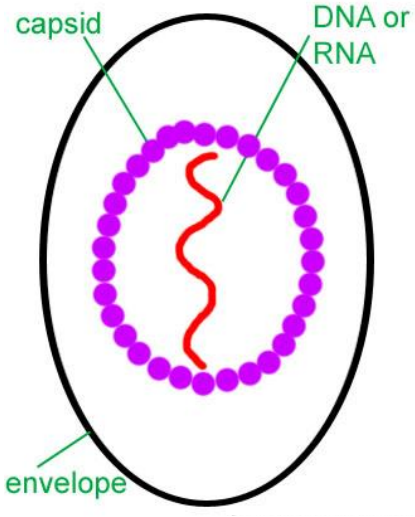



The **envelope** is used to gain entry into host cells.

The **capsid** is a protein coat and is used to protect the genetic information and give the virus structure.

The DNA or RNA (a different type of **nucleic acid**) contains the code for building new viruses.

**Examples** include the Tobacco Mosaic Virus and the Influenza virus (that causes 'flu).



# Section 2: Structures and Functions in Living Organisms

## a) Levels of Organisation

Organisms are made from organisations of smaller structures. You need to know the following hierarchy of structures:

**Organelles** - intracellular structures that carry out specific functions within a cell

**Cells** - the basic structural and functional unit from which all biological organisms are made

*You need to be able to recall an experiment you have done that explores the effect of temperature on enzymes. An example is the enzyme **catalase** that breaks down **hydrogen peroxide** into **water** and **oxygen**:*

$$2H_2O_2 \rightarrow O_2 + 2H_2O$$

*Catalase is found in potatoes. Therefore, putting potato chips into hydrogen peroxide will produce $O_2$. The rate of reaction is proportional to the volume of $O_2$ given off. Changing the temperature will alter the volume (i.e. initially increase it, reach an optimum, then decrease quickly as the **catalase** becomes **denatured**).*

## d) Movement of Substances Into and Out of Cells



**Diffusion** – the movement of molecules from an area of high concentration to an area of low concentration down a concentration gradient. A passive process – no energy is required.

**Osmosis** – the movement of water molecules from an area of high concentration to an area of low concentration across a partially permeable membrane. A passive process – no energy required.

**Active Transport** – the movement of molecules from an area of low concentration to an area of high concentration against the concentration gradient. Energy is required for movement to occur.

Diffusion and osmosis occur because molecules have **kinetic energy**. The molecules constantly bounce off each other all the time, gradually spreading out. Eventually there will be an even mixture of molecules that is called an **equilibrium**. Diffusion is affected by:

- temperature (increases kinetic energy)
- stirring (increases kinetic energy)
- surface area available for diffusion

| Leaf Structure | Adaptation for Photosynthesis |
|---|---|
| Cuticle | Prevents entry of pathogens and **reduces** water loss. |
| Epidermis | Transparent protective layer. Protects the leaf without inhibiting photosynthesis. |
| Palisade cells | Packed full of chloroplasts. Long and thin so light has to pass through as many chloroplasts as possible. |
| Air Spaces | Increase the surface area inside the leaf to maximise gas exchange across the surface of the Spongy Mesophyll cells. |
| Stoma | Allow exchange of $CO_2$ and $O_2$ |
| Guard Cells | Allow the stoma to open and close to stop the leaf losing too much water. |
| Vein (containing **Xylem**) | Steady supply of water to the leaf from roots. |

In addition to water and $CO_2$ plants also need specific minerals:

**Nitrate** – used to make amino acids for plant proteins (growth)
**Magnesium** – forms part of the chlorophyll molecule
**Potassium** - essential for cell membranes
**Phosphate** - essential part of DNA and cell membranes



*You need to know an experiment that shows how the rate of photosynthesis is affected by rate-limiting factors. The best example is using pond weed (**Elodea**) which produces bubbles of $O_2$ as it photosynthesizes. The rate of bubble production is approximately proportional to the rate of photosynthesis. Therefore, when you increase light intensity or give it more $CO_2$, the rate of bubble production increases.*

