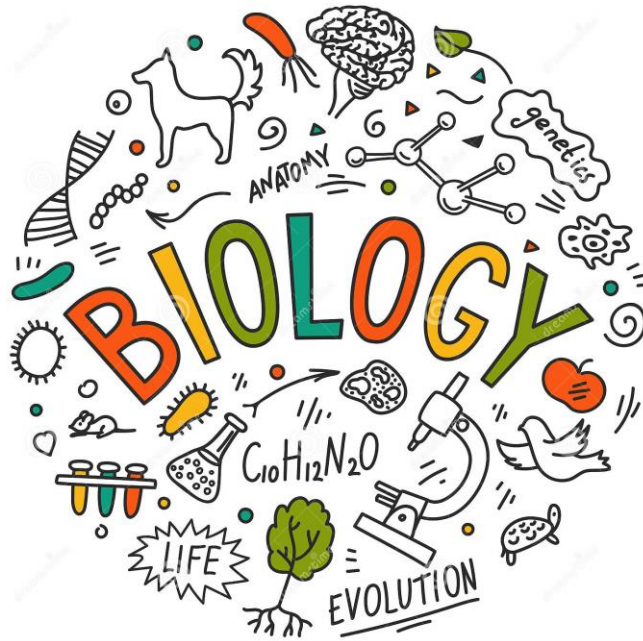


GCSE 9-1 BIOLOGY

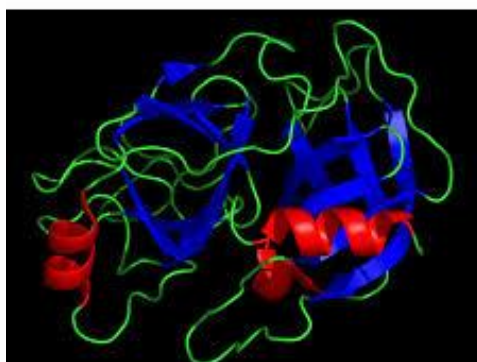


Paper 2

Revision booklet

Topic	Pages
Topic 1 – Key concepts in Biology	2-17
Topic 6 – Plant structure and their functions	18-28
Topic 7 – Animal control, coordination, and homeostasis	29-43
Topic 8 – Exchange and Transport in Animals	44-59
Topic 9 – Ecosystems and material cycles	60-74

GCSE 9-1 BIOLOGY



Topic 1 – Key concepts in Biology

Revision booklet

Topic	Pages
Microscopy	3-5
Eukaryotic and Prokaryotic cell structure	6-7
Specialised cells	8
Enzymes	9
Factors affecting enzyme function	10
Core Practical and rates of reaction	11
Transport in cells	12
CORE practical	13
Prove it questions	14-15
Mark Scheme	16-17



Microscopy

Extremely small structures such as cells cannot be seen without microscopes, which enlarge the image.

Light Microscopes

The most commonly used microscope is the light **microscope**. This was invented by Robert Hooke in the 1600's.

- It has two lenses (**eyepiece lens and objective lens**)
- It is usually illuminated from underneath
- Used to view tissues, cells and large sub-cellular structures

To work out a microscope's magnification you multiply the magnification of the eyepiece lens and the objective lens. So if the magnification of a microscope with a x10 eyepiece lens and x20 objective lens is $10 \times 20 = \times 200$.

Electron Microscopes

In the 1930s the electron **microscope** was developed, enabling scientists to view deep inside sub-cellular structures, such as mitochondria, ribosomes, chloroplasts and plasmids. Electrons pass through a sample to build an image. They have a greater magnification power and a greater resolution.

There are two types: a scanning **electron microscope** that create 3D images (at a slightly lower magnification) and a **transmission electron microscope** which creates 2D images detailing organelles

Comparing the two types of microscope

Electron microscopes can produce more detailed images because of their greater magnification power but also because of their greater resolution. The resolution is the smallest distance between two points that can still be seen as two points. So a microscope with a greater resolution can produce a clearer image of objects that are very close together.

CORE PRACTICAL

To use a light microscope, you should:

1. Place the slide on the stage and look through the eyepiece lens
2. Turn the focus wheel to obtain a clear image
3. Start with the lowest objective lens magnification
4. Increase the magnification of the objective lens and refocus.

In order to use specimens with a light microscope, you have to first prepare **the slide**. This is done using the following method:

Take a thin layer of cells from your sample by either **peeling** them off (onion cells) or **using a cotton bud (Animal cells)**

1. Add a small amount of the correct chemical stain (you will be told by your teacher which stain to use). Chemical stains are used to make some parts of the specimen more visible when you look at them through the microscope.
2. Apply the cells to your glass slide by placing them on or wiping the cotton bud against it.
3. Carefully lower a coverslip onto your slide, taking care to avoid air bubbles.

Magnification calculations

Using a microscope to estimate size:

The circular area you can see in a light microscope is called the field of view. If we know its diameter we can then estimate sizes of specimens / parts of specimens.

- Measure your field of view by placing a ruler/graticule on the stage.
- Convert your measurement from mm to μm by multiplying by 1000.
- Count how many cells can be seen across the field of view and divide your field of view measurement by the amount of cells.
- This will give you an estimate of the diameter of one cell.
- Make sure the magnification during both measurements are the same.

You should know how to perform magnification calculations. Remember:

Important calculations

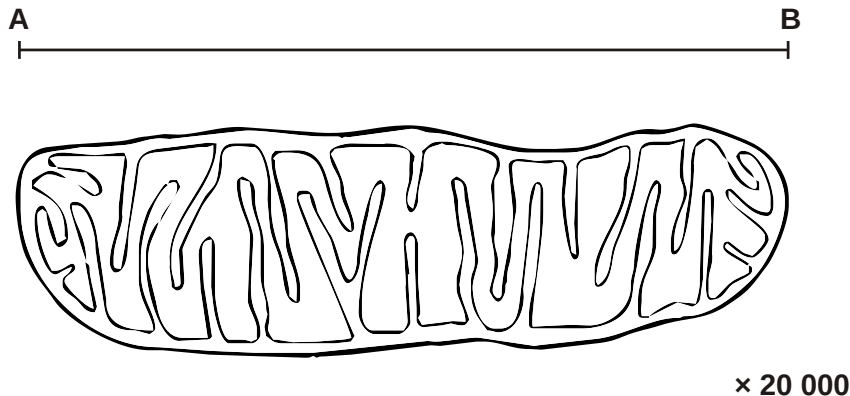
$$\text{Magnification} = \text{Image size} / \text{actual size}$$

$$\text{Actual size} = \text{Image size} / \text{magnification}$$

$$\text{Image size} = \text{Actual size} \times \text{magnification}$$

$$\text{Total magnification} = \text{objective lens magnification} \times \text{eyepiece lens magnification}$$

$$\text{Total magnification} = \text{objective lens magnification} \times \text{eyepiece lens magnification}$$



Calculate the actual length of the organelle above as shown by the line AB in the diagram. Express your answer to the nearest micrometer (μm).

Show your working.

- Measure the line A-B. This is your image size.

$$\begin{array}{lll} A = \frac{I}{M} & A = \frac{102\text{mm}}{20\,000} & A = \frac{102000\mu\text{m}}{20\,000} \end{array}$$

$$\text{Answer} = 5.1. \mu\text{m}$$

Unit Conversions

Due to the microscopic size of specimens we often look at in Biology we tend to use different units than standard, this is to prevent confusion caused by very large numbers below 1.

<u>Unit</u>	<u>Operation</u>	<u>New Unit</u>
Centimetre (cm)	Multiply by 10	Millimetre (mm)
Millimetre (mm)	Multiply by 1000	Micrometre (um)
Micrometre (um)	Multiply by 1000	Nano Metre (nm)
Nano Metre (nm)	Multiply by 1000	Picometre (pm)

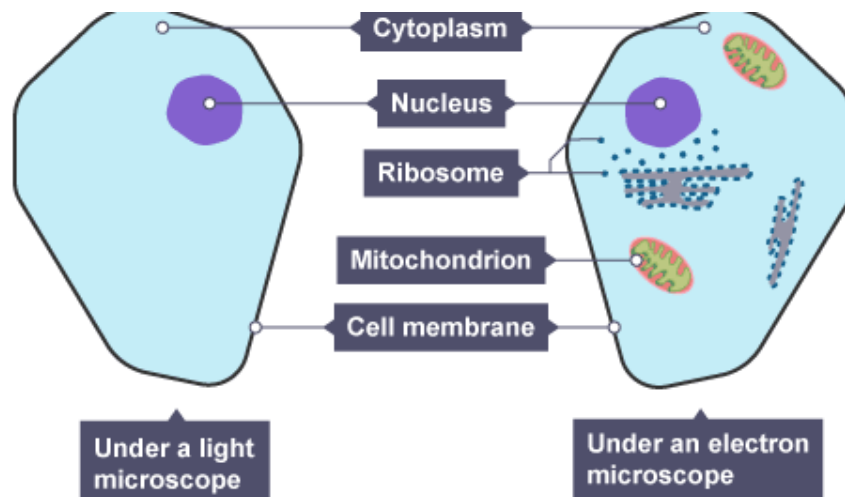
<u>Unit</u>	<u>Operation</u>	<u>New Unit</u>
Nano Metre (nm)	Divide by 1000	Micrometre (um)
Micrometre (um)	Divide by 1000	Millimetre (mm)
Millimetre (mm)	Divide by 10	Centimetre (cm)

Cells

We divide cells into two groups: **Eukaryotic** and **Prokaryotic**

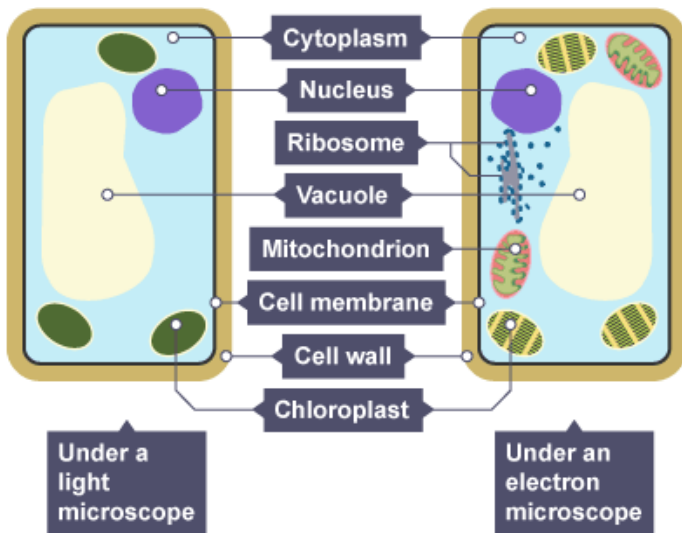
Eukaryotic	Prokaryotic
e.g. animal and plant cells	e.g. Bacteria cells
Membrane bound organelles	No membrane bound organelles
Have a nucleus	No nucleus
Larger than prokaryotic	Smaller than Eukaryotic

Animal cells



Structure	Function
Nucleus	- Contains DNA coding for a particular protein needed to build new cells. - Enclosed in a nuclear membrane.
Cytoplasm	- Liquid substance in which chemical reactions occur. - Contains enzymes (biological catalysts, i.e. proteins that speed up the rate of reaction). - Organelles are found in it
Cell membrane	Controls what enters and leaves the cell
Mitochondria	Where aerobic respiration reactions occur, providing energy for the cell
Ribosomes	- Where protein synthesis occurs. - Found on a structure called the rough endoplasmic reticulum.

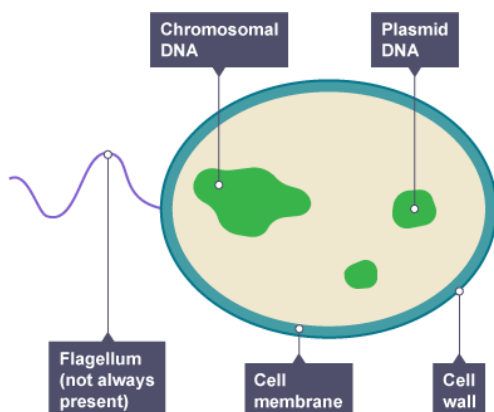
Plant cells



Structure	Function
Chloroplasts	- Where photosynthesis takes place, providing food for the plant - Contains chlorophyll pigment (which makes it green) which harvests the light needed for photosynthesis.
Permanent vacuole	- Contains cell sap - Found within the cytoplasm - Improves cell's rigidity
Cell wall (also present in algal cells)	- Made from cellulose - Provides strength to the cell

Bacterial cells

Bacteria cells are Prokaryotic, so do not have the same features as animal or plant cells



Structure	Function
Cell wall	Made of a different compound (peptidoglycan)
Chromosomal DNA (circular)	As bacterial cells have no nucleus, this floats in the cytoplasm
Plasmids	Small rings of DNA - code for extra genes to those provided by chromosomal DNA
Flagella	Long, thin 'whip-like' tails attached to bacteria that allow them to move

Specialised cells

Examples of specialised cells in animals:

Sperm cells: specialised to carry the male's DNA to the egg cell (ovum) for successful reproduction.

- Streamlined head and long tail to aid swimming.
- Many mitochondria (where respiration happens) which supply the energy to allow the cell to move.
- The acrosome (top of the head) has digestive enzymes which break down the outer layers of membrane of the egg cell
- Haploid nucleus - the word haploid simply means that it has 23 chromosomes, rather than the 46 that most other body cells have.

Egg cells: specialised to accept a single sperm cell and develop into an Embryo

- Surrounded by a special cell membrane which can only accept one sperm cell (during fertilisation) and becomes impermeable following this.
- Lots of mitochondria to provide an energy source for the developing embryo.
- Large size and cytoplasm to allow quick, repeated division as the embryo grows.

Ciliated epithelial cells: specialised to waft bacteria (trapped by mucus) to the stomach

- Long, hair-like processes called cilia waft bacteria trapped by sticky mucus down to the stomach, where they are killed by the stomach acid. This is one of the ways our body protects against illness.

Examples of specialised cells in plants:

Root hair cells: specialised to take up water by osmosis and mineral ions by active transport from the soil as they are found in the tips of roots.

- Have a large surface area due to root hairs, meaning more water can move in.
- The large permanent vacuole affects the speed of movement of water from the soil to the cell.
- Mitochondria to provide energy from respiration for the active transport of mineral ions into the root hair cell.

Xylem cells: specialised to transport water and mineral ions up the plant from the roots to the shoots.

- Upon formation, a chemical called lignin is deposited which causes the cells to die. They become hollow and are joined end-to-end to form a continuous tube so water and minerals can move through.
- Lignin is deposited in spirals which helps the cells withstand the pressure from the movement of water

Phloem cells: specialised to carry the products of photosynthesis (food) to all parts of the plants

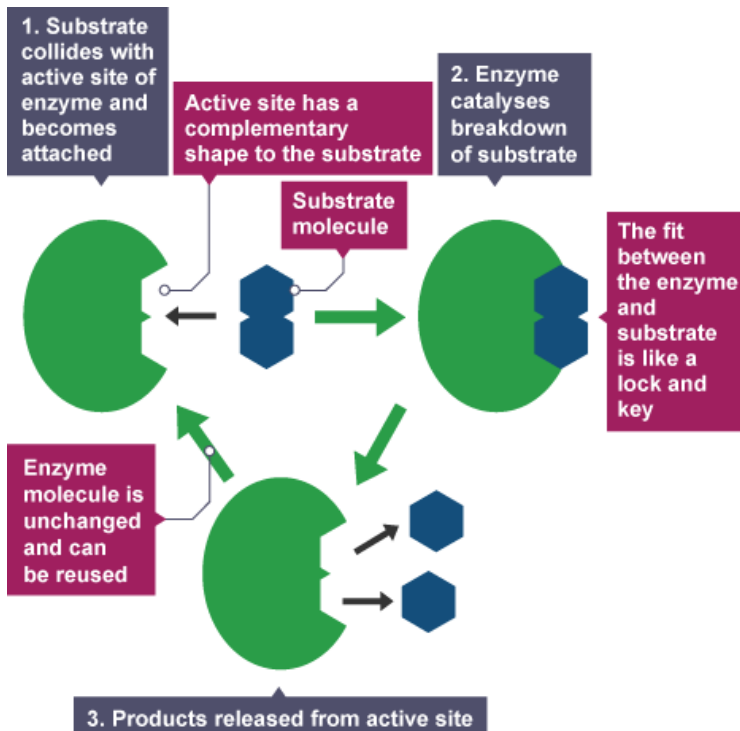
- Cell walls of each cell form structures called sieve plates when they break down, allowing the movement of substances from cell to cell
- Despite losing many sub-cellular structures, the energy these cells need to be alive is supplied by the mitochondria of the companion cells.

Enzymes

Enzymes are proteins that act as Biological Catalysts. This means that they speed up reactions without taking part in or changing as a result of the reaction.

The Lock and Key Hypothesis (a simplified explanation of how enzymes work):

Enzymes are folded into 3d shapes that allow other molecules to fit inside of them. A molecule that fits inside the enzyme is known as the substrate.



The shape of the substrate is specific to the shape of the active site on the enzyme (matches the shape of the active site), so when they bond it forms an enzyme-substrate complex.

Once joined, the reaction takes place and the products are released from the surface of the enzyme. Enzymes can digest (break down substances) or synthesise (join substances together).

Enzymes can only catalyse (speed up) reactions when they bind to a substrate that has a complementary shape, as this is the only way that the substrate will fit into the active site. This is called

enzyme specificity. The diagram shows this happening.

Enzymes in the body

Carbohydrases convert **carbohydrates** into simple **sugars**

Example: amylase breaks down starch into maltose and Glucose. It is produced in your salivary glands, pancreas and small intestine (most of the starch you eat is digested here)

Proteases convert **proteins** into **amino acids**

Example: pepsin, which is produced in the stomach, other forms can be found in pancreas and small intestine.

Lipases convert **lipids (fats)** into **fatty acids** and **glycerol**

Produced in the pancreas and small intestine.

Soluble glucose, amino acids, fatty acids and glycerol pass into the bloodstream to be carried to all the cells around the body.

They are used to build new carbohydrates, lipids and proteins, with some glucose being used in respiration. Building these new carbohydrates, lipids and proteins requires energy.

Factors affecting enzyme function

Enzymes are affected by **pH, temperature and substrate concentration**. If enzymes are exposed to extremes of pH or high temperatures the shape of their active site may change.

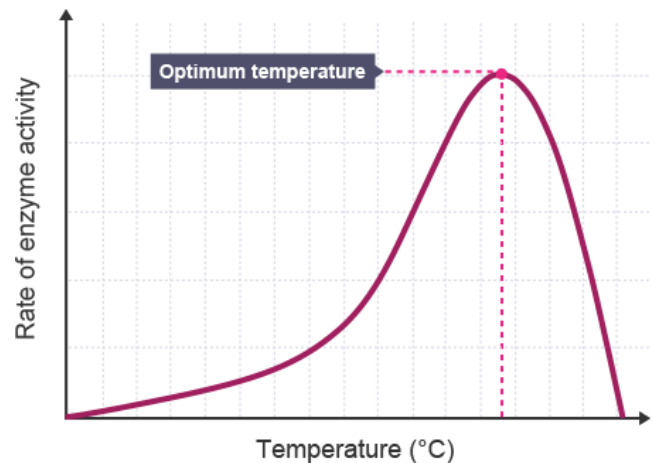
If this happens then the substrate will no longer fit into the enzymes. This means the key will no longer fit the lock. We say that the enzyme has been denatured. It is important you NEVER say that an enzyme has been killed. An enzyme is not alive therefore it cannot be killed it can simply be denatured.

Temperature and enzymes

The rate of reaction increases with an increase in temperature up to this optimum, but above this temperature it rapidly decreases and eventually the reaction stops. When the temperature becomes too hot, the bonds that hold the enzyme together will begin to break.

This changes the shape of the active site, so the substrate can no longer 'fit into' the enzyme.

