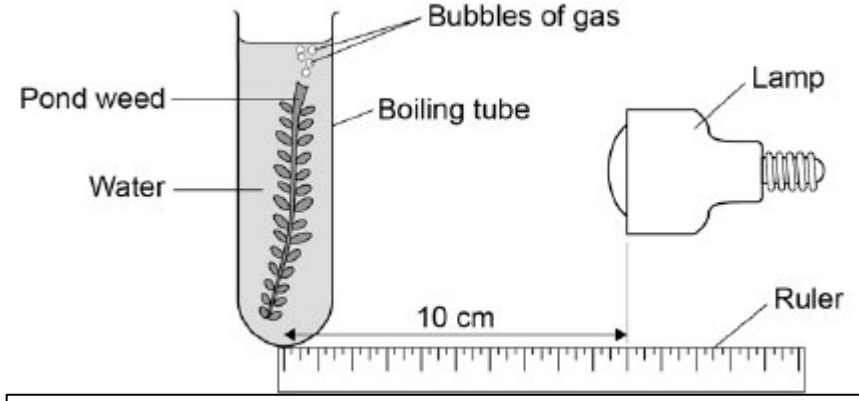
The glucose produced in photosynthesis may be:

- Used for respiration
- Converted into insoluble starch for storage
- Used to produce fat or oil for storage
- Used to produce cellulose, which strengthens the cell wall
- Used to produce amino acids for protein synthesis.

To produce proteins, plants also use nitrate ions that are absorbed from the soil.



Photosynthesis required practical



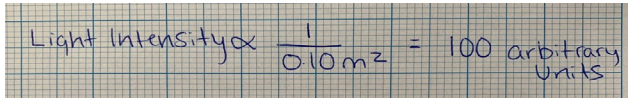
1. Set up the apparatus as shown in the diagram above.
2. Place the lamp 10 cm from the pondweed.
3. Turn the lamp on and count the number of bubbles produced in one minute.
4. Repeat with the lamp at different distances from the pondweed.

Independent variable: The distance of the lamp from the pondweed (cm)
Dependent variable: The number of oxygen bubbles produced per minute
Control variables: Same power bulb, all blinds down and the lights off, same piece of pondweed, same start temperature of the water, use a beaker of water as a water bath, monitor the temperature of the water with the pondweed in with a thermometer, change the water in the boiling tube and in the beaker between each distance if the temperature rises

(Higher Tier ONLY – calculating inverse square law: Inverse square law states that if the distance (in m) doubles then the light intensity will get 4x smaller)

$$\text{Light intensity} \propto \frac{1}{\text{Distance}^2}$$

e.g. When light is 10 cm from the plant:



25 BIOLOGY B4 Bioenergetics (Plant structure and Photosynthesis) - Knowledge Organiser Paper 1: KS4

Plant tissues, organs and structure of a leaf

Plant tissues include:
- Epidermal tissues
- Palisade mesophyll
- Spongy mesophyll
- Xylem and Phloem
- Meristem tissue found at the growing tips of shoots and roots.

The leaf is a plant organ. The roots, stem and leaves form a plant organ system for transport of substances around the plant.

Root hair cells are adapted for the efficient uptake of water by osmosis, and mineral ions by active transport.

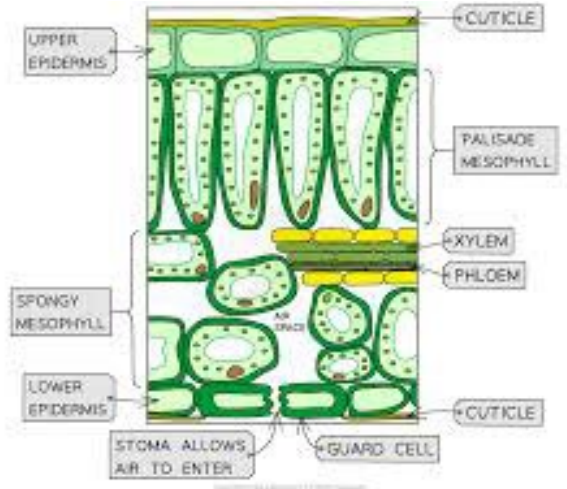
Xylem tissue transports water and mineral ions from the roots to the stems and leaves. It is composed of hollow tubes strengthened by lignin adapted for the transport of water in the transpiration stream.

The role of stomata and guard cells are to control gas exchange and water loss.

Phloem tissue transports dissolved sugars from the leaves to the rest of the plant for immediate use or storage.