*You also need to know an experiment that proves that light and $CO_2$ are essential for the production of starch. A good example is the **Geranium** plant. The leaves normally turn blue-black in the presence of iodine solution showing starch is present (you have to boil it in ethanol first to remove the chlorophyll to show the colour). However, if one leaf is put in aluminium foil and another is kept with lime water both **do not** turn blue-black, implying both $CO_2$ and light*

The purpose of digestion is to break large, insoluble pieces of food into small, soluble molecules that can be absorbed through the gut wall into the bloodstream. There are two types of digestion:

**Mechanical Digestion**: digestion by physically breaking food into smaller pieces (i.e. not using enzymes). Carried out by:

- mouth and teeth chewing food
- stomach churning food

**Chemical Digestion**: digestion using enzymes

You need to know the following enzymes:

| Where it is made | Where it works | Enzyme | Substrate | Products |
|---|---|---|---|---|
| Salivary Glands | Mouth | Amylase | Starch | Maltose |
| Stomach cells | Stomach | Protease | Protein | Amino Acids |
| Liver | Small Intestine | Bile Salts | Fat | Fat droplets |
| Pancreas | Small Intestine | Amylase<br>Protease<br>Lipase | Starch<br>Protein<br>Fat | Maltose<br>Amino Acids<br>Glycerol & Fatty acids |
| Small Intestine | Small Intestine | Maltase<br>Protease | Maltose<br>Protein | Glucose<br>Amino Acids |



**Bile salts** are not technically enzymes. They are made in the **liver** and stored in the **gall bladder**. They help by **emulsifying** lipid (i.e. turning large fat droplets into lots of tiny droplets). This increases the surface area, helping lipase to break the lipid down.

Bile also has a second job. Bile is **alkaline**. This is important for **neutralising stomach acid** as soon as it leaves the stomach. Stomach acid is important because it kills any bacteria that enter the stomach. Stomach acid does not play a significant role in digestion.

## Key Terms

**Ingestion**: taking food into the digestive system

**Digestion**: breaking food down into molecules small enough to be absorbed into the bloodstream.

**Absorption**: taking molecules into the bloodstream. This happens almost entirely in the small intestine (ileum).

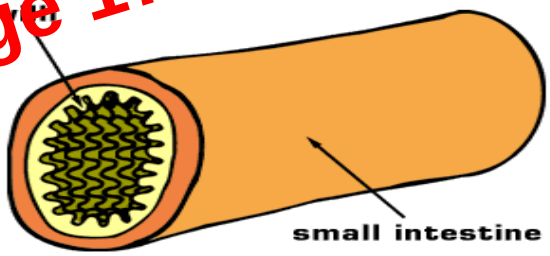
**Assimilation**: using food molecules to build new molecules in our bodies, i.e. the food molecule physically becomes part of our body.

**Egestion**: Removing unwanted food from the digestive system (having a poo!). This is **not excretion** because the unwanted food has never, technically, been inside the body.

**Peristalsis**: the contraction of muscle in the intestine wall **behind** a bolus of food (ball of food). This pushes the bolus through the intestine.



## Small Intestine Adaptations




| Adaptation | Explanation |
|---|---|
| Thin wall | The intestine wall is thin. This increases the rate of diffusion of molecules into the blood. |
| Rich blood supply | This helps carry absorbed molecules away from the intestine quickly. This means there is always a low concentration of food molecules in the blood. This maintains a steep concentration gradient. |
| Intestine length | Roughly 7m long. This increases the surface area and time available for absorption. |
| Surface area | Villi and microvilli increase the surface area of the small intestine by 1000x. |

## f) Respiration

Respiration is the process that releases energy in every living cell of every organism. The energy is essential for keeping the cell alive as it powers processes like protein synthesis, growth, repair, cell division, etc. Aerobic respiration is:

| | | | | | | |
|---|---|---|---|---|---|---|
| Glucose | + | Oxygen | → | Carbon Dioxide | + | Water |
| $C_6H_{12}O_6$ | + | $6O_2$ | → | $6CO_2$ | + | $6H_2O$ |

Some cells have the ability to respire without using oxygen. This is called **anaerobic respiration**. Only liver and muscle cells can do this in humans. Anaerobic respiration allows the cell to carry on working despite there being a shortage of oxygen (this is very useful in muscle cells, particularly if you are running for your life!).