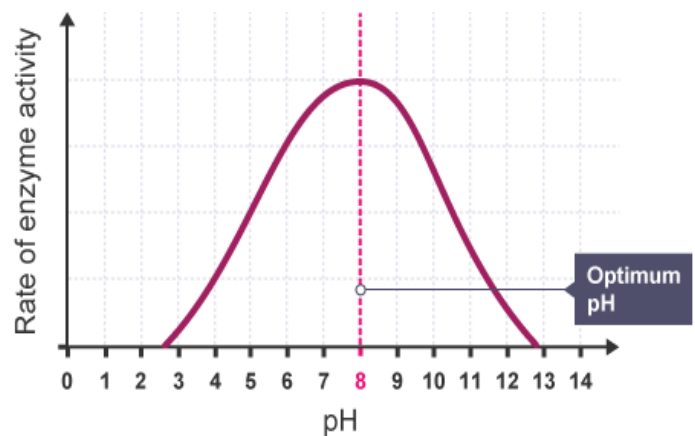
The enzyme is said to be denatured and can no longer work



pH and Enzymes

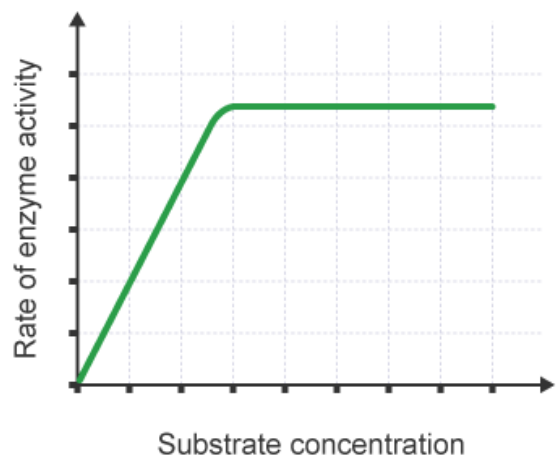
The optimum pH for most enzymes is 7 (neutral), but some that are produced in acidic conditions, such as the stomach, have a lower optimum pH.

If the pH is too high or too low, the forces that hold the amino acid chains that make up the protein will be affected. This will change the shape of the active site, so the substrate can no longer fit in. The enzyme is said to be denatured, and can no longer work.



Substrate concentration and Enzymes

Enzymes will work best if there is plenty of substrate. As the concentration of the substrate increases, so does the rate of enzyme activity. However, the rate of enzyme activity does not increase forever. This is because a point will be reached when the enzymes become saturated and no more substrates can fit at any one time even though there is plenty of substrate available.



CORE PRACTICAL – Investigating pH on enzyme activity

Amylase is an enzyme made in the salivary glands in your mouth and in the pancreas. It catalyses the breakdown of starch into smaller sugar molecules. The iodine test identifies the presence of starch, but does not react with sugar. You will use this test to show how effective amylase is in digesting starch at different pHs.

1. Place one drop of iodine solution into each dimple on the spotting tile.
2. Measure 2cm³ of amylase into a boiling tube
3. Add 2 cm³ of the first pH into the tube
4. Add 2 cm³ of starch solution and place into the water bath.
5. Take a sample every 30 seconds with an empty pipette
6. Add to the iodine, when it stops changing colour stop the experiment.
7. Record the time it took for the colour change to stop happening
8. Repeat using a different pH.

Rate Calculations

Rate calculations are very useful in Biology, and are especially important to determine how fast an enzyme is working (**the rate of reaction**). To perform a rate calculation, we use the formula:

$$\frac{1000}{\text{Time}} \quad \text{OR} \quad \frac{\text{Amount of substrate used / product formed}}{\text{Time}}$$

Proteases are a type of enzyme used to break down proteins. So as an example, if we added 5g of protein to a solution containing specific protease enzymes, and it took 30 minutes to convert ('use up') all the protein:

$$\text{Rate} = \text{change} / \text{time}$$

$$\text{Rate} = 5\text{g} / 30 \text{ minutes}$$

Rate = 0.17 g/min - this is the rate at which the enzyme is catalysing the reaction, and may change depending on temperature, pH and substrate concentration.

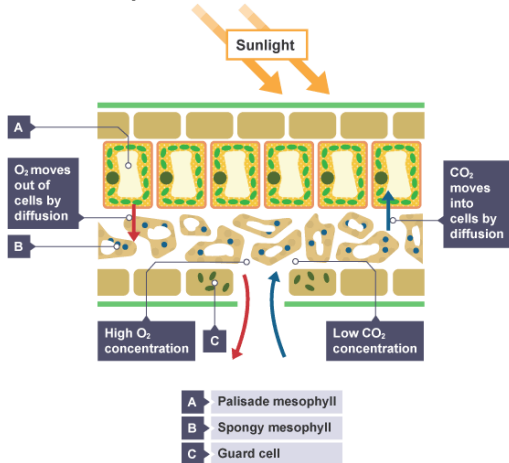
Or

$$\text{Rate} = 5\text{g} / 0.5 \text{ hours}$$

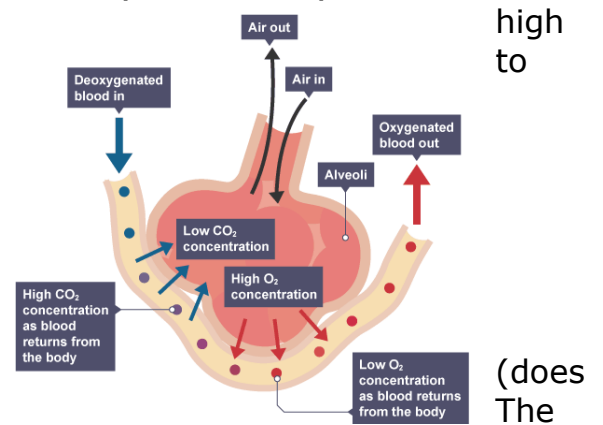
Rate = 10 g/hour - this is the rate at which the enzyme is catalysing the reaction, and may change depending on temperature, pH and substrate concentration.

Transport in cells

Substances like oxygen, glucose and waste products need to be transported in and out of cells constantly to support life processes. This transport generally occurs in one of 3 ways:

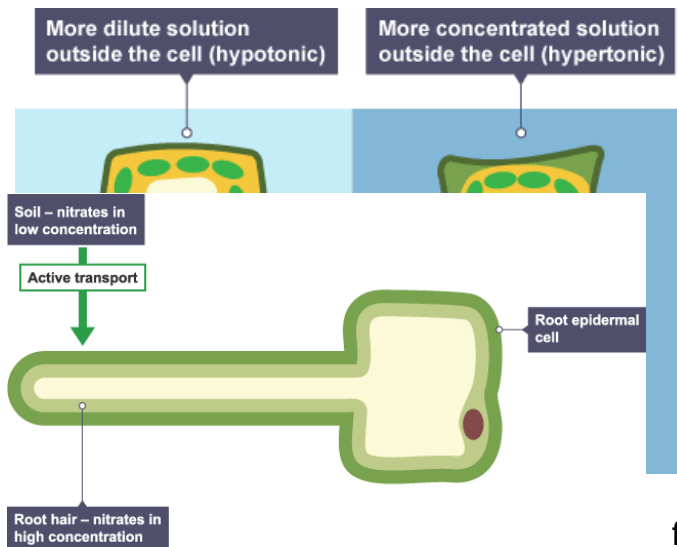


Diffusion - a form of passive transport (does not require energy). It is important to remember that molecules move in every direction and collide with each other, but the net (or resultant) movement is from an area of high concentration to an area of low concentration.

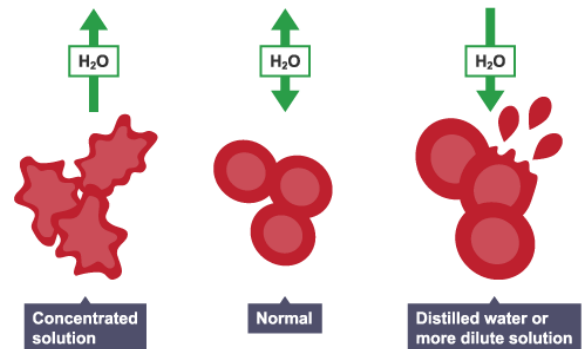


Osmosis is also a form of passive transport (does not require energy) but it only applies to water. The same rules as diffusion apply - however there is no such thing as 'concentration of water', so we say that movement is from a dilute solution to a more concentrated solution, across a selectively permeable membrane. Another way to think about this is that movement of water occurs from an area of low solute concentration to high solute concentration (e.g. if the solute was salt, from a less 'salty' solution to a more 'salty' solution).

Osmosis in plant cells



Osmosis in animal cells

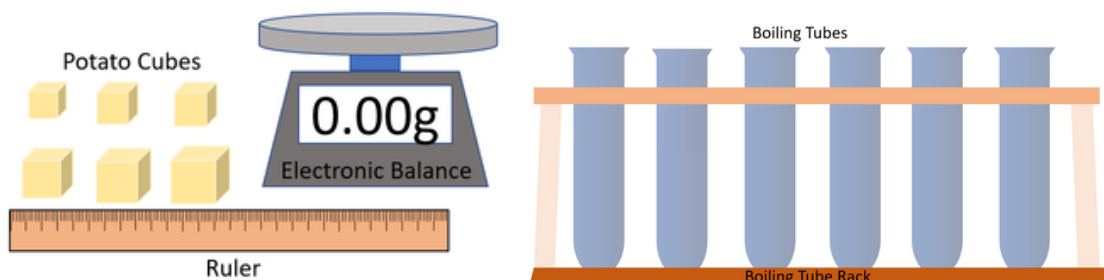


Active Transport - active transport is a form of transport that does require energy. This energy comes from ATP, which is the molecule produced in respiration. Active transport is used to move molecules against a concentration gradient (i.e. from an area of low concentration to an area of high concentration).

CORE PRACTICAL: Investigating osmosis

1. Prepare sucrose solution; 0%, 20%, 40% 60%, and 80%.
2. Set up a series of boiling tubes with each of these solutions. The 0% sucrose solution will act as the control in the experiment. Make sure each tube is labelled with the concentration.
3. Prepare a blank results table before you begin. Make sure when weighing the potato cylinders, that their masses are not mixed up when recording them. Each cylinder will have a different mass before and after the investigation.
4. Dry a potato strip using a paper towel. Measure the mass of the potato cylinder.
5. Place the potato strip into the 0% solution for 20 minutes.
6. Remove the potato strip, dry it carefully using paper towel. Measure and record the mass of the potato strip.
7. Repeat for each sucrose concentration.
8. For each sucrose concentration, repeat the investigation for several potato cylinders. This allows you to check the precision of your results (results that are close together for the same concentration suggest that the results are precise). The potato cylinders might not all behave in the same way. Making a series of repeat experiments means that any anomalous results can be identified and ignored when a mean is calculated.

This experiment shows the effect of osmosis on plant tissue. The cylinders will decrease or increase in mass if they lose or gain water by osmosis



Percentage change in mass

There is some variation in mass between the potato cylinders at the beginning of the experiment as it would be impractical to prepare the cylinders so that they were identical in mass.

So that we can compare changes in mass of different potato cylinders, it is necessary to calculate the percentage change in mass.

$$\text{change in mass} = \frac{\text{mass at end} - \text{mass at start}}{\text{mass at start}} \times 100$$

Some of the values we obtain for percentage change in mass will be positive, some will be negative.

For the potato cylinder in the distilled water:

$$\text{change in mass} = \frac{2.52 - 2.22}{2.22} \times 100$$

$$\frac{0.30}{2.22} \times 100 = 13.5\%$$

The changes in mass, as percentages, must be calculated for each potato cylinder.

Prove it Questions

Microscopy Pages 3-5

Question	Marks
1. A bacterial cell is a prokaryotic cell, which type of microscope would be best to use to enable you to see a more detailed image?	2
2. Calculate the magnification of a microscope with an objective lens magnification of x10 and an eyepiece lens magnification of x5.	1
3. Why did we discover more about bacterial cells following 1930?	2
4. Compare Electron and Light microscopes.	2
5. Calculate the image size of a specimen if the actual size is 5µm and the magnification is x200.	3

Cell Structure Pages 6-7

Question	Marks
1. Describe the difference between eukaryotic and prokaryotic cells.	2
2. Compare and contrast Animal and Bacteria cells	3
3. List the job of the Mitochondria and the Ribosomes	2
4. Compare and contrast Animal and Plant cells	3

Specialised cells Page 8

Question	Marks
1. Define "specialised cell."	1
2. What does Haploid mean?	1
3. List 2 adaptations of the sperm cell.	2
4. Name one specialised plant cell and describe its adaptations	3

Enzymes Page 9

Question	Marks
1. What is the job of the active site on an enzyme?	1
2. An enzyme is a protein, what are the smaller components it is made from?	1
3. What molecule does Amylase break down and what does it break it into?	2
4. Describe the lock and key theory.	3
5. Enzymes are known as biological catalysts – what does a catalyst do?	1

Factors affecting enzyme function Page 10

Question	Marks
1. List three factors that affect enzyme function	3
2. What does denatured mean?	2
3. Describe how temperature affects Enzyme function	3
4. Describe how substrate concentration affects enzyme function	3

Core practical and rates of reaction Page 11

Question	Marks
1. Write the equation to calculate rates of reaction.	1
2. It took 9 minutes for Amylase to break down Starch into Maltose, calculate the rate of reaction.	2
3. Catalase was used to break down a substrate, it produced 30cm ³ of product over 3 minutes. Calculate the rate of reaction.	2
4. List the independent variable and dependent variable you would have when investigating the effect of pH on rate of enzyme activity.	2

Transport in cells page 12-13

Question	Marks
1. Diffusion and Osmosis are passive processes, what does this mean?	1
2. What is a key difference between diffusion and Osmosis?	2
3. Why does Active Transport require energy?	2
4. Calculate the percentage change of a potato is its mass prior to being in Sucrose solution was 3g, and its mass following sucrose solution was 4.9g.	2
5. Using your answer to the above question, describe what this means has happened to the potato cells and why?	4

Prove it Mark scheme

Microscopy Pages 3-5

Answer	Marks
1. An electron microscope (1) as it has greater magnification and resolution (1) and a Prokaryotic cell is smaller. (1)	2
2. $10 \times 5 = \times 50$ (1)	1
3. Electron microscopes were invented, (1) allowing us to see greater detail in smaller cells like bacteria. Greater resolution and greater magnification. (1)	2
4. Light microscopes use light rays (1) and have two lenses. (1) Electron microscopes use electrons (1) Electron microscopes have greater magnification powers (1) and greater resolution (1)	2
5. Image size = Actual size x Magnification (1) Image size = 5×200 (1) Image size = 1000 μm (1)	3

Cell Structure Pages 6-7

Answer	Marks
1. Prokaryotic cells are smaller, (1) don't have a nucleus (1) and don't have membrane bound organelles (1) Eukaryotic cells are larger (1), have a nucleus (1) and have membrane bound organelles (1)	2
2. Animal cells have cytoplasm, mitochondria, ribosomes, nucleus, cell membrane, Bacteria cells have a cell wall, (1), no nucleus (1) Plasmid DNA (1) Chromosomal DNA (1) and often have a flagellum (1)	3
3. Mitochondria is the site for respiration (1) Ribosomes are the site for protein synthesis (1)	2
4. Animal cells have cytoplasm, mitochondria, ribosomes, nucleus, cell membrane, plant cells have all of the above (1) but also have chloroplasts (1) Vacuole (1) and a cell wall (1)	3

Specialised cells Page 8

Answer	Marks
1. A cell with an important (special job) that has specific differences to allow it to carry out that job (1)	1
2. Half the amount of chromosomes (23 individual ones instead of 46) (1)	1
3. Tail to help it swim (1) Acrosome on its head to help it penetrate the egg cell (1) streamlined shape to allow it to move efficiently (1) haploid cell (1)	2
4. Root hair cell (1) Large surface area (1) Thin cell walls (1) Xylem cell (1) no top and bottom to the cell (1) tough cell walls to withstand the pressure of liquid moving throughout (1) Phloem cell (1) Sieve plates in cell walls (1)	3

Enzymes Page 9

Answer	Marks
1. It is where the substrate fits into (1) where the reaction happens (1)	1
2. Amino acids (1)	1
3. Starch (1) into Maltose (1) accept Glucose (1)	2
4. Enzyme acts as lock (1) Substrate as key (1) Substrate fits into active site of enzyme due to special shape (1) Enzyme works to either break down or build substrate (1) Due to shape of active site enzymes are specific (only work with one type of substrate (1)	5
5. Speed up reactions without taking part or changing in a reaction (1)	1

Factors affecting enzyme function Page 10

Answer	Marks
1. pH, (1) Temperature (1) and Substrate concentration (1)	3
2. Active site of enzyme has changed shape (1) Meaning the enzyme cannot work with its specific substrate (1)	2
3. Increasing temp initially increases rate (1) until approx. 37.5°C (if enzyme works in the body) this is the optimum rate (1) Following this increasing temp changes the shape of the active site (1), denaturing the enzyme (1) reducing enzyme function (1)	3
4. As the concentration of the substrate increases so does the rate of enzyme activity. (1) However, the rate of enzyme activity does not increase forever. (1) This is because a point will be reached when the enzymes become saturated and no more substrates can fit at any one time even though there is plenty of substrate available. (1)	3

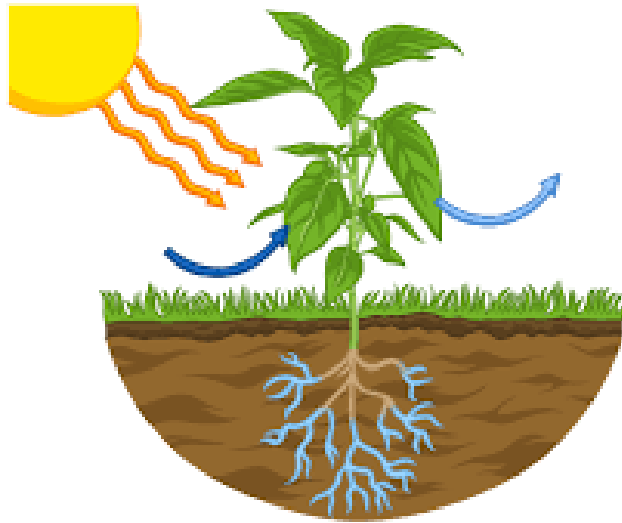
Core practical and rates of reaction Page 11

Answer	Marks
1. Either 1000/ time (1) or amount of product formed /time (1)	1
2. $9 \times 60 = 540\text{s}$ (1) $1000/540 = 1.85\text{s}^{-1}$ (1)	2
3. $3 \times 60 = 180$ (1) $30/180 = 0.17\text{s}^{-1}$ (1)	2
4. IV = pH (1) DV = Time taken for colour change to stop happening (no starch left)	2

Transport in cells page 12-13

Answer	Marks
1. Neither require energy (1)	1
2. Osmosis refers to the movement of water only, (1) diffusion describes the movement of solute or gases (1)	2
3. Because it moves substances against the concentration gradient (1) From an area of low concentration to an area of high concentration (1)	2
4. $4.9 - 3 = 1.9\text{ g}$ (1) $1.9/3 = 0.63$ $0.63 \times 100 = +63\%$ (1)	2
5. Mass has increased, (1) indicating water has moved from solution into the potato cell (1) Concentration of solution outside the cell was lower (1) (more water outside) than the concentration within the potato cell (less water inside) (1)	4

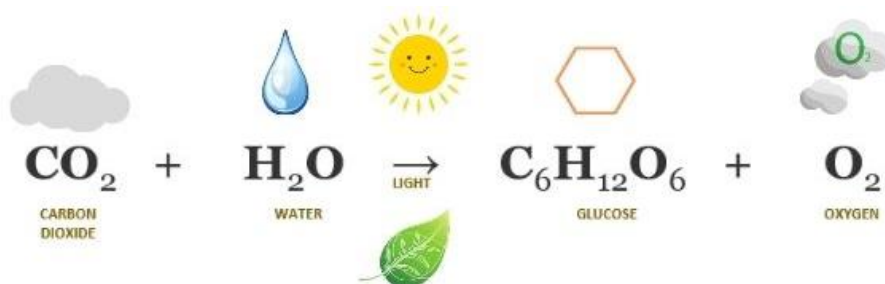
GCSE 9-1 BIOLOGY



Topic 6 Plant structure and their functions

Revision booklet

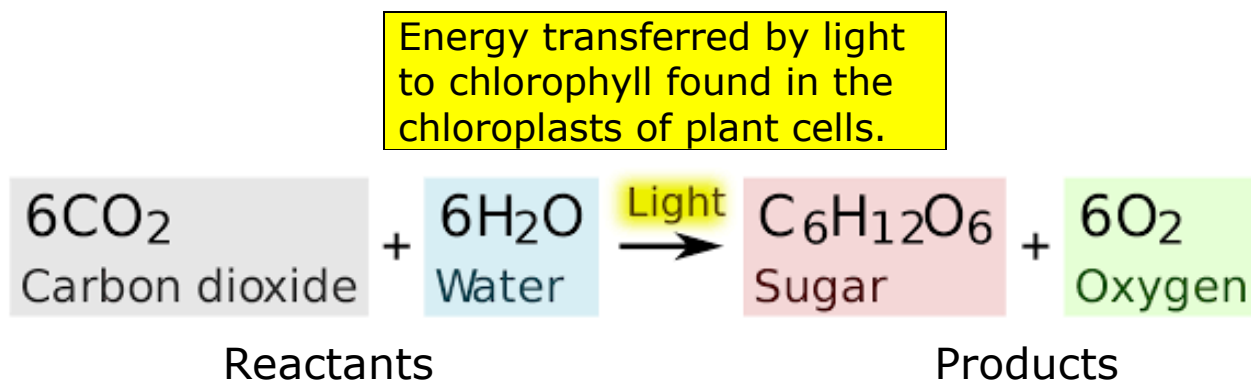
Topic	Pages
Photosynthesis	19
Leaf adaptations	20
Factors that affect Photosynthesis	21-22
Core Practical: Investigating light intensity & photosynthesis	23
Absorbing water and mineral ions	24
Transpiration and Translocation	25
Questions	26
Mark scheme	27-28



Photosynthesis

Plants and Algae can trap energy from the sunlight and use it to make glucose in a process called photosynthesis. This Glucose is a store of energy (**biomass**), animals take the energy when they eat the plants. **Biomass** is a renewable material that comes from organic matter such as plants. Plant **biomass** increases because of **photosynthesis**. Plants absorb energy from the sun and convert Carbon Dioxide and water into nutrients.