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

Phloem is composed of tubes of elongated cells. Cell sap can move from one phloem cell to the next through pores in the end walls.



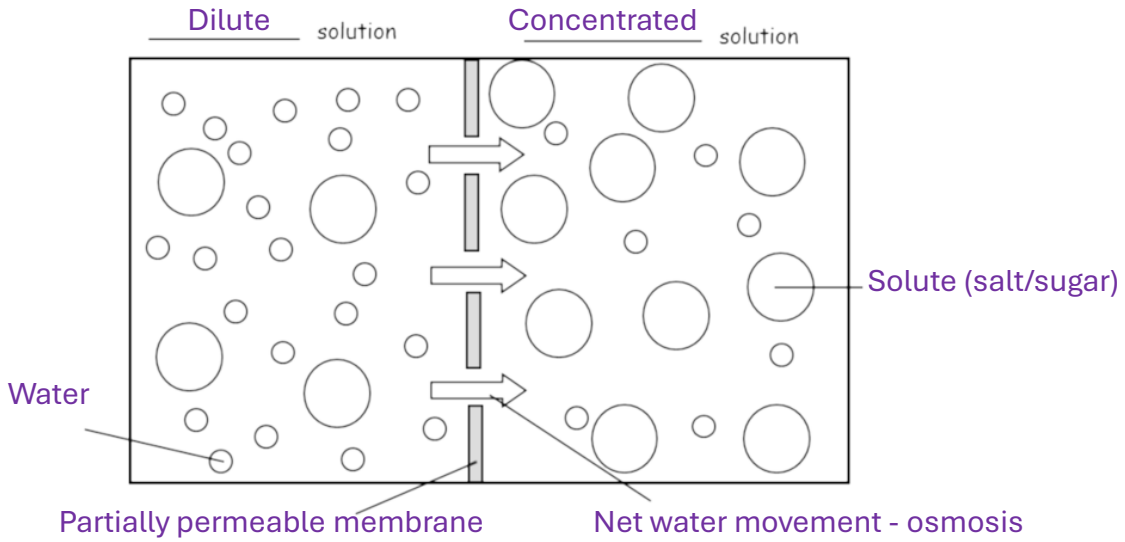
Plant tissues	Function
Waxy cuticle	A waterproof layer at the top of the leaf that prevents evaporation
Upper epidermis	A transparent layer that allows light to pass through
Palisade mesophyll	Contains many chloroplasts for photosynthesis
Spongy mesophyll	Contains air spaces to allow gas exchange
Xylem	To transport water and minerals
Phloem	To transport glucose
Stomata and guard cells (found in the lower epidermis)	The stomata are pores on the underside of the leaf to allow CO_2 in and O_2 out. The guard cells control the size of the stomata.

Transpiration and Translocation

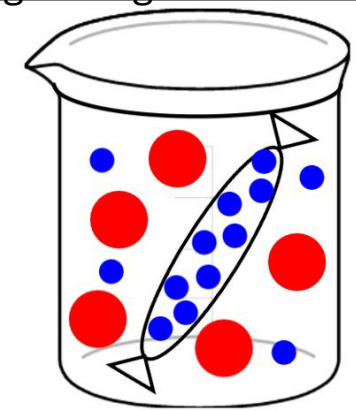
Transpiration and the xylem	Translocation and the phloem
Involves the movement of water and minerals	Involves the movement of glucose/sugars
Is uni-directional (from the roots to the leaves)	Is bi-directional (from the leaves to growing parts of the plant)
Involves the xylem	Involves the phloem
The xylem are dead cells	The phloem are living cells
The xylem cells are hollow	The phloem cells have sieve plates (end walls)
The xylem walls are supported by lignin	The phloem cells have companion cells

Osmosis theory

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.

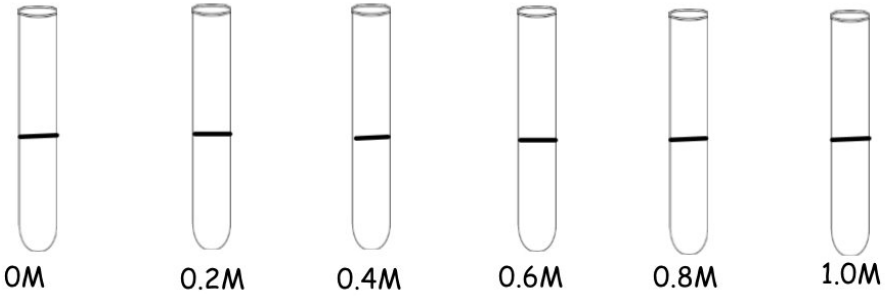


Visking Tubing Demonstration:



Water will move out of the Visking tubing into the salt solution by osmosis, causing the volume/mass of the tubing to decrease and feel floppy/flaccid.