Glucose → Lactic Acid

Anaerobic respiration produces **Lactic Acid** which is poisonous. Lactic acid builds up inside muscle cells and quickly leads to muscle fatigue and cramp. Eventually, the muscle cell will stop working.



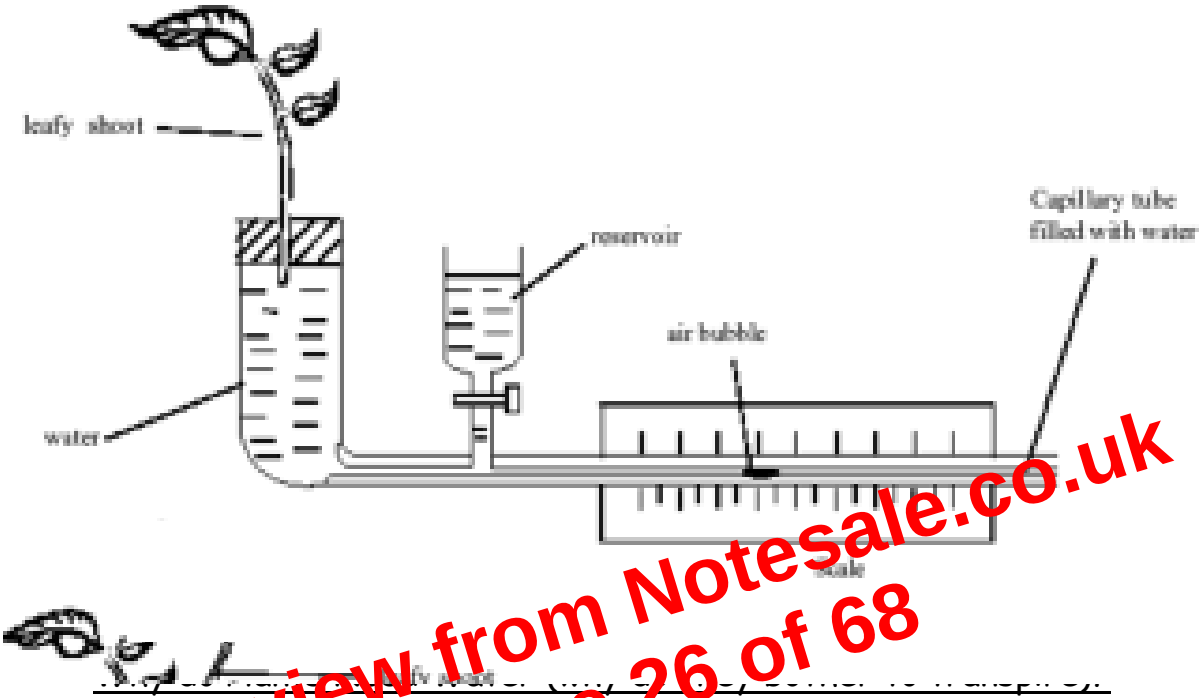
During recovery the lactic acid is transported to the liver via the bloodstream. The liver breaks the lactic acid into $CO_2$ and water. Oxygen is required for this which is called the **Oxygen Debt**.