Photosynthesis needs sun to provide the energy for it to occur. It is a chemical reaction represented by the following equation:



Where does photosynthesis happen?

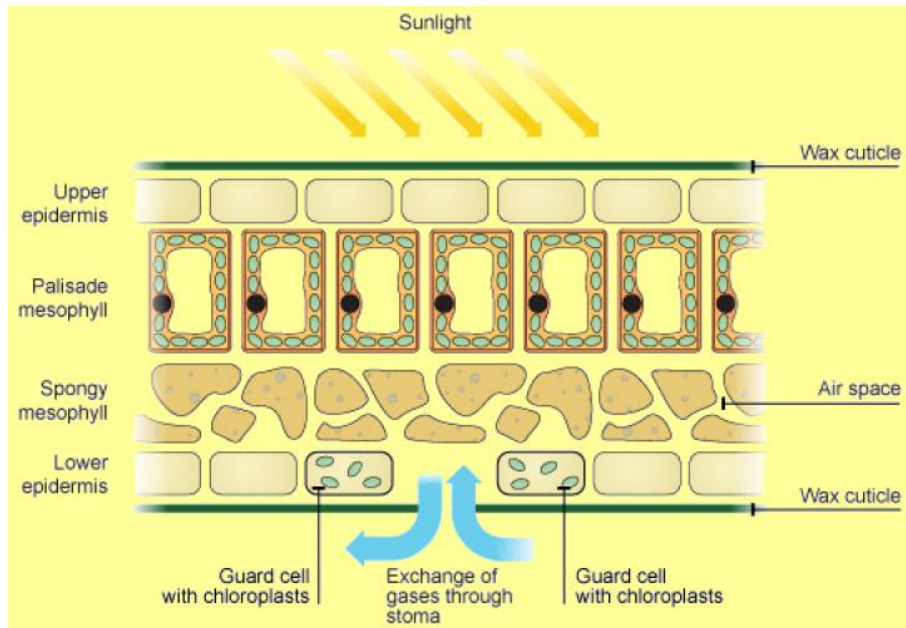
Photosynthesis occurs in an organelle called **Chloroplasts**, found within plant cells only. Animal cells do not have chloroplasts as they do not photosynthesise. The **Chloroplasts** are found in the leaves of the plants.

Within each **Chloroplast** is a chemical called **Chlorophyll** – this is a green colour and is what makes plants appear green. If an object looks a certain colour, it is because the object reflects that colour and absorbs other colours in the spectrum. So plants reflect the colour green.

- Photosynthesis is an **endothermic** reaction as energy enters from the surroundings and the products have more energy than the reactants.
- The **Glucose** molecules that are made get joined together into long chains (**a polymer**) called **Starch**. **Starch** can be broken down when needed into simpler substances which then get moved into the cytoplasm and used to make different sugars (**sucrose**)
- Sucrose can then be used to make **Starch** again, or to make **cellulose, lipids or proteins** or **Glucose for respiration**.

Leaf Adaptations

Photosynthesis takes place in the **Chloroplasts** which are found in cells within the leaves. Below is a cross section of a leaf. You can see that the majority of **chloroplasts** are found in the **Palisade layer** towards the top of the leaf.



Structure	Function
Wax Cuticle	To help prevent water loss.
Upper Epidermis	Thin and transparent to allow more light through to the chloroplasts.
Palisade cells	Contains lots of chloroplasts to absorb more light. Also found at the top of leaves where light is most likely to hit.
Spongy mesophyll	Contains lots of air spaces to allow carbon dioxide to diffuse through the leaf and increase the surface area.
Stomata	Holes in the leaf to allow carbon dioxide to diffuse in and oxygen to diffuse out.
Guard cells	When water flows into the guard cells it makes them rigid which opens the Stomata, when water flows out of the guard cells they close the stomata.

Leaves are **broad** and **flat** so they can catch more sunlight. They are also very **thin** so that **carbon dioxide** can **diffuse** quickly to the area it needs to go (where the **chloroplasts** are). The flow of gases in and out of the leaf is an example of **gas exchange**.



Factors that affect Photosynthesis

A factor that prevents a rate from increasing is known as a **limiting factor** (see table below). A **limiting factor** is something that slows down or stops **Photosynthesis** regardless of the abundance of other factors required. **For example** if **light intensity** is low it restricts any increase in the rate of **photosynthesis**. Despite increases in other factors (such as **temperature** or **carbon dioxide concentration**), the rate of **photosynthesis** will not increase any more. However, if you were to increase the **light intensity** then the rate of **photosynthesis** would again start increasing.

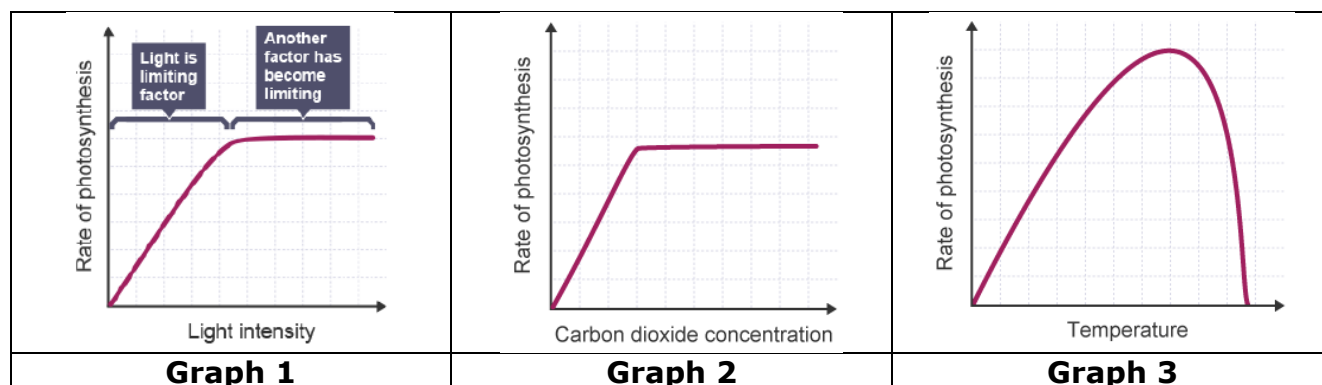
An easier example to think of is a car – imagine you are in a factory building cars – each car has 4 doors and needs 4 wheels. You have 16 doors which means you could make 4 cars, however you only have 12 wheels. The wheels have become the limiting factor so it doesn't matter if someone keeps giving you more doors, unless you have more wheels you can't make any more than 3 cars.

The graphs below show examples of how different **limiting factors** affect the rate of **photosynthesis**.

In **Graph 1** the **limiting factor** when rate of **photosynthesis** decreases and stops is **CO₂** or **temperature**, as **light intensity** is increasing.

In **Graph 2** the **limiting factor** will be either **light intensity** or **temperature** as we can see that **CO₂** concentration is increasing.

In **Graph 3** **temperature** is the **limiting factor** – rate is slow at too low a **temperature** and then slows down past the **optimum temperature**.



Factor	Effect
Light Intensity Graph 1	For most plants, the higher the light intensity , the faster the rate of the reaction .
Carbon dioxide Graph 2	Carbon dioxide concentration is also needed to make glucose (see equation). As the concentration of carbon dioxide increases, the rate of reaction increases .
Temperature Graph 3	With an increase in temperature , the rate of photosynthesis increases. As the reaction is controlled by enzymes , this trend continues up to a certain temperature until the enzymes begin to denature and the rate of reaction decreases.

HIGHER ONLY

As mentioned above, light intensity is directly proportional to the rate of photosynthesis. This is because the greater the intensity of light, the more photons (light energy) hit the chloroplasts in the plants cells, and the more photosynthesis can occur at once.

It makes sense, then, that the opposite pattern can be seen between the rate of photosynthesis and the distance from the light source.

Inverse proportion describes a relationship between two factors which involves one increasing whilst the other is decreasing.

As the distance between the light source and the plant increases, the light intensity decreases.

The light intensity is inversely proportional to the square of the distance- called the inverse square law.

$$\text{Light intensity} \propto 1/\text{distance}^2$$

This means that if a lamp is 2 metres away from a plant, then the light intensity of the lamp is $\frac{1}{4}$ of its original value.

$$1/2^2 = \frac{1}{4} (0.25)$$

$$L_{\text{new}} = \frac{L_{\text{orig}} \times D_{\text{orig}}^2}{D_{\text{new}}^2}$$

E.g: A light source provides an intensity of 2000 lux at 20 cm. Calculate the intensity at 40cm

$$L_{\text{new}} = \frac{2000 \times 20^2}{40^2}$$

$$L_{\text{new}} = 500 \text{ lux}$$

L_{new} = new light intensity

L_{orig} = original light intensity

D_{orig} = original distance

D_{new} = new distance

CORE PRACTICAL: Investigating Light intensity and photosynthesis.

For this investigation you will use algal balls, this is algae that has been immobilized in jelly. This makes the algae easier to work with and allows it to last for longer. You are hoping to find out how different light intensity affects the rate of photosynthesis.

1. Place the same number of algal balls (rinsed with distilled water) into 5-6 bijou bottles.
2. Fill each bottle with indicator solution using a pipette and replace the lid
3. Place the bottles equal distances apart along a 30cm ruler
4. Place a switched off lamp at one end of the ruler facing the bottles
5. Switch on the lamp and set your timer the time you have chosen
6. When the time is up, record the colour and /or pH in each tube



for

Independent variable: Distance from the lamp.

(The further from the lamp it is the lower the light intensity.)

The Dependent Variable: pH.

(The pH tells us how much carbon dioxide is left in the solution. Remember that when photosynthesis happens Carbon dioxide is used up. So we would expect there to be less Carbon dioxide left in the tubes that most photosynthesis has happened in.)

Control Variables: Temperature, pH at start.

- You should calculate the change in pH/hour.
- You can plot a graph of your results by putting distance from lamp (light intensity) along the x axis → and change in pH/hour along the Y axis ↑ .
- **The colour in the tube indicates the pH of the solution. Remember during photosynthesis carbon dioxide is used up. When there is no carbon dioxide in a solution the indicator will turn purple, this indicates it is an alkaline solution.**
- **Therefore, the solution that is most strongly alkali is the solution where most carbon dioxide has been used up, therefore where most photosynthesis has happened.**

Absorbing Water and Mineral ions

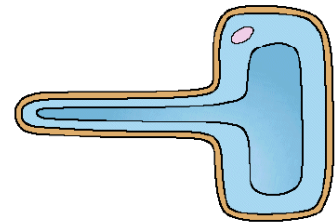
Water absorbed by **plant roots** is used to carry **dissolved mineral ions**, to keep cells rigid, and to cool the leaves through evaporation.

Substances move into and out of plants through **3** processes. **Diffusion**, **osmosis** and **active transport**. Diffusion and osmosis are both **passive** processes which means they do not require energy. Active transport is an **active** process which means it requires energy in order for it to happen.

Several cells in plants are adapted to perform specific functions:

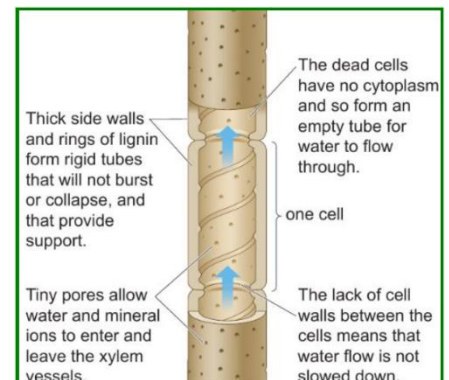
Root hair cells: Specialised to take up **water** by **osmosis** and **mineral ions** by **active transport** from the soil as they are found in the **tips** of **roots**.

- Have a **large surface area** due to root hairs, meaning more water can move in
- The **large permanent vacuole** affects the speed of movement of water from the soil to the cell
- **Mitochondria** to provide energy from respiration for the active transport of mineral ions from the surrounding soil into the root hair cell.



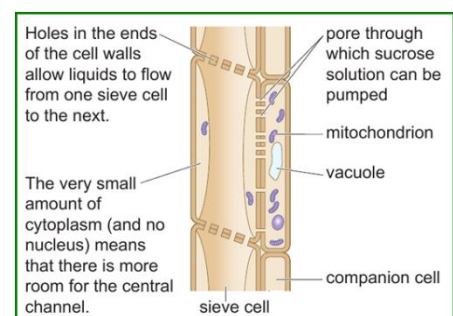
Xylem cells: Specialised to transport **water** and **mineral ions** up the plant from the **root** to the **shoots**. Only allows movement up the plant.

- **No cytoplasm:** During formation, a chemical called **lignin** is deposited which causes the cells to die. We say that these dead cells have become lignified. They become hollow (no cytoplasm). Cytoplasm would slow the movement of substances down. They are joined end-to-end to form a continuous tube so water and mineral ions can move through.
- **Hard cell walls:** Lignin is deposited in spirals which makes the cell walls tough so they can withstand the **pressure** from the movement of water
- **Pores** in walls so that **minerals** and **water** can enter and leave the vessels.
- **No cell wall** between the cells that make up the vessels so that water can continue to flow freely and quickly through the vessel.



Phloem cells: Specialised to carry the products of **photosynthesis** (sugar) to all parts of the plants. Moves substances up and down the plant.

- **Holes in the cell walls** of each cell allowing the movement of substances from **cell** to **cell**
- Unlike **xylem**, the cells within **phloem** are **alive**
- **Companion cells have lots of mitochondria.** These cells use this **energy** to pump **sucrose** into the sieve cells and around the plant.
- **Sieve cells only have a small amount of cytoplasm** – this means there is more room for things to move through the central channel.



Transpiration and Translocation

Transpiration is the **loss of water** or **water vapour** from the **leaves** and **stems** of the plant. It is a consequence of **gas exchange**, as the **stomata** are open so that **transpiration** can occur. Water also **evaporates** at the open **stomata** (pores) on the leaf surfaces

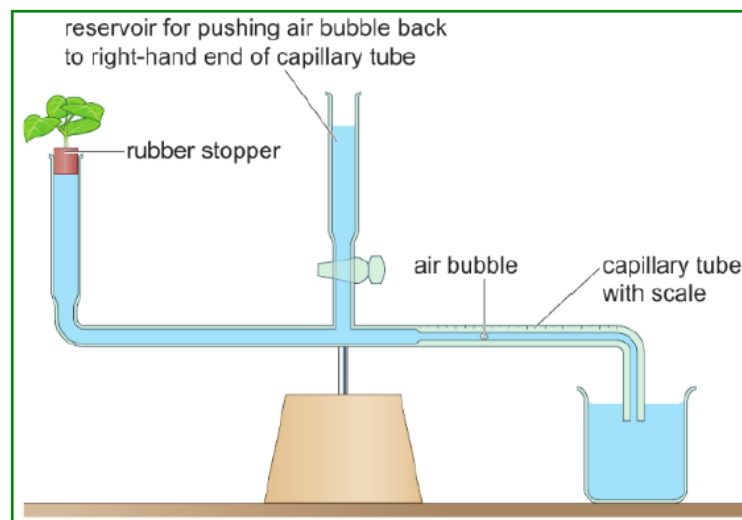
- As water molecules are attracted to each other, when some molecules leave the plant the rest are pulled up through the **xylem**
- This results in more water being taken up from the soil resulting in a continuous **transpiration stream** through the plant
- **Transpiration** happens more quickly in **windy conditions**, **low humidity**, **higher temperature** and **greater light intensity**.

Translocation is the movement of **food substances** (such as **sucrose**) made in the leaves up or down the **phloem**, for use immediately or storage.

- **Translocation** only occurs in the **phloem**, not the **xylem** or any other tissues in the plant.
- **Translocation** of **sucrose** occurs from the **sources** (the places where it is made) to the **sinks** (the places where it is used or stored)
- The location of the **sources** and sinks can depend on the season. For example, in spring the source could be located in the root, and the sink in the leaf - and in summer this could be the other way around.

Measuring rate of transpiration

A **potometer** can be used to measure the rate of transpiration (how fast transpiration happens.)



- An **air bubble** in the tube moves through the tube as the water is being pulled through to the leaves of the shoot to indicate **transpiration** is happening.
- If you measure the **distance** the air bubble moves in mm in a set **time** (30 secs) you can calculate the **rate** of **transpiration**.

$$\text{Rate of transpiration} = \frac{\text{Distance air bubble moves (mm)}}{\text{Time taken (s)}}$$

Prove it Questions

Page 19 Photosynthesis	
1. Write the equation for Photosynthesis and identify the reactants and products	2
2. Is Photosynthesis Endothermic or Exothermic and why?	2
3. What polymer do Glucose molecules make when they are joined together?	1
4. What is Sucrose used for in a plant?	3

Page 20 Leaf Adaptations	
1. Name the cells that are found towards the top of a leaf and contain a lot of chloroplasts.	1
2. Describe the roles of the Stomata and the Guard cells.	2
3. Describe 2 adaptations of the leaf.	4
4. Why do Stomata close during the night and open during the day?	2

Page 21-22 Limiting factors in photosynthesis	
1. Describe what the term limiting factor means.	1
2. State 3 factors that affect rate of Photosynthesis.	3
3. Explain how Carbon Dioxide can be a limiting factor for Photosynthesis.	2
4. (HIGHER) What does Inverse law mean in terms of photosynthesis?	2
5. (HIGHER) Calculate light intensity if the distance between a plant and light source is 3m.	3

Page 23 Core Practical: Investigating light intensity & photosynthesis	
1. What is the independent variable in this investigation?	1
2. What is the dependent variable in this investigation?	1
3. How do you calculate rate of photosynthesis using pH?	1
4. How can indicator be used to inform us how much photosynthesis has taken place?	2

Page 24 Absorbing water and mineral ions	
1. Name the processes that are used to transport substances in and out of cells.	3
2. Describe two adaptations of the root hair cells.	4
3. How is active transport different to both Osmosis and Diffusion?	1
4. What is water in plants used for?	2

Page 25 Transpiration and Translocation	
1. What is transpiration?	1
2. What is translocation?	2
3. What factors increase the rate of transpiration?	2
4. How are xylem cell adapted to allow water to flow through them easily?	3

Mark scheme

Page 19 Photosynthesis	
1. Carbon Dioxide + Water $\longrightarrow$ Glucose + Oxygen (1) (Carbon Dioxide and Water – reactants) Glucose and Oxygen (Products) (1) One for correct equation. One for identifying the reactants and products correctly.	2
2. Endothermic. (1) The products have more energy than the reactants. (1)	2
3. Starch (1)	1
4. To make Glucose for respiration (1), To make Starch, (1) or to make cellulose, lipids and proteins (1)	3

Page 20 Leaf Adaptations	
1. Palisade cells	1
2. Stomata are holes that allow gas to enter and leave the leaf. (1) Guard cells open and close the stomata (1)	2
3. Broad (1) To increase amount of sunlight it catches (1) Stomata (1) To allow gas exchange (1) Spaces in spongy mesophyll (1) To allow fast movement of substances through the leaf (1) Palisade cells at top of leaf (1) Increase the amount of sunlight getting to where it needs to (1) Waxy cuticle on top of leaf (1) To reduce water loss by evaporation (1)	4
4. During daytime there is more sunlight, so stomata open to allow gases in to let photosynthesis happen. (1) During nighttime Stomata close as there is less sunlight, so gas exchange is not necessary. (1)	2