Osmosis required practical



1. Collect 5 potato cylinders. Use a ruler and a knife to cut them so they are all 50mm in length. Be careful when using the knife.
2. Record the starting mass of each potato cylinder using the mass balance.
3. Measure out 20ml of each solution using a measuring cylinder and place in boiling tubes. Label each tube.
4. Immerse the potato cylinders in each concentration of salt solution.
5. After 20 minutes, take out the potato cylinder. Record the final mass of each potato cylinder then calculate the percentage change in mass using the formula in the results section. Also write down any observations on the feel or appearance of each potato cylinder at the end.

Calculate the percentage change in mass using the formula below:

$$\% \text{ change in mass} = \frac{\text{change in mass}}{\text{starting mass}} \times 100$$

Independent variable: Concentration of salt solution (M)
Dependent variable: % Change in mass of the potato chips
Control variables: Length of potato cylinders, same potato and variety of potato, volume of salt solution

Limiting factors

As well as the reactants for photosynthesis (carbon dioxide and water), plants need to have some other factors to help them photosynthesise:

You can remember this using TLCC:

- Temperature
- Light intensity
- Carbon dioxide concentration
- Chlorophyll

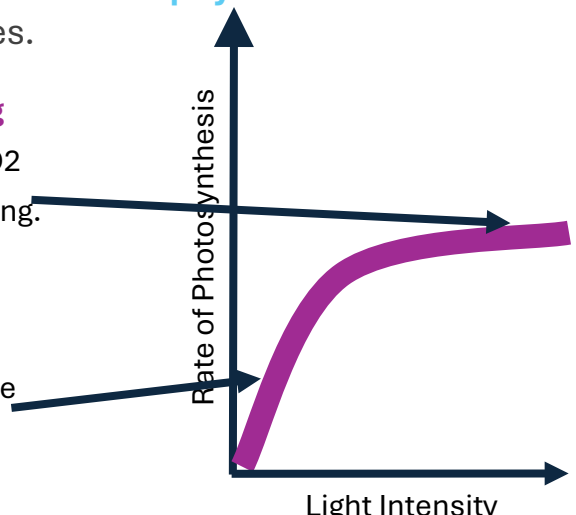
If any one factor is not available in a large amount, photosynthesis will be kept at a **constant rate** and will not increase.

- As the **concentration of carbon dioxide** increases, the **rate of photosynthesis** increases.
- As the **light intensity** increases, the **rate of photosynthesis** increases.
- As the **temperature increases,** the **rate of photosynthesis increases** to an optimal point. As the **temperature continues to increase** the **rate of photosynthesis decreases.**
- As the **photosynthesize amount of chlorophyll in the leaf** increases, the **rate of photosynthesis** increases.

Light intensity **is NOT the limiting factor.** Another factor such as CO2 conc. or temperature is now limiting.

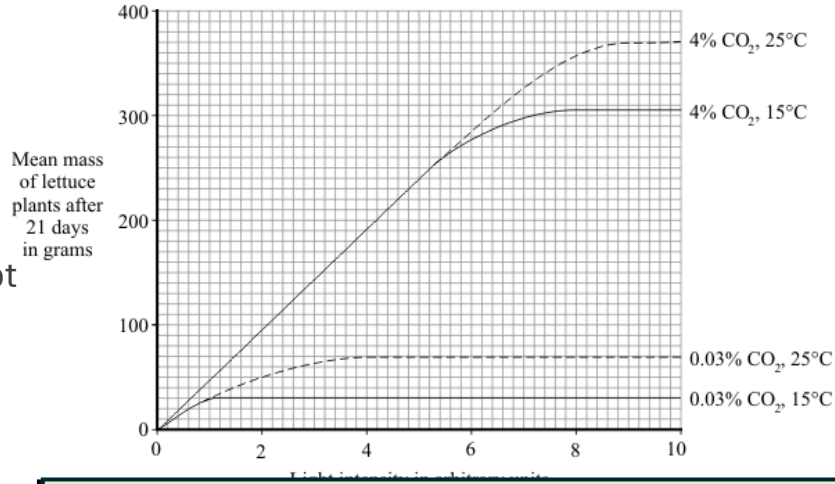
Light intensity **is the limiting factor**.