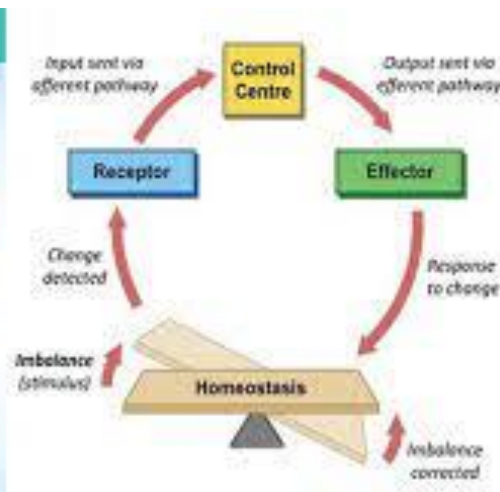
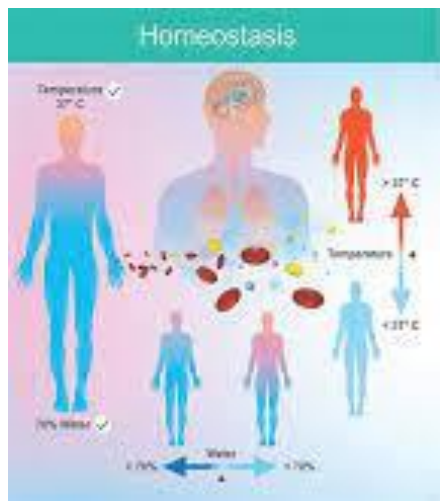
Page 21-22 Limiting factors in photosynthesis	
1. Limiting factor – is a factor that prevents a rate from increasing (1) Something that stops Photosynthesis from happening despite the presence of other factors being in abundance (1)	1
2. Carbon Dioxide (1) Light intensity (1) temperature (1)	3
3. If all factors are present for photosynthesis to occur then the rate will increase (1) If Carbon Dioxide runs out then photosynthesis can't continue despite the other factors being present (1) Photosynthesis cannot happen without Carbon Dioxide (1)	2
4. Inverse proportion describes a relationship between two factors which involves one increasing whilst one decreasing. (1) For example, as the distance between the light source and the plant increases, the light intensity decreases. (1)	2
5. Light intensity $\propto 1/\text{distance}^2$. (1) $1/3^2$ (1) $1/9$ (1)	3

Page 23 Core Practical: Investigating light intensity & photosynthesis	
1. Light intensity (1) Distance from light (1)	1
2. pH (1) Rate of photosynthesis as calculated by pH (1)	1
3. pH / hours (1)	1
4. Carbon Dioxide affects the pH of the solution (1) Carbon Dioxide will be used up as Photosynthesis happens which will then change the pH of the solution (1) When there is no Carbon Dioxide the solution will be purple (1)	2

Page 24 Absorbing water and mineral ions	
1. Diffusion (1) Active Transport (1) Osmosis (1)	3
2. Have a protrusion that increases the surface area of the cell (1) allowing more absorption of water and mineral ions (1) Thin cell walls (1) Allowing fast flow of water into the cell (1)	4
3. Active Transport is an active process which means it requires energy. Diffusion and Osmosis are both passive (1).	1
4. Carrying dissolved mineral ions (1) Keeping cells rigid (1) Cooling leaves (1) photosynthesis (1)	2

Page 25 Transpiration and Translocation	
1. Loss of water from a plant (1)	1
2. Movement of food substances through plant (1)	2
3. Increased temperature, (1) windy conditions, (1) low humidity, (1) greater light intensity (1)	2
4. No ends on cells allowing water to flow freely (1) Thick cell walls stops the vessels from breaking under pressure (1) Made of dead cells with no cytoplasm which would slow the flow of water down (1) Tiny pores in walls allowing mineral ions and water to flow in and out (1)	3

GCSE 9-1 BIOLOGY



Topic 7 Animal control, coordination, and homeostasis

Revision booklet

Topic	Pages
Hormones	30
<i>Hormonal control of metabolic rate (HIGHER)</i>	31-32
The Menstrual cycle and Contraception	33-34
<i>Hormones and the menstrual cycle (HIGHER)</i>	35
<i>IVF (HIGHER)</i>	36
Homeostasis (foundation) and <i>Control of blood glucose. (HIGHER)</i>	37-38
Diabetes	39
Questions	40-41
Mark scheme	42-43



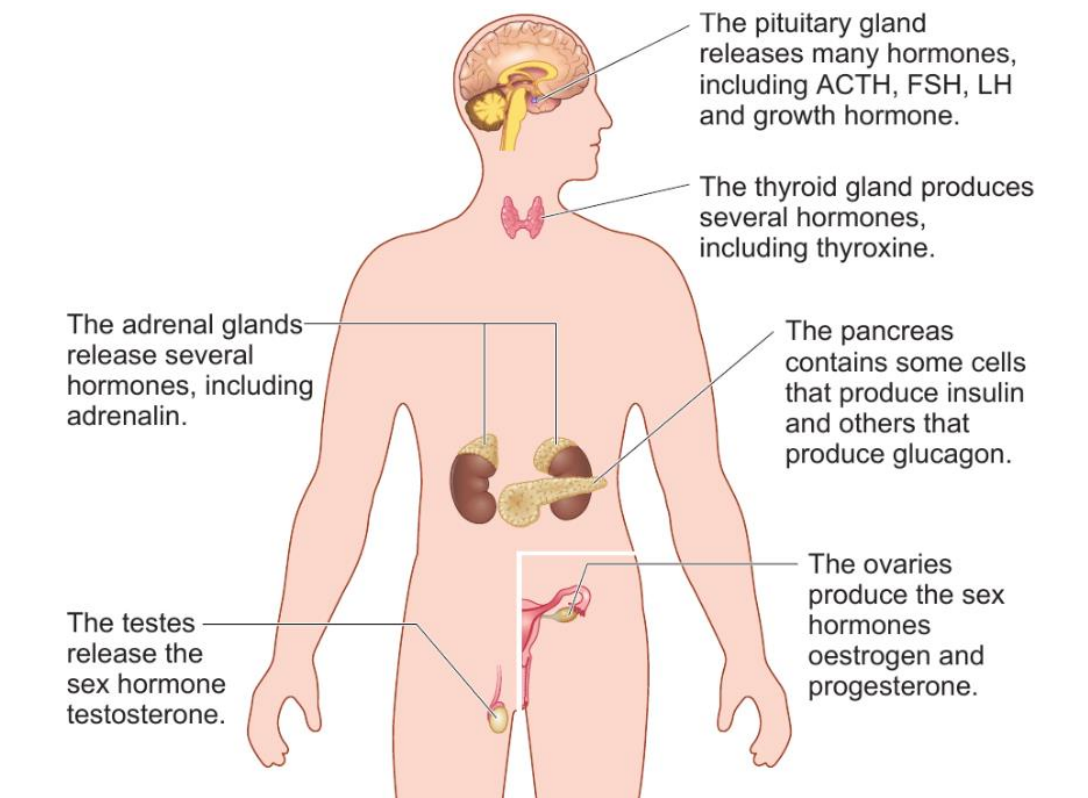
Hormones

Hormones are produced by and excreted from **endocrine glands** including the pituitary, thyroid, adrenals, ovaries and testes, and are transported by the blood to their target organs. Many processes within the body are coordinated and controlled by chemical substances called hormones.

Hormones, being directly released into the blood, are carried to all parts of the body BUT only affect the function of particular cells.

Hormones effectively act as 'chemical messages' to trigger particular biochemical reactions. Their effects are relatively long-lasting compared to the nerve impulses and responses of reflex arc, but both the nervous system and hormones also help us to control conditions inside our bodies. The nervous system is a faster messenger system than the endocrine system.

- The pituitary gland is located in the brain and releases many hormones including **ACTH, FSH, LH** and **growth hormone**. **Growth** hormone stimulates cells in muscles and bones to encourage them to start dividing, it also stimulates the digestive system to absorb calcium ions to help growth or strong bones. The target organs for growth hormones would be the **muscles** and **bones**.
- The thyroid gland produces **thyroxine**.
- Adrenal glands produce several hormones one of which is **adrenalin**. Target organs would be **heart, lungs, liver**.
- The pancreas produces **insulin** and **glucagon**.
- The ovaries produce the sex hormones **oestrogen** and **progesterone**.
- The testes release the sex hormone **testosterone**.



Hormones and metabolic rate (HIGHER ONLY)

Adrenaline and the Fight-or-Flight response

Adrenaline is a hormone that is produced by the adrenal glands to prepare the body for a fight or flight response. A flight-or-flight response is the body's response to a dangerous situation: historically this would have been being confronted by a dangerous animal for example.

Aspects of the fight or flight response include:

- **Increased heart rate:** this allows oxygen to reach the muscles more quickly, so we can move out of the path of danger
- **Increased blood pressure:** as above.
- **Increased blood flow to muscles:** blood vessels leading to vessels dilate_(widen) to allow more blood to reach them. This allows them to contract with greater strength, and more quickly.
- **Increased blood sugar levels:** the liver is stimulated to break down glycogen (a storage molecule) into glucose, which muscles can use to contract.

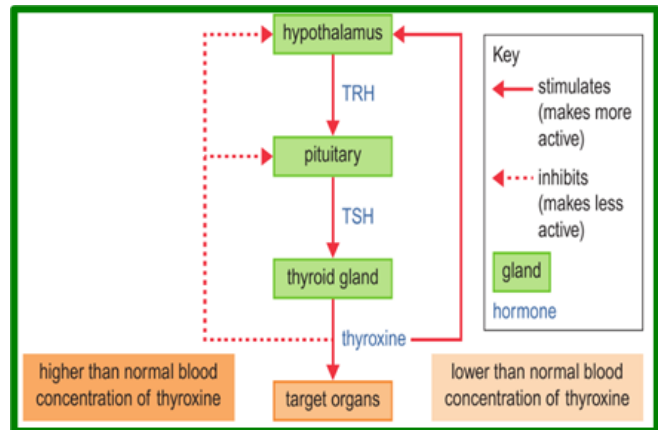
Thyroxine and Metabolic Rate

Thyroxine regulates metabolic rate (how quickly reactions occur). It is also important in growth and development.

Thyroxine levels are controlled by **negative feedback**: Where an increase in something directly brings about a decrease in something else. See below:

Low levels of thyroxine

- Hypothalamus is stimulated to produce a hormone called TRH
- TRH causes the release of TSH from the pituitary gland
- TSH acts on the thyroid to produce thyroxine.



Thyroxine levels at normal level

- Thyroxine inhibits the release of TRH from the hypothalamus.
- This inhibits the production of TSH from the pituitary Gland
- This inhibits the release of thyroxine, so levels of thyroxine fall

The menstrual cycle

Sexual reproduction cannot happen without several sex hormones. When your body reaches puberty it starts to release sex hormones that trigger the formation of secondary sexual characteristics - exemplified by the obvious physical changes to the male and female bodies! E.g. in men, facial hair develops. The main reproductive male sex hormone is testosterone, produced in the testes, this stimulates sperm production and is important for the development of the male reproductive system. In women the main reproductive sex hormone is oestrogen, produced in the ovaries. Apart from promoting physical changes e.g. breast development, oestrogen is also involved with other hormones in the menstrual cycle linked to female fertility

Stage 1 - Menstruation starts - the bleeding starts on day 1 as the uterus lining breaks down for 4 days promoted by the **decrease in progesterone level**. The lining of the uterus wall is called endometrium.

Stage 2 - over days 5 to 14 the uterus lining builds up again ('repaired') to give a thickish spongy layer of tissue full of blood vessels, ready to receive a fertilised egg for implantation - this is promoted by the **rise in oestrogen level**.

Stage 3 - around day 14 an egg is developed and released from an ovary follicle in the process called ovulation - this is facilitated by the **increase in the FSH and LH hormone** - they peak at day 13, and the egg is released at day 14, hardly a coincidence!

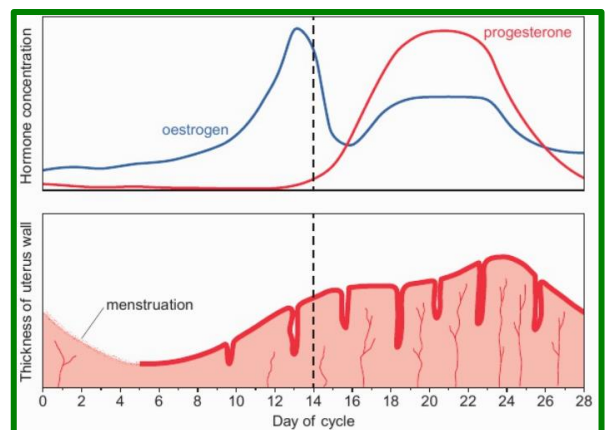
Ovulation is the release of a mature egg from an ovary follicle which typically happens once during each menstrual cycle, approx day 14 in the cycle. The egg cell lives for up to 24 hours after being released, if the egg cell is not fertilised, the egg cell dies and the menstrual cycle progresses to the next phase.

Ovarian follicles are small sacs filled with fluid and an immature egg, that are found inside a woman's ovaries. They secrete hormones which influence stages of the menstrual cycle and when women begin puberty. Each has the potential to release an egg for fertilisation. Follicles and their size and status are a vital part of assessing fertility and fertility treatment (see later section on treating infertility).

Stage 4 - the thickened uterus tissue wall lasts for around 14 days. The uterus wall is maintained by the presence of increased levels of progesterone. If no fertilised egg settles on the uterus wall by day 28, the spongy uterus lining breaks up and the whole cycle repeats itself.

What does the graph show us?

- Just before Ovulation the concentration of Oestrogen falls. (day 12/13)
- A rising level of Oestrogen causes thickening of the uterus wall. (day 8)
- A high level of Progesterone maintains the thickness of the uterus wall (day 18-24)
- In the final days of the cycle, a fall in concentration of oestrogen and progesterone leads to a breakdown of the thickened uterus wall, resulting in menstruation. (Day 24 onwards.)



Contraception

Contraception is the prevention of fertilisation and therefore pregnancy.

Method	How it prevents fertilisation	<u>Success Rate</u>
Male Condom	Placed over erect penis, prevents sperm entering vagina	98%
Diaphragm or Cap	Placed over the cervix (entrance to uterus), prevents sperm in the vagina entering the uterus	92-96%
Hormone pill or implant placed under the skin	Release hormones to prevent ovulation and thickens mucus at the cervix, making it difficult for sperm cells to pass through.	>99%

Hormones and the menstrual cycle (HIGHER ONLY)

Several sex hormones are involved in the menstrual cycle of a woman and hormones are involved in promoting the release of an egg: The monthly release of an egg from a woman's ovaries and the changes in the thickness of the lining of her womb are controlled by hormones secreted by the pituitary gland and by the ovaries. You now need to know, as described below, the function of various hormones that control the different stages of the menstrual cycle.

(a) The ovaries produce the hormone oestrogen, which causes the lining of the uterus to grow and thicken. It also triggers the release of LH (luteinising hormone), which causes the release of an egg, and inhibits further release of FSH (follicle-stimulating hormone) so that only one egg is released in each cycle.

(b) The follicle stimulating hormone (FSH) is secreted by the pituitary gland (in the brain) and causes an egg to mature in one of the ovaries in a structure called a follicle. It also stimulates the ovaries to produce hormones including oestrogen,

(c) The luteinising hormone (LH), is also secreted from the pituitary gland, and stimulates the release of an egg from the ovary around day 14 in the cycle (Stage 3 ovulation).

- LH causes the follicle to rupture and an egg is released.
- LH also indirectly stimulates progesterone production.
- LH further stimulates the remains of the follicle to develop into a structure called a corpus luteum, which secretes progesterone which maintains the physical integrity of the uterus lining.

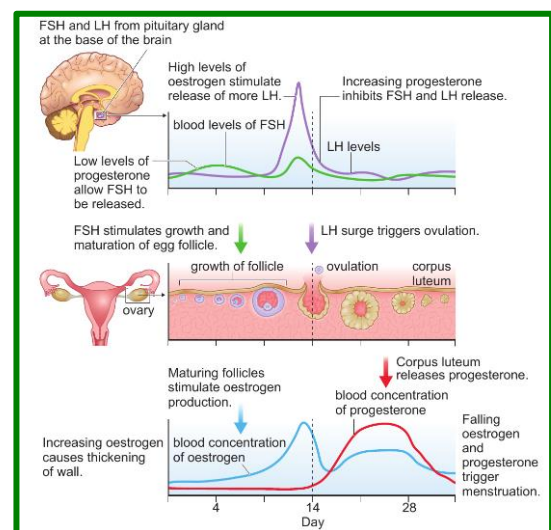
(d) Progesterone is produced in the ovaries by the remains of the follicle after ovulation (its level peaks in the middle of Stage 4). Progesterone maintains the lining of the uterus wall in the 2nd half of the cycle (see diagram) and when its level falls, the uterus lining breaks down. It also inhibits the release of LH and FSH (described above).

If pregnancy occurs, the progesterone level stays high to maintain the uterus lining.

As the progesterone level falls, the lining of the uterus begins to break down as the menstrual cycle repeats itself and it is a low progesterone level that allows the FSH hormone level to rise.

Pregnancy

If a fertilised egg lands on the uterus lining and becomes implanted, the woman becomes pregnant. Also, the level of progesterone stays at a high level to maintain the lining of the uterus during pregnancy.



IVF (HIGHER ONLY)

Sometimes giving FSH and LH in a 'fertility drug' to a woman whose own level of FSH is too low to stimulate eggs to mature doesn't always work.

If women are unable to get pregnant with hormonal treatment they may try 'In Vitro Fertilisation' (IVF) treatment.

IVF involves giving a mother FSH and LH to stimulate the maturation of several eggs where they would not have been released - this must be done before egg collection, and it also means more than one egg can be collected.

In IVF treatment, after the potential mother has been treated with FSH and LH, eggs are collected from her ovaries and fertilised in the laboratory by sperm from the father. In either case, in a laboratory, the fertilised eggs grow and develop into embryos in an incubator.

At the stage when the fertilised eggs are just tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb) to attempt a pregnancy.

Advantages and disadvantages of IVF treatment

IVF has enabled many mothers to get pregnant and give birth to healthy children - a wonderful application of medical science and technology.

BUT it doesn't always work for an infertile couple and there other downsides too.

It is possible for several eggs to be simultaneously matured resulting in multiple pregnancies eg twins, triplets and more develop from the growth of more than one embryo into a baby!

This increases the risk for mother and babies - multiple pregnancy puts extra strain on the mother - there is an increased risk of an unsuccessful birth e.g. miscarriage or stillbirth.

IVF has a low success rate, averaging 26% in the UK. It ranges from 29% for women under 35, down to 23% or less for women over 35. Age is an important factor and fertility decreases as a woman gets older.

This low success rate makes the whole process very stressful both physically and mentally - the situation is emotionally draining, especially if IVF treatment fails several times.

Women can suffer side-effects from the hormone treatment which can be physically and emotionally demanding e.g. abdominal pain, dehydration, vomiting - an overlap of side effect symptoms from hormonal contraception

Most infertile couples would regard IVF treatment as worth the risk.

Homeostasis

Homeostasis is the maintenance of a constant internal environment. Mechanisms are in place to keep conditions optimal and constant despite internal and external changes.

Homeostasis is important to maintain enzyme action and all cell functions – including growth, replication and controlled cell death.

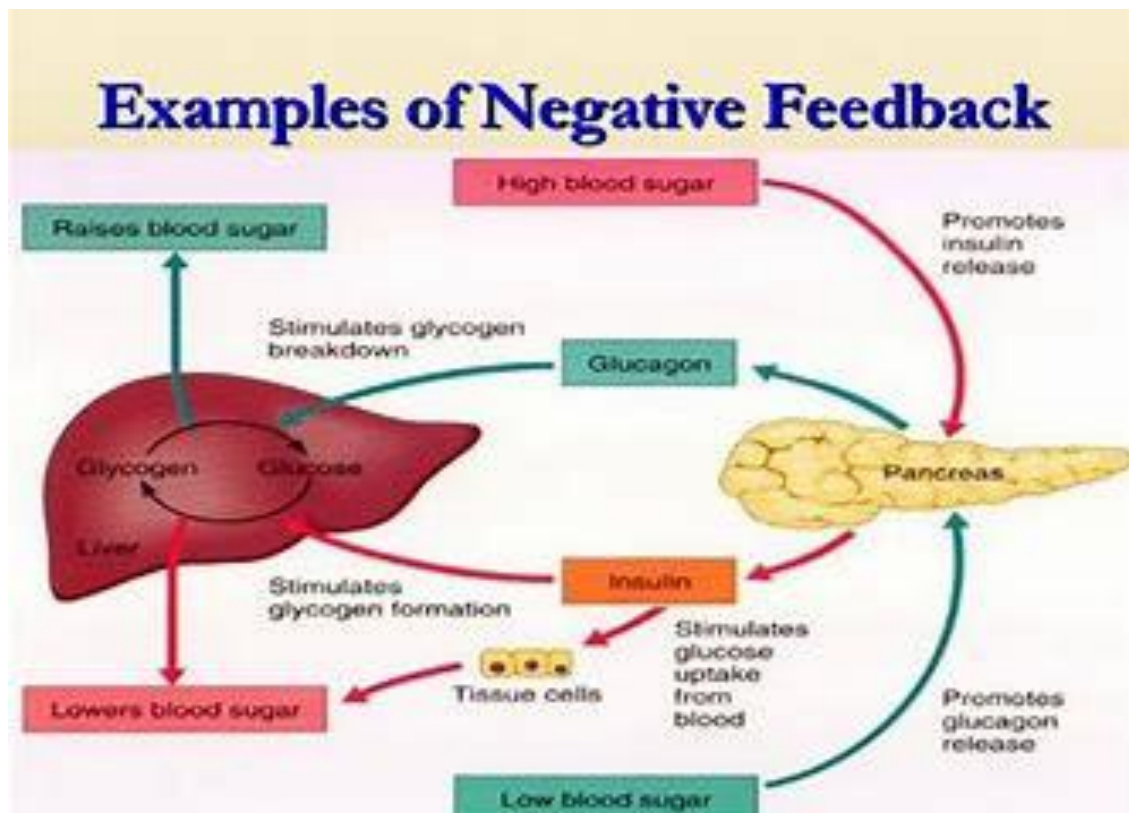
In the human body, homeostasis controls:

- Blood glucose concentration
- Body temperature
- Water levels

Nervous and hormonal communication is involved in the automatic control systems, which detect changes and respond to them.

All control systems have:

- **Receptors** - cells that detect stimuli (changes in the environment)
- **Coordination centres** - process the information received from the receptors, e.g. brain, spinal cord and pancreas
- **Effectors** - bring about responses to bring the conditions in the body back to optimum levels, e.g. muscles or glands



Control of blood glucose

Glucose is released from Carbohydrates into our small intestine and it then passes through the wall of the small intestine into the bloodstream and taken to cells where it is then used in respiration to create energy.

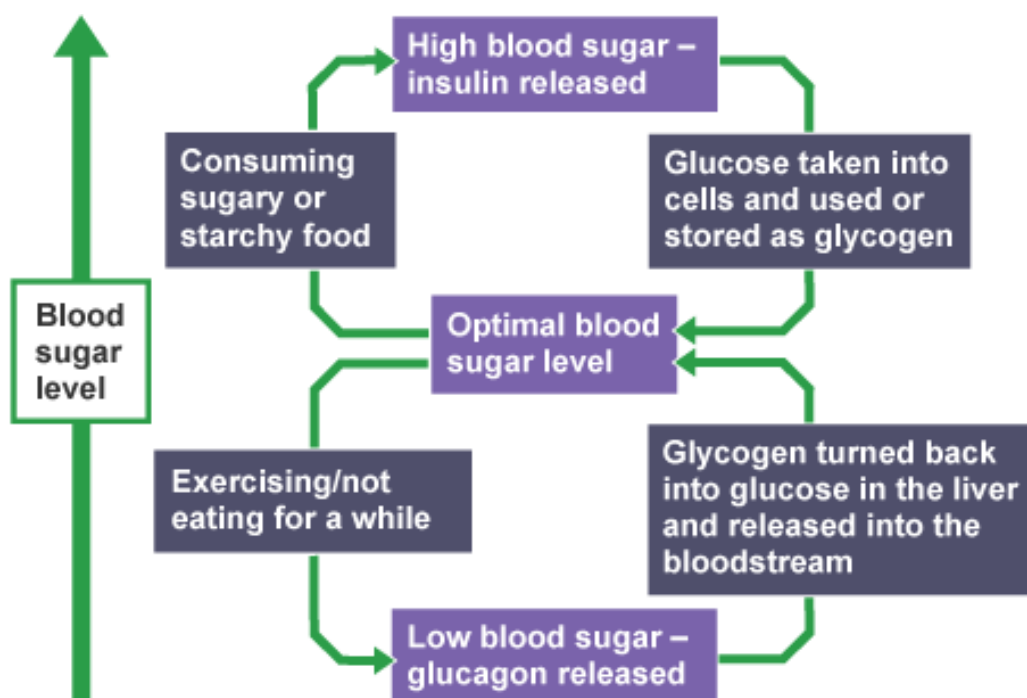
It takes time for cells to absorb Glucose from the blood, so there is a risk that the concentration of Glucose can become too high, which can cause damage to organs.

The pancreas releases a hormone called insulin, insulin causes cells in the liver and other organs to take in Glucose which reduces the level of Glucose in the blood. As the levels of Glucose fall, less insulin is released.

HIGHER ONLY

The Glucose that is absorbed is converted to Glycogen which is stored in the Livers cells. If Glucose levels fall too low the pancreas releases a hormone called Glucagon, this causes Liver cells to convert Glycogen back into Glucose which can be released into the blood stream.

This is known as a negative feedback system – Where an increase in something directly brings about a decrease in something, for example an increase in blood sugar levels causes a release of insulin, this causes a decrease in blood sugar level, the pancreas is then stimulated to produce Glucagon which then releases Glucose into the blood stream.



Diabetes

There are two types of diabetes: Type 1 and Type 2

Type 1 Diabetes: This is a genetic disease. People with type 1 diabetes do not produce insulin, this means they cannot control blood glucose levels without help. They have to inject insulin into the fat layer beneath the skin where it enters the blood and causes Glucose levels to fall.

Type 2 diabetes: People with type 2 diabetes either don't produce enough insulin or the target organs do not respond to the insulin that is produced. Treating type 2 diabetes is different, sometimes it is simply by reducing the amount of sugar in their diet and being physically active. A more severe type of type 2 diabetes may be treated with medicines that reduce the amount of Glucose that the liver releases, or that increase the sensitivity of the cells in target organs that respond to insulin.

There is a correlation between the amount of people suffering from type 2 diabetes and body mass, as one has increased so has the other. It is likely that the more fat someone has in their body the more likely they are to develop type 2 diabetes.

We calculate BMI to analyse the risk:

$$\text{BMI} = \frac{\text{Mass (kg)}}{\text{Height}^2 \text{ (m)}}$$

A BMI of 30 or over would indicate a person is obese.

When calculating BMI – please remember to square the height.

For example:

Mass = 100kg

Height = 1.88m

$\text{BMI} = 100 / (1.88^2)$

$\text{BMI} = 100 / 3.5344$

$\text{BMI} = 28.3.$

The BMI is below 30, this means this person is NOT classified as obese.

An alternative to calculating this is to work out the waist: hip ratio. As people increase in mass they tend to develop more fat around their hips. This also correlates with the risk of developing type 2 diabetes.

In topic 5 we practiced calculating BMI and waist hip ratio.

Prove it Questions

Page 30 Hormones

Q1	How are hormones carried around the body?	(1)
Q2	Explain why hormones are considered specific.	(2)
Q3	What are hormones secreted from?	(1)
Q4	What is the hormone secreted from the testes called?	(1)
Q5	What is the difference between nerves and hormones?	(4)

Page 31-32 Hormonal control of metabolic rate

Q1	What is the metabolic rate?	(2)
Q2	Where is thyroxine released?	(1)
Q3	What does negative feedback mean?	(2)
Q4	Name two target organs of adrenalin	(2)
Q5	How does adrenalin affect the heart?	(3)

Page 33-34 The menstrual cycle and contraception

Q1	What is menstruation?	(2)
Q2	What happens when menstruation ends?	(1)
Q3	What is ovulation?	(1)
Q4	What is contraception?	(1)
Q5	Give 3 contraception methods and explain how they prevent fertilisation.	(6)

Page 35-36 Hormones and the menstrual cycle

Q1	Explain the process of IVF	(4)
Q2	Which two hormones are involved in the growth and maintenance of the uterus lining?	(2)
Q3	What effect does FSH have on follicles in the ovaries?	(1)
Q4	Which hormone inhibits the release of FSH?	(1)
Q5	Which two glands secrete the hormones that control the menstrual cycle?	(2)

Page 37-38 Homeostasis and Control of blood glucose

Q1	What is insulin?	(2)
Q2	What does the liver do to excess glucose?	(2)
Q3	What is glucagon?	(2)
Q4	What does glucagon do to the liver?	(2)
Q5	What is type 1 diabetes?	(2)

Page 39 Diabetes

Q1	What is type 2 diabetes?	(2)
Q2	How can type 2 diabetes be controlled?	(2)
Q3	What is BMI?	(2)
Q4	What is the waist to hip ratio?	(2)
Q5	How is diabetes linked to obesity?	(2)

Mark scheme

Page 30 Hormones

Q1	By the blood	(1)
Q2	Hormones only affect target (1) organs making them specific (1)	(2)
Q3	Endocrine glands	(1)
Q4	Testosterone	(1)
Q5	Hormones are chemical messengers (1) which travel in the blood to activate cells in target organs acting for a long time (1). Nerves are electrical impulses (1) that carry messages to a very specific area and act for a short time. (1).	(4)

Page 31-32 Hormonal control of metabolic rate

Q1	The rate at which the energy stored in food is transferred (1) by all the reactions taking place in your body to stay alive (1)	(2)
Q2	The thyroid gland	(1)
Q3	Negative feedback is a control mechanism (1) that reacts to a change in a condition within the body (1) by trying to bring that condition back to a normal level (1)	(3)
Q4	Heart and Liver	(1)
Q5	The heart muscle cells contract more rapidly (1) increasing the heart rate more strongly (1) increasing blood pressure (1).	(3)

Page 33-34 The menstrual cycle

Q1	The uterus lining breaks down (1) and is lost with the unfertilised egg (1)	(2)
Q2	The uterus lining starts to thicken again	(1)
Q3	When the ovary releases the egg	(1)
Q4	The prevention of fertilisation	(1)
Q5	Male condom (1) – placed over erect penis, preventing sperm entering the vagina (1). Diaphragm/cap (1) – placed over the cervix, prevents sperm in the vagina entering the uterus (1). Hormone pill/implant under the skin (1) – releases hormones to prevent ovulation and thickens mucus at the cervix (1).	(6)

Page 35-36 Hormones and the menstrual cycle

Q1	IVF process: - Egg follicle maturation is simulated by hormones (1) - Egg cells removed from ovary & sperm cells taken from the man (1) - Egg and sperm cells combined to allow for fertilisation (1) - One/two healthy embryos placed in the uterus (1)	(4)
Q2	Oestrogen (1) Progesterone (1)	(2)
Q3	Causes the follicles to mature	(1)
Q4	Progesterone	(1)
Q5	The pituitary gland (1) the ovaries (1)	(2)

Page 37-38 Control of blood glucose

Q1	Insulin is a hormone (1) produced by the pancreas. It decreases blood glucose levels (1).	(2)
Q2	The liver, after the production of insulin, converts glucose (1) into the storage molecule glycogen (1).	(2)
Q3	Glucagon is a hormone (1) produced by the pancreas. It increases blood glucose levels (1).	(2)
Q4	The liver, after production of glucagon, converts glycogen (1) into glucose (1).	(2)
Q5	Type 1 diabetes is a condition where the pancreas produces little insulin (1) or no insulin (1).	(2)

Page 39 Type 2 diabetes

Q1	Type 2 diabetes is a condition where the pancreas doesn't produce enough insulin (1), or a person becomes resistant (cells don't respond properly) to their own insulin (1).	(2)
Q2	Any 2 of: Healthy diet (1), regular exercise (1) or weight loss (1).	(2)
Q3	BMI is an estimate of how healthy a person's mass (1) is in relation to their height (1)	(2)
Q4	A measure of the amount of fat in the body (1) calculated by dividing the waist circumference by the hip circumference (1).	(2)
Q5	If a person is obese (BMI >30/W:H >1.0) they are storing a lot of excess fat (1). This has been linked to an increased risk in developing type 2 diabetes (1).	(2)

GCSE 9-1 BIOLOGY



Topic 8 Exchange and Transport in Animals

Revision booklet

Topic	Pages
Organisms and diffusion	45
Factors affecting diffusion	46
The lungs and gas exchange	47
The blood	48
Blood vessels	49
The heart	50
Faulty valves & cardiac output	51
Respiration	52-53
Questions	54-55
Mark scheme	56-58



Organisms – Single celled vs multi-cellular

Living organisms obtain many of the substances they require for life by **diffusion** e.g. **Oxygen, minerals** and **dissolved food**. They also get rid of waste products by diffusion as well such as **carbon dioxide** and **urea**. **Single celled organisms** do not need transport systems to bring materials to the cell or take waste away. They are able to receive enough substances through their cell membrane by diffusion alone due to a **large surface area to volume ratio**.

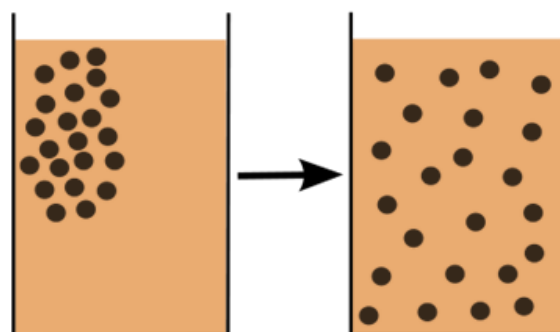
Larger **multicellular** organisms need a **mass transport system** because they have a relatively **small surface area to volume ratio**.

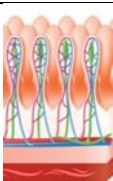
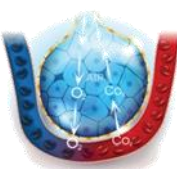
Cells towards the centre of the organism would not receive enough oxygen by diffusion alone without a transport system and gas exchange surface. In humans, the mass transport system is the **blood** and the gas exchange surface is the **lungs**.



What is diffusion?

Diffusion is the spreading of the **particles of a gas or substances in solution**, resulting in a **net movement** of particles from a region where they are of a **higher concentration** to an area of **lower concentration**. Some examples of where diffusion can take place include the air (e.g. smell of perfume), in solutions (e.g. dye in water) and through membranes (e.g. see table below).



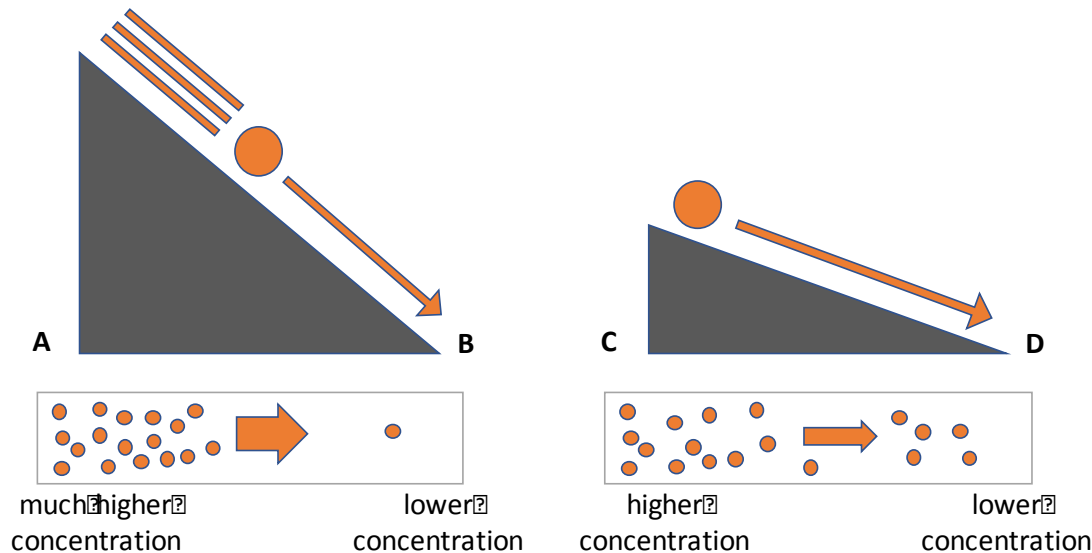
Substances that are transported into and out of cells				
Location		Particles transported	From	To
Small Intestine		Digested food e.g. glucose & amino acids	Small intestine	Blood in capillary of villus
Lungs		Oxygen	Air in alveoli	Blood circulating around the lungs
Kidneys		Urea	Cells	Blood plasma

Factors affecting diffusion

There are 3 main factors that affect the rate of diffusion.

- The concentration gradient
- The surface area of the membrane
- The diffusion distance (cell thickness)

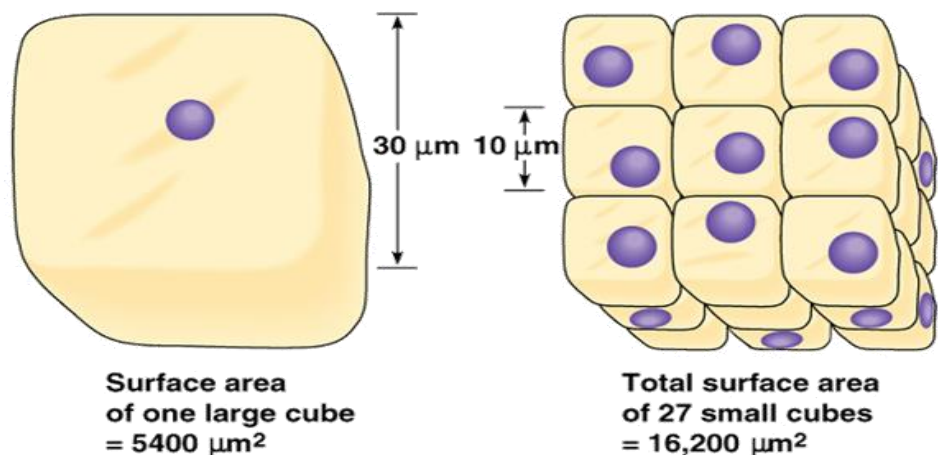
The concentration gradient:



A **difference in concentration** between two **areas next to each other**. Particles will move **down the concentration gradient from high to low**.

The surface area of the membrane:

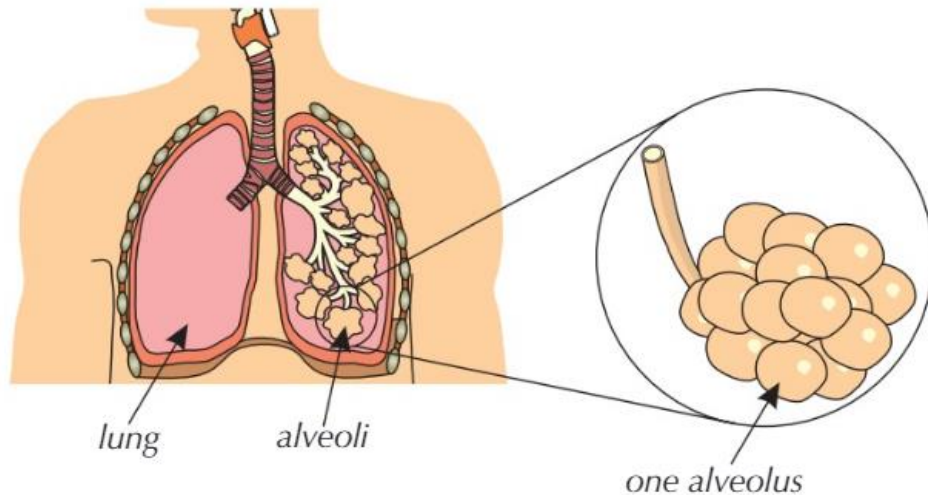
A **single-celled organism** has a large surface area compared to its volume. This allows sufficient **transport** of molecules into and out of the cell to meet the needs of the organism.



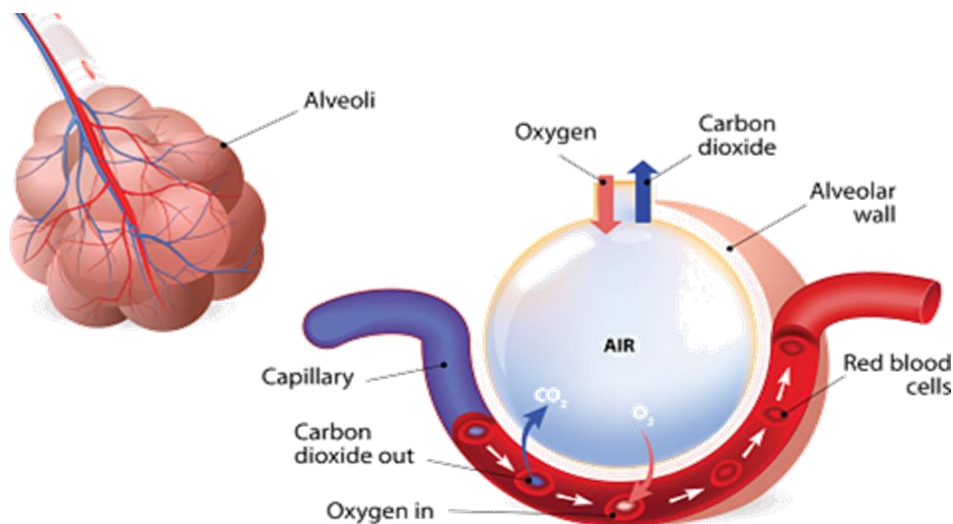
The diffusion distance:

Substances will diffuse faster if the distance they have to move across is smaller. Respiratory surfaces are usually only **one cell thick** for this reason. Capillary walls are also only one cell thick ($5\text{-}10\ \mu\text{m}$) to make diffusion faster into and out of the blood.