By increasing the light intensity the rate of photosynthesis will increase.



(Higher Tier ONLY – interpreting more than one limiting factor on a graph)

The graph shows the effects of changing the temperature, light intensity and carbon dioxide concentration on the growth of lettuce plants.



Describe and explain the effect of increasing light intensity on the mean mass of lettuce plants at 4% carbon dioxide and 15°C. **(3 marks)**

ANSWER:

Mean mass increases up to 7/8 units then levels off

Light limiting factor up to 7/8 units

For photosynthesis

Other factor/temperature limiting above 7/8 units

Greenhouse economics (Higher Tier ONLY)

(Higher Tier ONLY)

Limiting factors are important in the economics of enhancing the conditions in greenhouses to gain the maximum rate of photosynthesis while still maintaining profit.

Farmers can manipulate the conditions inside greenhouses to maximise the rate of photosynthesis and increase growth rate.

- Use artificial lights
- Use gas or electric heaters
- Increase carbon dioxide concentration
- Ensure mineral content (nitrates, magnesium etc.) are kept high enough

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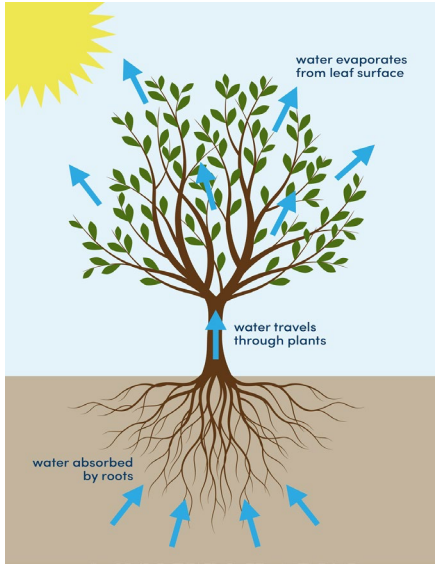
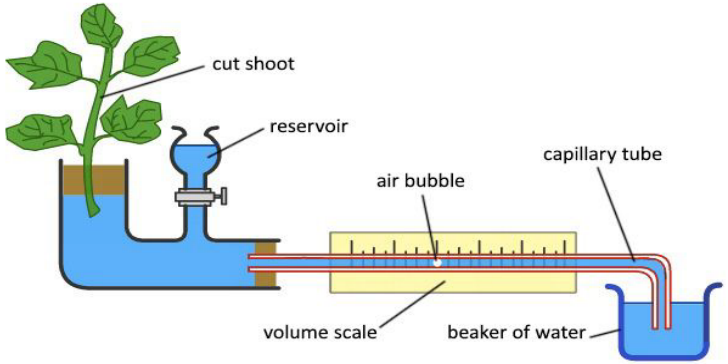
Transpiration theory

The constant stream of water through the plant is called the transpiration stream.
It keeps water moving up through a plant against the force of gravity.



1. Water enters the root hair cell from the soil by osmosis.
2. Water moves from the root into the xylem.
3. Water enters the leaf from the xylem.
4. Water moves up the stem to the leaves in the xylem.
5. Water evaporates from the surface of the leaf through the stomata.

The rate of transpiration can be measured using a special piece of equipment called a potometer.



The transpiration rate = $\frac{\text{Distance bubble moved}}{\text{Time taken}}$

Factors that affect transpiration

These are the factors that affect the rate of transpiration:

- Light intensity
- Air flow (windy)
- Temperature
- Humidity (the amount of moisture in the air)

An **increase** in light intensity **increases** the rate of **transpiration**.

This is because the **stomata open wider** to allow **more CO_2** into the leaf for **photosynthesis**. This **increases** the rate of **evaporation** from the **stomata**.

So **more water** is lost from the plant.

An **increase** in wind speed **increases** the rate of transpiration.

This is because the wind **removes more water vapour** from the surface of the stomata, so the rate of **evaporation** increases.

So **more water** is lost from the plant.

An **increase** in temperature **increases** the rate of transpiration. This is because the water particles have **more energy**, so they **evaporate** and **diffuse** out of the stomata faster.

So **more water** is lost from the plant.

An **increase** in humidity **decreases** the rate of **transpiration. This** is because **moist air** surrounds the stomata which **decreases** the rate of evaporation.

So **less water** is lost from the plant.