The lungs and gas exchange



The **heart** pumps **low oxygen/high carbon dioxide** containing **blood** to the lungs. In the **lungs**, oxygen and carbon dioxide are **exchanged** in the tiny air sacs (**alveoli**) at the end of the **bronchial tubes**. The **alveoli** are surrounded by **capillaries**.

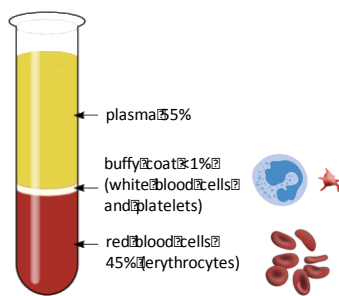


The lungs have several adaptations to make them efficient at gas exchange. They are as follows:

- By having **millions** of alveoli (air sacs) the **surface area** of the lungs is **increased**.
- The alveoli are **surrounded** by lots of **capillaries**, this allows for the **concentration gradients** to be **maintained** when moving **oxygen into** the blood and **carbon dioxide out** of the blood into the alveoli via **diffusion**.
- To aid diffusion further the **membranes** of the alveoli are **very thin**. This allows for a **short diffusion distance**.
- A **moist lining** for dissolving gases. The gases need to be dissolved before they can **diffuse** through the **alveolar walls**.

The blood

Blood is a **tissue** consisting of four different things.



These are:

- Red blood cells
- White blood cells
- Plasma
- Platelets

Red blood cells:

These cells are also known as erythrocytes. They have three key features which are as follows:

- have **no** nucleus (more room to carry O_2)
- contain the red pigment **haemoglobin** which carries O_2
- they have a **large surface area to volume ratio** for faster diffusion of oxygen

White blood cells:

These cells are an important part of the **immune** system. Two main types called:

- **Lymphocytes** produce **antibodies**, which are **proteins** that **bind** to microbes and **destroy** them.
- **Phagocytes**, which **surround** and **engulf** the foreign cells.

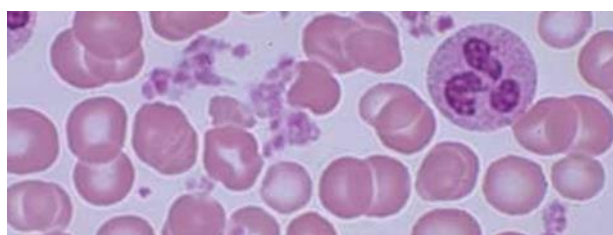
Plasma:

The **plasma** is the liquid that all of the other 3 parts are suspended in.

This is a **pale yellow** fluid part of blood. Being a liquid allows it to transport cells, CO_2 , hormones and waste around the body.

Platelets:

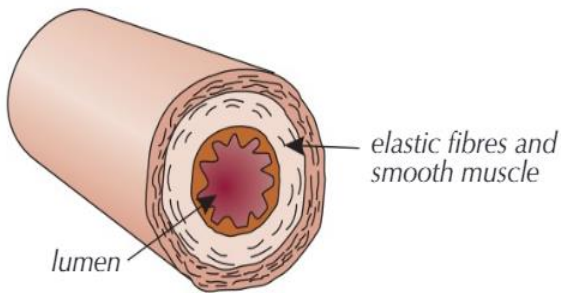
Platelets are **tiny fragments** of cells that have **no nuclei**. Their primary function is **clump** together to help form **clots (scabs)**, protecting the body by **reducing or stopping** the flow of blood externally.



The blood vessels

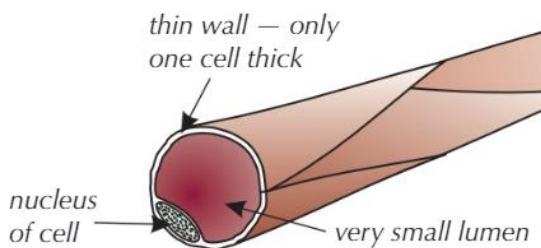
The circulatory system consists of 3 types of blood vessel, the **arteries**, the **capillaries** and the **veins**. Each has an important function in the delivery of blood around the body.

Arteries:



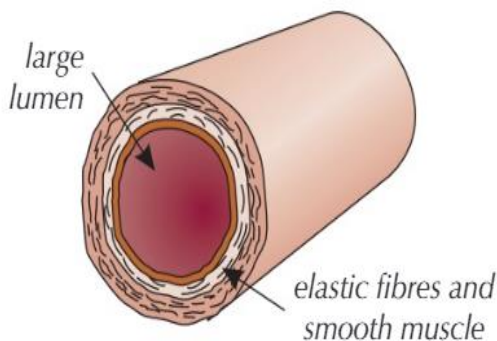
These vessels carry blood **away** from the heart. They have **thick** layers of **muscle** to withstand the **high pressure** generated by left ventricle. They also have **elastic tissue** to **stretch** and **recoil** as blood enters. The inner layer is called the **lumen** (internal hole) which **maintains** pressure. All arteries carry **oxygenated blood** except the **pulmonary** artery.

Capillaries:



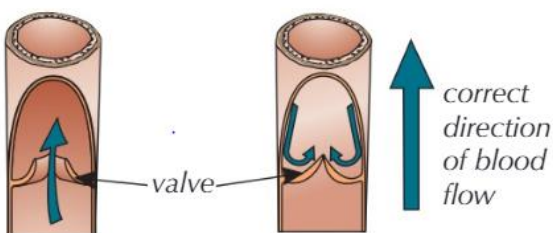
The capillaries **connect** arteries and veins. These vessels are the site of **exchange** between blood and body tissues. The capillaries are only **one cell thick**, which enables **rapid diffusion** to occur. The blood is under **low** pressure and travels **slowly** maximising the time for exchange.

Veins:



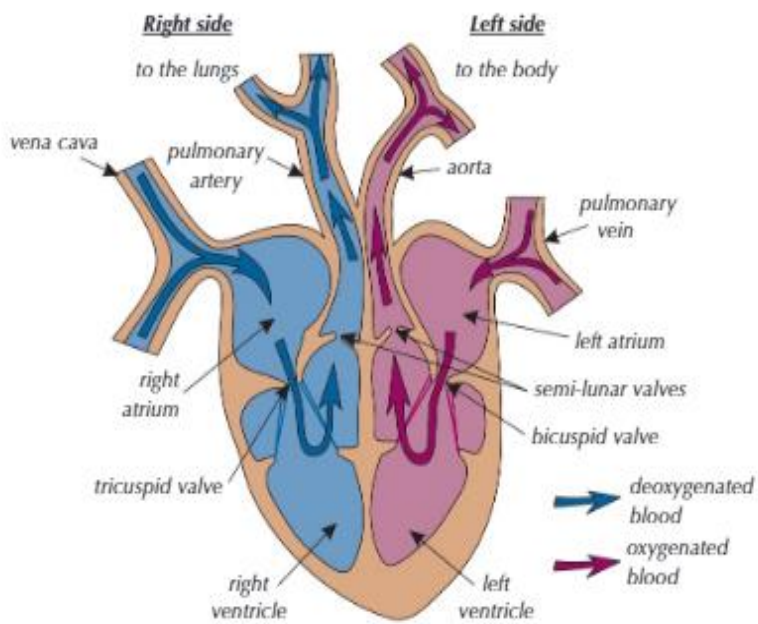
The veins carry blood **into** the heart. These vessels have **thin** walls alongside **thin** layers of muscle and elastic tissue. They have **large** lumen (internal hole). Unlike the other vessels they have **one-way valves** to keep blood moving back to heart. The blood is carried under **low** pressure. All veins carry deoxygenated blood except **pulmonary** vein.

Valves:



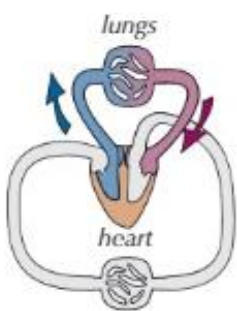
The **valves** are designed to prevent **backflow** by only allowing blood to flow in **one direction**. This is why the blood only needs to be under **low** pressure in the veins

The heart



The heart consists of **four** chambers, the **left atrium**, the **left ventricle**, the **right atrium** and the **right ventricle**. This organ is used by the body to **pump blood** around via the **circulatory system**. The main **blood vessels** in the heart are the **pulmonary artery**, the **aorta**, the **pulmonary vein** and the **vena cava**. The **walls** of the heart are made of mainly **muscle tissue** which helps the heart pump the blood. The **left side** of the heart has **thicker muscle tissue** than the right side as it needs to pump the **blood further**. The heart has **valves** to make sure that the blood only goes in **one direction** preventing **backflow**.

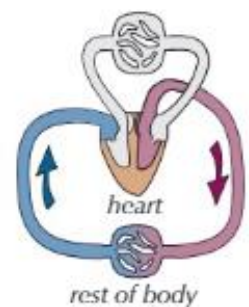
Blood flows through the heart in **two separate** ways. The **oxygenated blood** flows through the **left side** of the heart through to the **rest of the body** whilst the **deoxygenated blood** flows through the **right side** of the heart through **to the lungs**. As the blood flows through each side of the heart **simultaneously**, the heart is often called a '**double circulatory**' system.



In **circuit one**, the heart pumps **deoxygenated blood** to the lungs to take in oxygen. Once the blood has been oxygenated it returns to the heart.

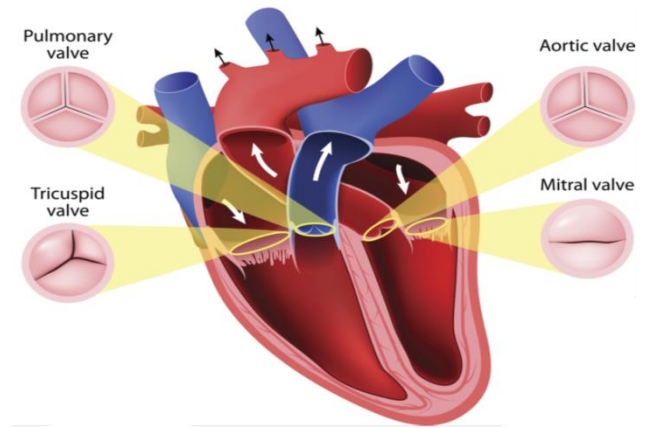


In **circuit two**, the heart pumps the **oxygenated blood** around all the organs in the body. The blood transports oxygen into the body cells and the deoxygenated blood returns to the heart.



Faulty valves & cardiac output

Heart valves prevent the blood in the heart from flowing in the wrong direction. In some people heart valves may become faulty, preventing the valve from opening fully or the heart valve might develop a leak because it does not close fully.

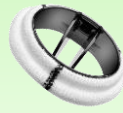


Faulty heart valves can be replaced by biological or mechanical valves.

Biological



Mechanical



Cardiac output:

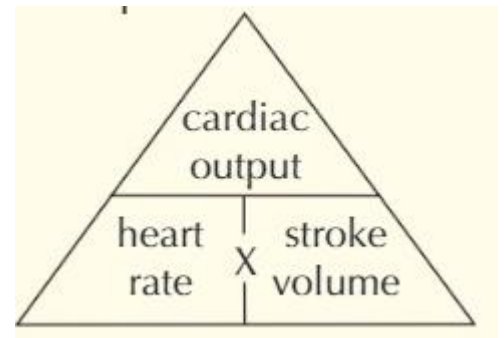
Cardiac output is a calculation used to work out how much blood is pumped every minute by the heart. To do this the following equation is used:

$$\text{Cardiac output} = \text{heart rate} \times \text{stroke volume}$$

Cardiac output is the volume of blood pumped by a ventricle per minute. The units are $\text{cm}^3 \text{ min}^{-1}$

Heart rate is the number of beats per minute (bpm)

Stroke volume is the volume of blood pumped by one ventricle per contraction (cm^3).



Example calculation:

If a person has a heart rate of **70 bpm** and a stroke volume of **82 cm³** what is their cardiac output?

$$\text{Cardiac output} = \text{heart rate} \times \text{stroke volume}$$

$$\text{Cardiac output} = 70 \times 82$$

$$\text{Cardiac output} = \underline{5740 \text{ cm}^3 \text{ min}^{-1}}$$

Respiration

Respiration is also sometimes called **cellular respiration**. This is because the reactions of respiration occur inside cells.

Every **living cell** needs energy and this energy is released from food (glucose) by a series of chemical reactions called respiration.

Respiration is an **exothermic** reaction which means energy is transferred to the environment. Some of the **energy** is used inside cells for **metabolic processes**.

Why do living organisms need energy?

For **movement** - To enable muscles to contract in animals.

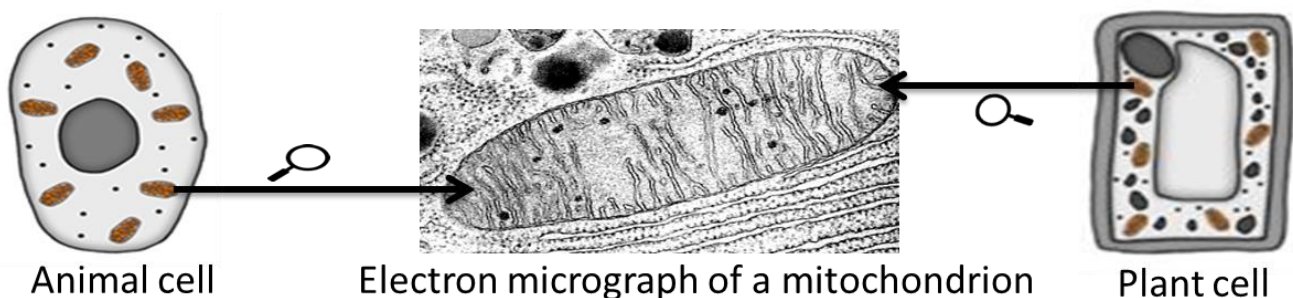
For **chemical reactions** - To build larger molecules from smaller ones

For **keeping warm** - To keep a steady body temperature in a cold environment

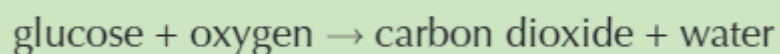
There are two types of respiration, **Aerobic** and **Anaerobic**.

Aerobic Respiration

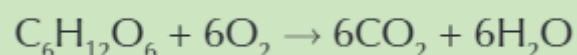
Aerobic respiration is the process of respiration in the **presence of oxygen**. This is the **most efficient** way to transfer energy from glucose. Aerobic respiration occurs continuously in plants and animals. This reaction takes place in the **mitochondria**.



The **word** equation for aerobic respiration is:



The **symbol** equation for aerobic respiration is:

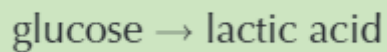


Anaerobic respiration

Anaerobic respiration is the process of respiration **without oxygen**.

During **intense exercise** muscles cells are respiring so **fast** that the blood cannot **transport** enough **oxygen** to meet their needs. This means that the muscle cells switch to **respiring anaerobically** to **transfer energy**.

During this process glucose is **not** completely broken down to carbon dioxide and water, so **less energy** is transferred. An end product called **lactic acid** is formed. This builds up in the muscle cells. The word equation for this process is as follows:



After exercise the **lactic acid** must be combined with oxygen to convert it to carbon dioxide. The amount of **oxygen** which must be taken in to **convert** all the lactic acid to carbon dioxide is called the **oxygen debt**.

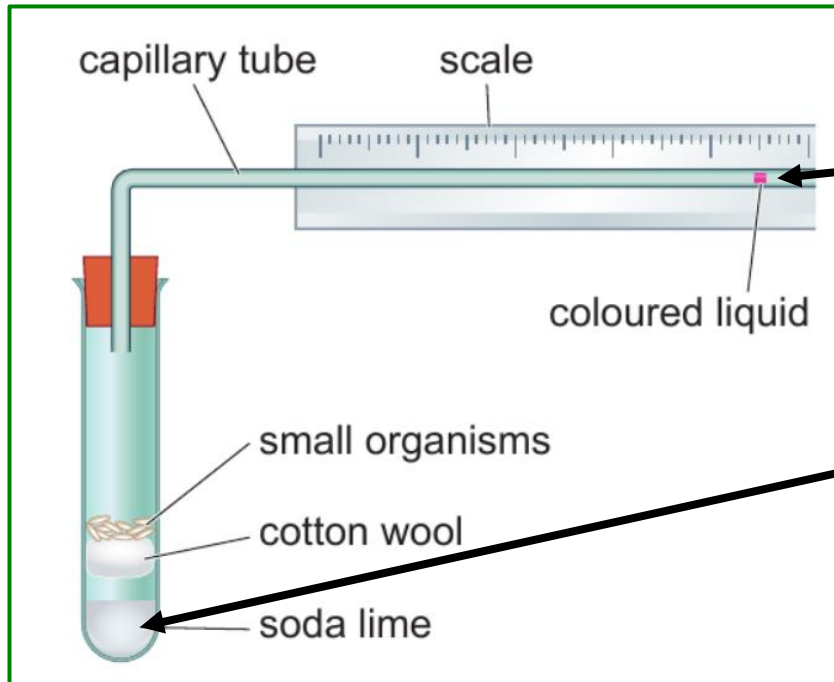
Aerobic vs anaerobic respiration

The table below summarises the key parts of the two types of respiration.

	Aerobic	Anaerobic
Oxygen	Required	Not required
End products	Carbon dioxide & Water	Lactic acid
Oxidation of glucose	Complete	Incomplete
Efficiency of energy transfer	High	Low

CORE PRACTICAL

This is a respirometer



As the organisms respire it takes in oxygen, moving the coloured liquid along the scale allowing us to measure it.

Soda lime absorbs the carbon dioxide released by respiration. Therefore the uptake of Oxygen gas for respiration is the only gas change causing the coloured liquid to move.

How far this moves in unit time is a measure of the rate of respiration.

Method

1. Collect a boiling tube with some soda lime in it, held in place with cotton wool. Soda lime is corrosive, so should not be handled. The cotton wool is to protect you and the organisms.
2. Collect some small organisms and place them in the boiling tube, then insert the bung and capillary tube.
3. Set up a control tube (without the organisms) so you can compare movement when no respiration has taken place.
4. Place tubes into a water bath (no higher than 35°C) and allow the organisms to adjust to the warmer temperature for approx. 5 mins before taking measurements.
5. Hold a beaker of coloured liquid to the ends of the capillary tubes, so that the liquid enters.
6. Mark the position of the coloured liquid in the tubes and time for five minutes, then mark the position of the coloured liquid again and measure the distance travelled.
7. Repeat the experiment at different temperatures, Use the same number of organisms each time.

Calculate rate of respiration : $\frac{\text{Distance moved (mm)}}{\text{Time taken (s)}}$

Independent variable: Temperature

Dependent Variable: Distance coloured liquid moved/ rate of respiration.

Control variables: Amount of organisms, Time to adjust, time measured. Control tube with no organisms.

Prove it Questions

Page 45 Organisms

Q1	What 3 substances can living organisms obtain via diffusion?	(3)
Q2	What two waste products can be removed via diffusion?	(2)
Q3	Single celled organisms have a _____ surface area to volume ratio.	(1)
Q4	Multicellular organisms have a _____ surface area to volume ratio.	(1)
Q5	What substance is the mass transport system in the human body?	(1)

Page 45 What is diffusion?

Q1	Diffusion is the spreading of particles in a _____ or _____	(2)
Q2	How do the particles move in diffusion?	(2)
Q3	Where can diffusion take place?	(3)
Q4	What particles are transported in the small intestine?	(2)
Q5	Outline the transportation via diffusion in the kidneys	(3)

Page 46 Factors affecting diffusion

Q1	What are the three factors that affect the rate of diffusion?	(3)
Q2	Draw a diagram to show a concentration gradient	(2)
Q3	What is special about a single-celled organism and diffusion?	(2)
Q4	What is the diffusion distance?	(1)
Q5	Why are the capillaries suited to diffusion?	(1)

Page 47 The lungs and gas exchange

Q1	What levels of substances are found in blood going to the lungs?	(4)
Q2	Where does gas exchange take place in the lungs?	(1)
Q3	Why does having lots of alveoli make the lungs efficient for gas exchange?	(2)
Q4	What surrounds the alveoli?	(1)
Q5	Why do the alveoli need to be moist?	(2)

Page 48 The blood

Q1	What are the four parts of the blood?	(4)
Q2	What is the red pigment called in the red blood cells?	(1)
Q3	What are the two types of white blood cell?	(2)
Q4	Why is the plasma a liquid?	(2)
Q5	What is the primary function of the platelets?	(1)

Page 49 The blood vessels

Q1	What are the three types of blood vessel?	(3)
Q2	Why do arteries have thick layers of muscle?	(1)
Q3	What is the key feature of a capillary?	(1)
Q4	Which blood vessels carry blood into/out of the heart?	(4)
Q5	What are the valves in veins designed to do?	(1)

Page 50 The heart

Q1	What are the four chambers of the heart called?	(4)
Q2	Why is the left side of the heart more muscular?	(1)
Q3	How does blood flow through the heart?	(3)
Q4	What happens in circuit 1?	(1)
Q5	What happens in circuit 2?	(1)

Page 51 Faulty valves and cardiac output

Q1	Why is a faulty valve bad for your heart?	(2)
Q2	What are the names of the two types of replacement valves?	(2)
Q3	What is the equation for working out cardiac output?	(2)
Q4	What are the units for stroke volume?	(1)
Q5	Calculate the cardiac output for a person who has a heart rate of 80bpm and a stroke volume of 75cm^3	(3)

Page 52-53 Respiration

Q1	What does the term exothermic mean?	(2)
Q2	Why do living organism need energy?	(3)
Q3	What is the word equation for aerobic respiration?	(2)
Q4	Why does the body undergo anaerobic respiration?	(2)
Q5	What is the word equation for anaerobic respiration?	(1)

Mark scheme

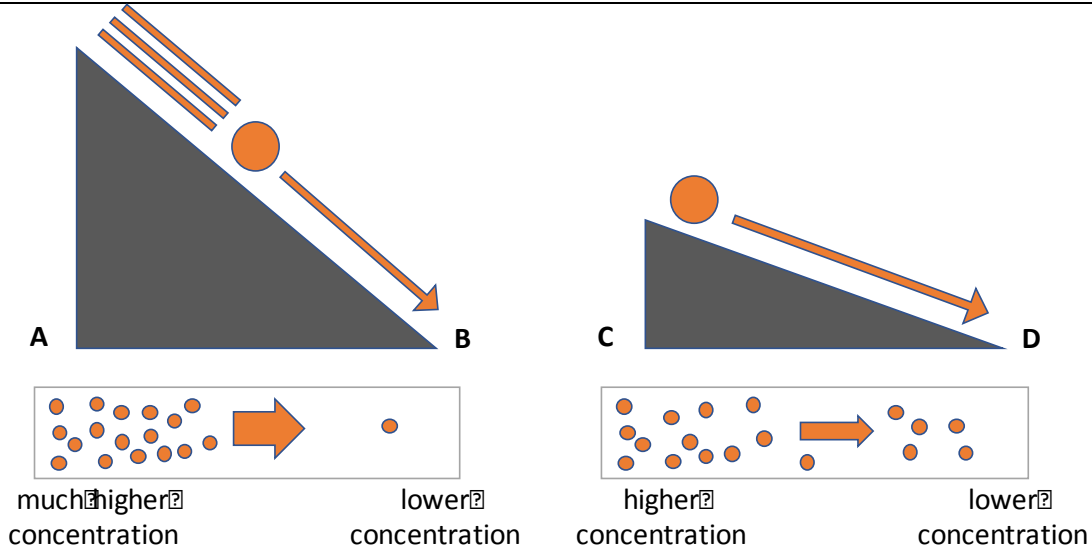
Page 45 Organisms

Q1	Oxygen (1), minerals (1) and dissolved food (1).	(3)
Q2	Carbon dioxide (1) and urea (1).	(2)
Q3	Single celled organisms have a large surface area to volume ratio.	(1)
Q4	Multicellular organisms have a small surface area to volume ratio.	(1)
Q5	The blood.	(1)

Page 45 What is diffusion?

Q1	Diffusion is the spreading of particles in a gas (1) or substances in solution (1).	(2)
Q2	The particles move from an area of high concentration (1) to an area of low concentration (1).	(2)
Q3	Air (1), solutions (1) and through membranes (1).	(3)
Q4	Digested food e.g. glucose (1) and amino acids (1).	(2)
Q5	Urea (1) is transported from the cells (1) to the blood plasma (1).	(3)

Page 46 Factors affecting diffusion

Q1	The concentration gradient (1) The surface area of the membrane (1) The diffusion distance (cell thickness) (1)	(3)
Q2	 Diagram A shows a steep slope from point A to point B. Below it, a box shows a high concentration of particles on the left and a low concentration on the right, with an arrow pointing from high to low concentration. Diagram C shows a shallow slope from point C to point D. Below it, a box shows a moderate concentration of particles on the left and a low concentration on the right, with an arrow pointing from high to low concentration. Either fully labelled diagram (A/B or C/D) scores 2 marks	(2)
Q3	Single celled organisms have a large surface area (1) compared to its volume (1)	(2)
Q4	The diffusion distance is the distance substances need to travel during diffusion.	(1)
Q5	Because they are only one cell thick.	(1)

Page 47 The lungs and gas exchange

Q1	Low (1) oxygen (1) and high (1) carbon dioxide (1).	(4)
Q2	The alveoli.	(1)
Q3	It increases (1) the surface area (1).	(2)
Q4	Capillaries.	(1)
Q5	For dissolved gases (1) as without being dissolved they will not dissolve through the alveolar walls (1).	(2)

Page 48 The blood

Q1	Red blood cells (1) White blood cells (1) Plasma (1) Platelets (1)	(4)
Q2	Haemoglobin.	(1)
Q3	Lymphocytes (1) and Phagocytes (1).	(2)
Q4	It allows it to transport (1) CO ₂ , hormones and waste (1) around the body.	(2)
Q5	To clump together to form clots.	(1)

Page 49 The blood vessels

Q1	Arteries (1) Veins (1) Capillaries (1)	(3)
Q2	To withstand the high pressure generated by the left ventricle.	(1)
Q3	Only one cell thick.	(1)
Q4	Arteries carry oxygenated blood (1) except the pulmonary artery (1). Veins carry deoxygenated blood (1) except the pulmonary vein (1).	(4)
Q5	Designed to prevent backflow.	(1)

Page 50 The heart

Q1	Left atrium (1) Left ventricle (1) Right atrium (1) Right Ventricle (1)	(4)
Q2	Because it needs to pump blood further (1)	(1)
Q3	The blood flows through in two separate ways (1). The oxygenated blood flows through the left side (1). The deoxygenated blood flows through the right side (1).	(3)
Q4	The heart pumps deoxygenated blood to the lungs.	(1)
Q5	The heart pumps oxygenated blood around all the organs in the body.	(1)

Page 51 Faulty valves and cardiac output

Q1	Prevent the heart from opening fully (1) Develop a leak because it doesn't close fully (1)	(2)
Q2	Biological (1) and Mechanical (1).	(2)
Q3	Cardiac output = heart rate x stroke volume	(2)
Q4	cm ³	(1)
Q5	Cardiac output = heart rate x stroke volume (1) = 80 x 75 = <u>6000 cm³ min⁻¹</u>	(3)

Page 52-53 Respiration

Q1	Energy (1) is transferred to the surroundings (1)	(2)
Q2	Movement (1) Chemical reactions (1) Keeping warm (1)	(3)
Q3	Glucose + Oxygen (1) → Carbon dioxide + Water (1)	(2)
Q4	During intense exercise muscles are respiring fast (1) and the blood cannot transport enough oxygen to meet the muscles needs (1)	(2)
Q5	Glucose → lactic acid	(1)

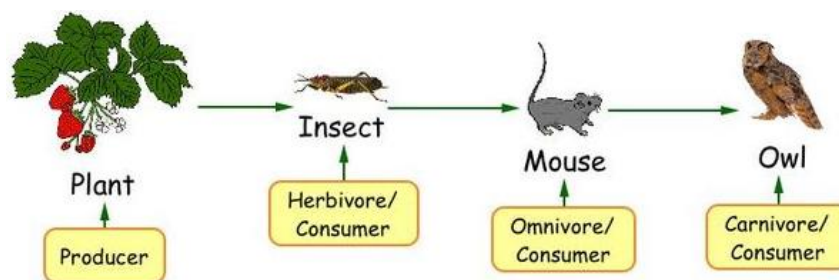
GCSE 9-1 BIOLOGY



Topic 9 Ecosystems and material cycles

Revision booklet

Topic	Pages
Ecosystems and organisation	61
Abiotic factors and communities	62
Biotic Factors and communities	63
CORE PRACTICAL Quadrats and Transects	64
Parasitism and mutualism	65
Biodiversity and humans & Preserving biodiversity	66-67
The Water cycle	68
The Carbon cycle	69
The Nitrogen cycle	70
Questions	71-72
Mark scheme	73-74



Ecosystems

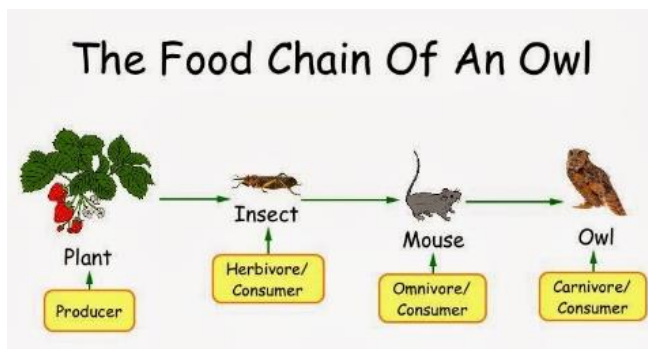
- An **ecosystem** is the interaction between a community of living organisms and their environment
- The **environment** consists of all the conditions that surround any living organism - both the other living things and the non-living things or physical surroundings.
- A **population** is all the organisms of the same or closely related species in an area
- A **habitat** is the place where an organism lives.
- A **community** is two or more populations of organisms.
- **Abundance** is a measure of how common something is in an area, e.g. population size.

Organisation

Organisms within an ecosystem are organised into levels.

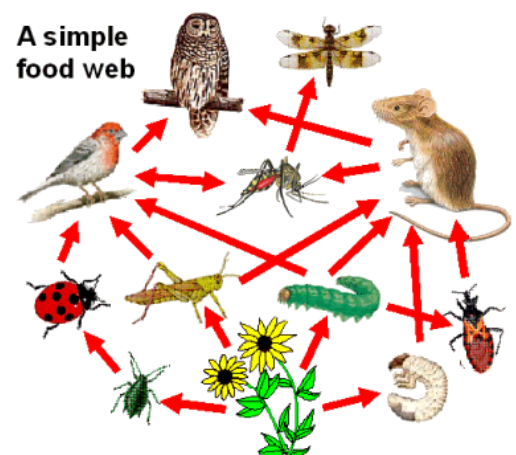
- Producer – Plants which photosynthesise
- Primary consumers – Herbivores which eat producers
- Secondary consumer – Carnivore, eat primary consumers
- Tertiary consumer – Carnivores. Eat secondary consumers.

This can be used to represent relationships between organisms in an ecosystem. This can be done simply in the form of food chains, with more detail in the form of food webs. Or with pyramids of biomass or numbers.



The arrows represent energy and their direction shows the direction energy is moving in. (up through the different trophic levels.) As you move up through the trophic levels, less energy is passed on. This is because the organisms use energy for various living processes before the remaining energy is passed onto the next level.

Here is a food web, it is similar to a food chain as the arrows represent the same thing however it shows more relationships within an ecosystem.



Abiotic factors and communities

An **abiotic factor** is a **non-living factor**. You need to be able to explain the effect of a change in an abiotic factor. Abiotic factors can impact upon population sizes and the presence of absence of organisms within a community.

1. Light intensity

- Light is required for photosynthesis.
- The rate of photosynthesis affects the rate at which the plant grows.
- Plants can be food sources or shelter for many organisms.
- A lot of plants can't survive without light – less plants grown in a dense forest. Algae in the sea can often only get enough light if they are no more than 30m from the surface.

2. Temperature

- Temperature affects the rate of photosynthesis. Cacti are adapted to live in a hot environment, polar bears are adapted to living in cold conditions.

3. Moisture levels

- Both plants and animals need water to survive. Few organisms can survive a drought for long.

4. Soil pH and mineral content

- Soil pH affects the rate of decay and therefore how fast mineral ions return to soil (which are then taken up by other plants).
- Different species of plants thrive in different nutrient concentration levels.

5. Wind intensity and direction

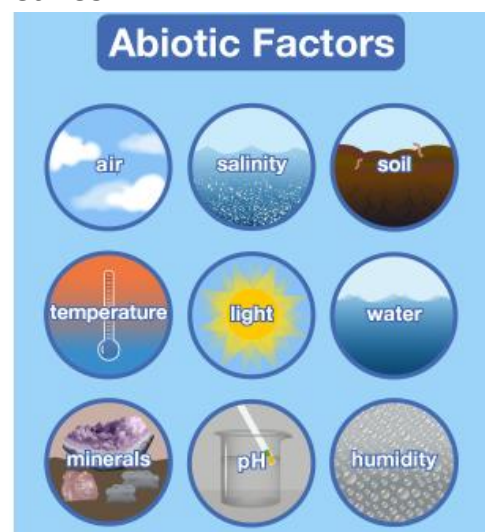
- Wind affects the rate of transpiration (movement of water from root to leaves) in plants.
- Transpiration affects the temperature of the plant, and the rate of photosynthesis because it transports water and mineral ions to the leaves.

6. Carbon dioxide levels

- CO² affects the rate of photosynthesis in plants.
- It also affects the distribution of organisms as some thrive in high CO₂ environments.

7. Oxygen levels for aquatic animals

- Levels in water vary greatly, unlike oxygen levels in air. Most fish need a high concentration oxygen to survive.



of

Biotic Factors

A **biotic factor** is a **living factor**. Biotic factors can also affect the population of organisms within an ecosystem. You need to be able to explain the effect of a change in a biotic factor.

Biotic factors that can affect a community:

1. Food availability: more food means organisms can breed more successfully and therefore the population can increase in numbers. An abundance of food could reduce competition between organisms.
2. New predators.
3. New pathogens: When a new pathogen arises, the population has no resistance to it so they can be wiped out quickly
4. Competition: if one species is better adapted to the environment than another, then it will outcompete it until the numbers of the lesser adapted species are insufficient to breed.

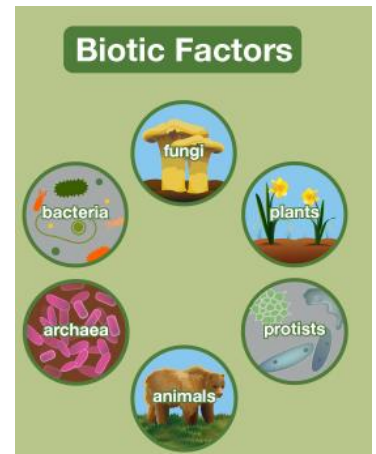
Interdependence- describes how organisms in a community depend on other organisms for vital services.

These include for food, shelter and reproduction (pollination, seed dispersal), e.g. birds take shelter in trees, and flowers are pollinated with the help of bees.

The removal or addition of a species to the community can affect the populations of others greatly, as it changes prey or predator numbers.

A stable community is one where all the biotic (living) and abiotic (non-living) factors are in balance.

- As a result the population sizes remain roughly constant.
- When they are lost it is very difficult to replace them.
- Examples include tropical rainforests, oak woodlands and coral reefs.



Sampling techniques

We can determine the number of organisms in a given area using fieldwork techniques, and tools such as quadrats and transects.

Imagine we wanted to estimate the number of 3-leaf clover in a 10m x 10m field. This might be a useful experiment in determining the biodiversity of an area. We could either:

- a) Measure every single 3-leaf clover in the field, or:
- b) Take a sample of 3-leaf clover from a small area and use this to estimate the entire population of clover

Method a) would be time consuming and there would be a high likelihood of error – however b) would take significantly less time and with less risk of error.

To carry out this estimate, we can:

- Divide the field into 100 equal 1m x 1m squares.
- Use a random number generator to randomly select a single square.
- Take a 1m x 1m quadrat and place it in the selected square.
- Count the number of clover in the square.
- Repeat with a different square 4 times and average the 5 results.
- Multiply the average by 100 to estimate the number of clover in the field.



$$\text{Population size} = \frac{\text{Number of organisms in all quadrats}}{\text{Total area of quadrats}} \times \text{Total size of area where organism lives}$$

Belt transects

A belt transect can be useful to identify correlations between distribution of organisms and other factors, such as pH, Light intensity, Water content of soil etc.

- Place a quadrat at regular intervals along a line (belt transect).
- Count the number of organisms within the quadrat and record this.
- From within the same quadrat take a sample that will allow you to determine the other factor you are measuring (e.g. if pH take a soil sample to allow you to determine pH when you return to the lab)
- You should be able to compare the amount of organisms found within each quadrat and the other factor to identify any patterns, e.g. if pH is high then is number of organisms lower?
- This may indicate the organism does not grow well in alkaline soil conditions.

Parasitism and mutualism

Some species live together in a symbiotic relationship. There are two types of symbiotic relationship:

- If a smaller species lives directly within or on a larger species, and benefits at the expense of the other species, it is known as a parasite. **Parasitism** involves taking nutrients from another species, to the detriment of the other species. For example, in humans, the tapeworm is a parasite that lives inside the gut. It 'steals' nutrients from the host and can lead to malnutrition.

Head lice:

- Eggs are glued to hairs to prevent them falling off.
- Sharp mouthparts can pierce skin and suck blood.
- Sharp claws to grip on to hair and skin.



Tapeworm:



- Hooks and suckers to attach firmly to the host's intestine wall.
- Flattened body allows absorption of nutrients across surface without digestive system.
- Segments contain male and female sex organs so fertilisation can occur.

- If it provides some benefit or resource to the other species, for instance providing nutrients, it is known as a mutualistic relationship. **Mutualism** is when there is no damage caused to either species, and there is often a mutual benefit.

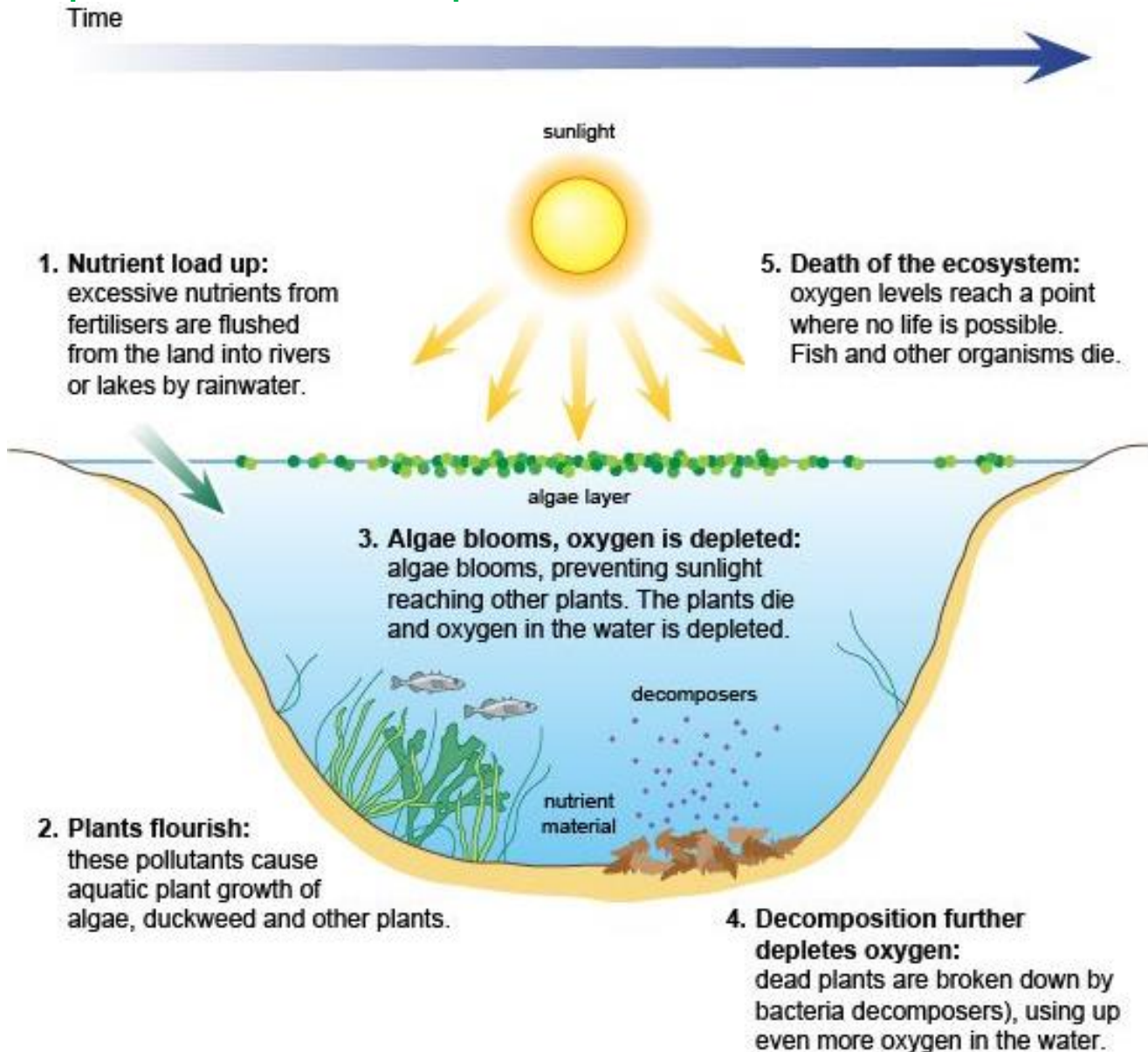
For example, algae and coral polyps live together in a mutualistic relationship. Algae can photosynthesise to provide sugars it allows the coral polyp to share, whereas the coral polyp offers protection, allowing the algae to live in more extreme conditions than those under which it would normally thrive.



Human Interactions with Ecosystems

Positive human interactions with ecosystems	Negative interactions with ecosystems
Maintaining rainforests, ensuring habitats here are not destroyed.	Production of greenhouse gases leading to global warming
Raising awareness among the public about how to protect ecosystems through large scale community projects.	Introducing non-indigenous species into the environment, which prey on native species. For example, cane toads from South America were introduced to Australia to control the number of cane beetles, which were eating sugar cane crops. However, now the number of cane toads is a problem as the toads are poisonous and kill native animals.
Reducing water pollution and monitoring the changes over time.	Producing sulphur dioxide in factories which leads to acid rain – affects habitats.
Preserving areas of scientific interest by stopping humans from going there.	Chemicals used in farming leak into the environment – if they leak into a lake this can cause <u>eutrophication</u> – excessive growth of plant life which can deplete the amount of Oxygen in the water (meaning it can't easily sustain other species such as fish)
Replanting hedgerows and woodlands to provide habitats which were previously destroyed.	Clearing land in order to build on, reducing the number of habitats.
	Overfishing which reduces biodiversity and can lead to endangerment of some species. To prevent this from becoming a bigger issue, fish farming takes place. Fish farms have been set up to deal with the impact of overfishing, which has damaged ecosystems. The aim is to produce more fish and reduce overfishing of wild fish. However, this can cause problems because fish are often kept in a relatively small space, and waste produced from the fish can harm the organisms living there.

The picture below shows Eutrophication.



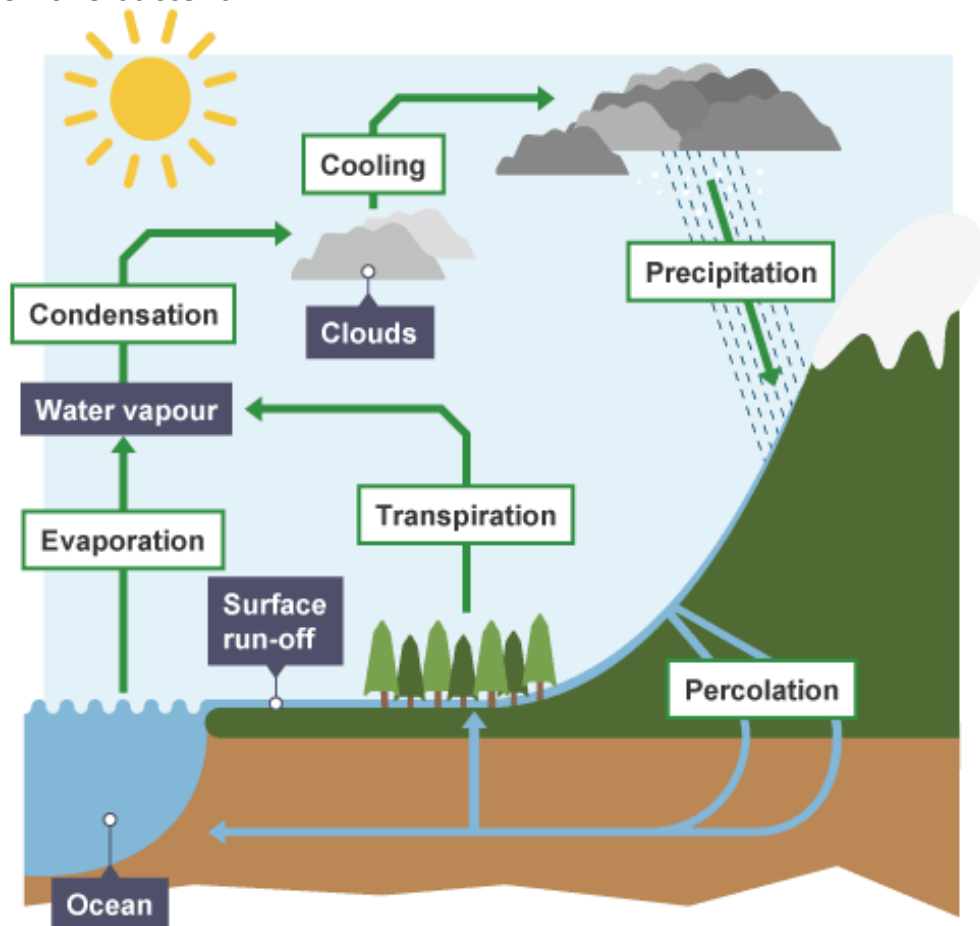
Maintaining biodiversity

To reduce humans' negative impact on ecosystems, programs have been put in place to maintain biodiversity.

1. Breeding programs: to stop endangered species from becoming extinct.
2. Protection of rare habitats: to stop the species here from becoming extinct, if damaged they may even be regenerated to encourage populations to live here
3. Reintroduction of hedgerows and field margins around land where only one type of crop is grown: maintains biodiversity as the hedgerows provide a habitat for lots of organisms (because a field of one crop would not be able to support many organisms) and field margins provide areas where wildflowers and grasses can grow.
4. Reduction of deforestation and carbon dioxide production: reduces the rate of global warming, slowing down the rate that habitats are destroyed
5. Recycling rather than dumping waste in landfill: reduce the amount of land taken up for landfills, and slows the rate we are using up natural resources.

The Water Cycle

- The sun's energy causes water to evaporate from the sea and lakes, forming water vapour.
- Water vapour is also formed as a result of transpiration in plants.
- Water vapour rises and then condenses to form clouds.
- Water is returned to the land by precipitation (rain, snow or hail), and this runs into lakes to provide water for plants and animals.
- This then runs into seas and the cycle begins again.
- In areas of drought, we can harness the water cycle to produce **potable** (drinkable) water. For example, **desalination** is the process by which we remove salt and other minerals/impurities from seawater to make it drinkable.
- **Desalination** can be performed by **distilling** water (heat salt water, boil the water, condense the water vapour, collect pure water) to make it potable or it can be performed by a process called **reverse osmosis** (passing water through a partially permeable membrane under high pressure – expensive) and generally occurs on a large scale.
- **Water treatment** involves passing water through a **sedimentation** tank (removes larger impurities), **filtering** it, (remove insoluble impurities) then treating it with Chlorine (**Chlorination**) to remove bacteria.



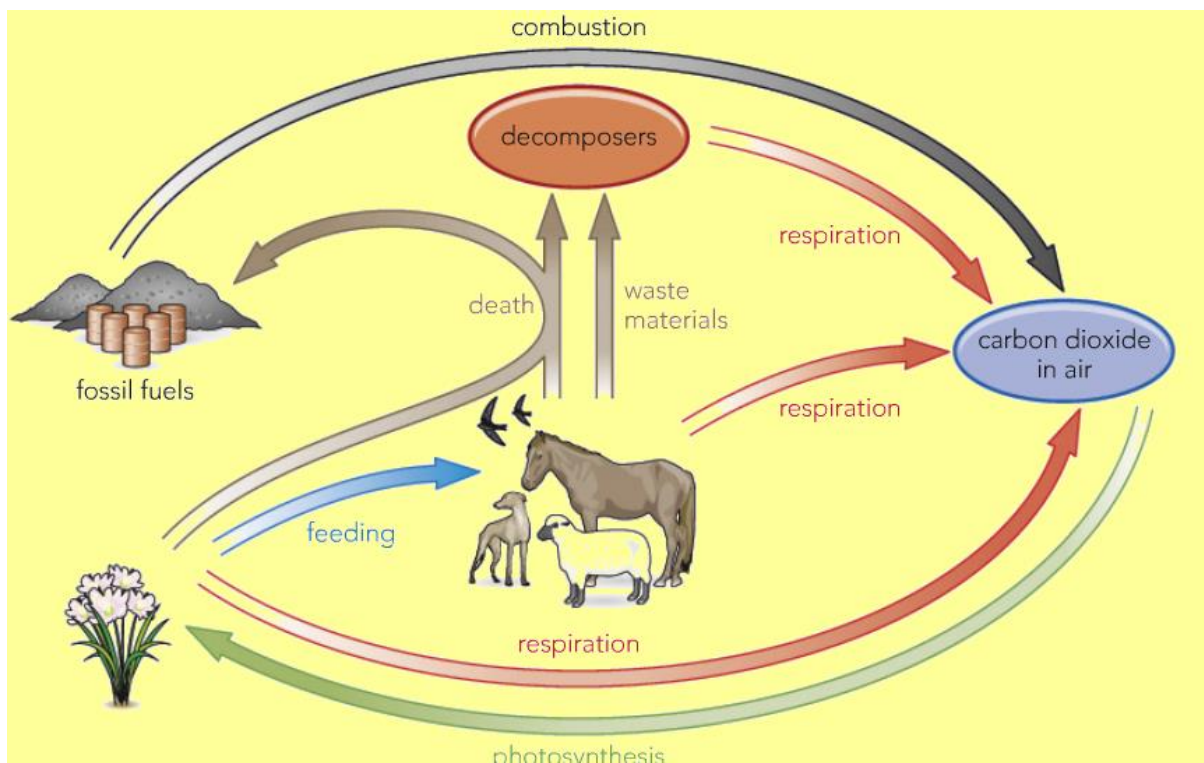
Biotic factors in the Carbon cycle

Animals drink water, removing water from the ground. Animals also sweat and excrete waste urine, releasing water back to the environment. Plants absorb water from their roots and release water through a process called transpiration (water evaporates from their leaves)

The Carbon Cycle

The Carbon Cycle – this describes how Carbon is recycled in our atmosphere.

- CO_2 is REMOVED from the air during **photosynthesis** by green plants and algae – they use the carbon to make carbohydrates, proteins and fats. They are eaten by a primary consumer, which may then be eaten by a secondary consumer and so on, so the Carbon passes along the food chain. Eventually these animals will die and their bodies will decompose.
- CO_2 is RETURNED to the air when plants, algae and animals **respire**. **Decomposers** (a group of microorganisms that break down dead organisms and waste) also **respire** while they return mineral ions to the soil.
- CO_2 is RETURNED to the air when wood and **fossil fuels are burnt (called combustion)** as they contain carbon from photosynthesis.

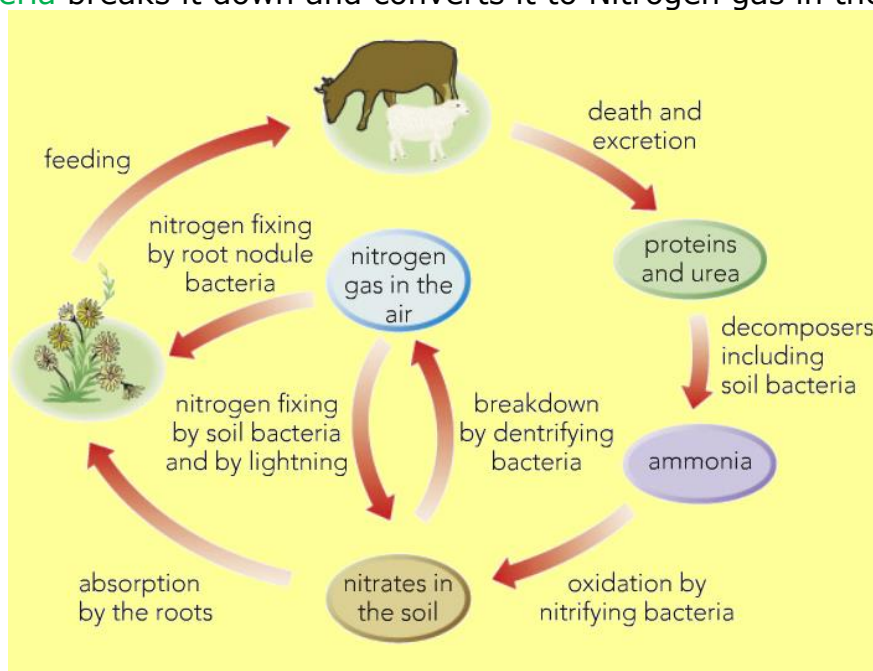


The Nitrogen Cycle

This describes how Nitrogen is taken from the air around us and used before being recycled back to the atmosphere.

Nitrogen gas makes up 78% of our atmosphere, however Nitrogen gas in the atmosphere is too unreactive so cannot be used directly by plants. There are 3 types of bacteria that are involved in the Nitrogen cycle. Plants need the Nitrogen to be in the form of Nitrates so that they can use it.

- **Nitrogen-fixing bacteria** present in the root nodules of legume plants convert nitrogen gas from the air into nitrates that can be used for growth.
- Lightning can also convert nitrogen gas into nitrates
- Plants absorb nitrates through the roots by active transport.
- Nitrogen is often included in fertilisers in the form of ammonium nitrate. This provides an artificial way to ensure that plants get nitrates required for growth, without relying on external processes such as nitrogen-fixing bacteria or lightning.
- Plants get eaten by animals who take on the Nitrates and then excrete substances (wee and poo) and eventually die.
- **Decomposers** produce ammonia which can then be oxidised by **nitrifying bacteria** and converted back to nitrates.
- Either the nitrates get absorbed by plants and the cycle begins again here or **denitrifying bacteria** breaks it down and converts it to Nitrogen gas in the air.



Farmers rely on the nitrogen cycle to help increase yield.

1. They use manure as fertilisers, relying on decomposers to break waste down into useful nitrogen compounds.
2. Crop rotation: "Planting a sequence of crops in different years such as wheat followed by potatoes followed by peas." Plants such as peas or beans contain nitrogen fixing bacteria in their root nodules. When they have been harvested, farmers leave their roots in the soil so that the useful Nitrates in the roots can be absorbed by different plants that will be planted in those fields the following year. Crop rotation also helps to manage pests naturally.

Prove it Questions

Page 61 Ecosystems and Organisation

Q1	What is an ecosystem?	1
Q2	What is a community?	1
Q3	What do the arrows in a food chain and food web show?	1
Q4	Define producer and state where a producer gets its energy from?	2

Page 62 Abiotic factors

Q1	What is an abiotic factor?	1
Q2	Name two abiotic factors related to climate.	2
Q3	Using an example describe how temperature could affect population of organisms.	2

Page 63 Biotic factors

Q1	What is a biotic factor?	1
Q2	Name two biotic factors	2
Q3	Wolves and Coyotes both feed on Elk. Elk and Beavers are both herbivores and compete for food from trees. Wolves are larger than coyotes and can chase them away. How would increasing numbers of Wolves affect the population of Coyotes and the population of Elks?	3
Q4	Using information from the above question. How would the changing population of Elks affect the population of Beavers?	2

Page 65 Interdependence

Q1	How does a parasite benefit from its relationship with a host organism?	1
Q2	How does the host organism get harmed from its relationship with a parasite – use an example in your answer?	1
Q3	Use an example to describe a mutualistic relationship.	2
Q4	What is the difference between a mutualistic relationship and a parasitic relationship?	2

Page 66-67 Humans and the ecosystem

Q1	State two ways in which humans can affect ecosystems and reduce biodiversity.	2
Q2	Describe eutrophication	4
Q3	What is an indigenous species?	1
Q4	How does fish farming aim to benefit the aquatic ecosystem?	2

Page 8 Water cycle

Q1	Describe what happens during the evaporation phase of the water cycle.	1
Q2	Describe what happens during the condensation phase of the water cycle	1
Q3	What word describes the process used to remove salt and other impurities from rainwater making it fit for human consumption?	1
Q4	What does precipitation mean?	1

Page 69 Carbon cycle

Q1	State and describe what process removes Carbon from the atmosphere.	2
Q2	State and describe one process that replaces/returns Carbon in/to the atmosphere	2
Q3	State and describe a second process that replaces/returns Carbon in/to the atmosphere.	2
Q4	What role do decomposers play in the Carbon cycle?	2

Page 70 Nitrogen cycle

Q1	Nitrogen forms 78% of our atmosphere, why can't plants and animals use this directly?	1
Q2	Describe the role of Nitrogen fixing bacteria	2
Q3	Describe the role of decomposers in the Nitrogen cycle.	2
Q4	Describe how Nitrogen is returned to the atmosphere.	2

Mark scheme

Page 61 Ecosystems and Organisation

Q1	interaction between a community of living organisms and their environment (1)	1
Q2	is two or more populations of organisms (1)	1
Q3	Direction of energy movement (1)	1
Q4	Producer is a plant that produces its own food source (1) OR an organism that photosynthesises (1) Energy for this comes from the sun (1)	2

Page 62 Abiotic factors

Q1	A non-living factor that can affect a community (1)	1
Q2	Temperature (1) Moisture (1)	2
Q3	A long-term rise or fall in temp will change the distribution or organisms (1) Polar bears would not survive an increase in temperature as they are not adapted for high temperatures (1) Cacti would not survive a decrease in temperature as they are not adapted for lower temperatures (1)	2

Page 63 Biotic factors

Q1	A living factor/ organism that can affect a community and a population (1)	1
Q2	New predators (1) New pathogens (1) Competition (1) Food availability (1)	2
Q3	Increasing wolves would mean coyotes don't get as much food (1) Therefore population of Coyotes would decrease (1) Population of Elks would decrease as the Wolves would not have to compete to eat them (1) Must have explanations as well as direction of population movement.	3
Q4	Reduced population of Elks would cause increase population of Beavers (1) As beavers would not be competing with Elks for the same food sources (1)	2

Page 65 Interdependence

Q1	Takes nutrients (1)	1
Q2	The parasite takes nutrients that the host needs (1)	1
Q3	Mutualistic relationship is one where both organisms benefit (1) algae and fungi - Algae can photosynthesise to provide sugars for the fungi, whereas the fungi allow the algae to live in more extreme conditions than those under which it would normally thrive.	2
Q4	A parasitic relationship is where the parasite benefits, but the host is harmed (1) A mutualistic relationship is where both parties benefit (1)	2

Page 66-67 Humans and the ecosystem

Q1	Greenhouse gases (1) Introducing non indigenous species (1) Producing Sulphur dioxide (1) Clearing land (1) Eutrophication (1) Over fishing (1)	2
Q2	Fertiliser containing nitrates and phosphates used on land (1) rain washes the excess off – enters rivers and lakes (1) Nitrates and Phosphates cause extra growth of plants and Algae (1) This covers the surface of water (1) Reducing light so Photosynthesis can't happen (1) reduces Oxygen in lake (1) Aquatic animals die due to lack of Oxygen (1)	4
Q3	A species of organism that is native to the land (1)	1
Q4	Replenish stock or reduced fish due to overfishing (1) Reduce overfishing (1)	2

Page 68 Water cycle

Q1	Water on land is heated by the sun and turns into water vapour (1)	1
Q2	Water Vapour cools as it rises and turns back into water (1)	1
Q3	Desalination (1)	1
Q4	Rain (1)	1

Page 69 Carbon cycle

Q1	Photosynthesis (1) Plants absorb Carbon Dioxide from the atmosphere and use it to produce Oxygen and Glucose (1)	2
Q2	Respiration (1) All living things respire and use Oxygen to create energy and Carbon Dioxide, which is then releases into the atmosphere. (1)	2
Q3	Combustion (1) Burning of fossil fuels releases Carbon Dioxide into the atmosphere (1).	2
Q4	They break down(decompose) dead organisms and waste (1) they respire when they do this and release Carbon Dioxide into the atmosphere (1)	2

Page 70 Nitrogen cycle

Q1	It is very unreactive so can't be split (1)	1
Q2	Found within roots nodules of some plants and in soil (1) Converts Nitrogen into Nitrates (1) that can be used for growth.	2
Q3	Break down dead organisms and waste and produce ammonia (1) Which is then oxidised by Nitrifying bacteria to create nitrates and used for growth (1).	2
Q4	Nitrates are broken down by denitrifying bacteria (1) and released back into the atmosphere as Nitrogen (1)	2