**Yeast** also respire anaerobically but they do not produce lactic acid like humans. Instead, they make ethanol. This type of anaerobic respiration is also called **alcoholic fermentation**. It is used in the baking and brewing processes.

| | | | | | |
|---|---|---|---|---|---|
| Glucose | → | Ethanol | + | Carbon Dioxide | |
| $C_6H_{12}O_6$ | → | $2CH_3CH_2OH$ | + | $2CO_2$ | **(interest only)** |

*You need to know an experiment that shows that living organisms produce $CO_2$ through respiration. The best example is to suspend some maggots or seeds near the top of a test tube sealed with a bung (suspend the maggots / seeds in a wire mesh). A small amount*

*You need to know an experiment that can show the effect of the above factors on the rate of transpiration. The best experiment is a **potometer** that measures how quickly a little bubble of air moves up a glass tube attached to the bottom of a leafy stem. Adding a fan, changing the humidity, increasing the temperature, etc. will all change the speed the bubble moves up the tube.*






- Used in photosynthesis (~10%)
- A solvent for transporting other things (e.g. minerals) (~10%)
- Used in chemical reactions (~5%)
- A site of chemical reactions (~5%)
- **Cooling the plant (~70%)**

## Transport in Humans

**Plasma** – mostly water used for **transporting** things around the body (i.e. **$CO_2$**, **glucose**, **amino acids**, other products of digestion, **urea**, **hormones** and **heat energy**.

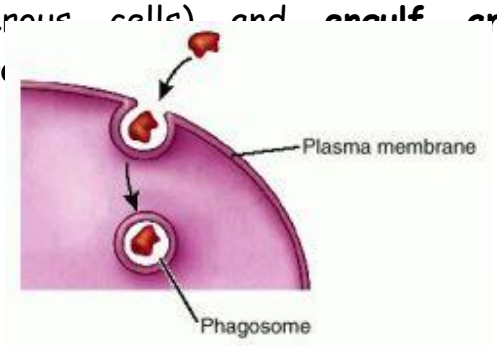
**Red Blood Cells** – adapted to carry $O_2$ around the body. $O_2$ attaches to the protein **haemoglobin** (and forms oxyheamoglobin) which the RBCs are filled with. Other adaptations of RBCs include:

- Smooth edges
- **Biconcave** shape (increases surface area and allows folding)
- Made in huge quantities
- No nucleus (so more room for haemoglobin)

**Platelets** – help clot the blood. This stops blood loss and also prevents micro-organisms entering the body.

**White Blood Cells** – are part of the immune system. There are two main types: **macrophages** and **lymphocytes**.



| **Macrophages** (sometimes called Phagocytes) | **Lymphoctyes** |
|---|---|
| Travel in the blood. They detect foreign bodies (i.e. foreign cells, toxins, cells infected with virus and cancerous cells) and **engulf and destr**<br>  <br><br>Engulfing and destroying is called **phagocytosis**. | Stay in the lymph system (you don't need to know what this is). They make proteins called **antibodies** in large numbers. Antibodies travel in the blood and stick to foreign objects. This helps because:<br>1. foreign objects are stuck to each other, stopping them spreading; and<br>2. macrophages can engulf many foreign objects at the same time, speeding up the killing process. |

## b) Inheritance

The nucleus of every cell contains **DNA**. DNA is a **genetic code**. Each instruction in the code is called a **gene**. Each gene tells the cell how to make a **specific protein**. The proteins are what control the cell (e.g. enzymes are proteins, so are structural proteins like collagen). Sometimes there are more than one version of a gene. The different versions are called **alleles** (e.g. we all have the gene for iris pigment, but there are different colours of iris pigment, same gene but different alleles).

DNA is a very long molecule. To stop it from breaking it is coiled up inside the nucleus. The coiled up DNA forms a **chromosome**. Humans have 23 different chromosomes inside their cells. We have two copies of each chromosome, so each cell contains 46 chromosomes. The **haploid number** is the number of different chromosomes (i.e. 23) and the **diploid number** is the total number of chromosomes in the cell (i.e. 46).



Key Word Summary

**This topic, more than any other, confuses people. Learn these thoroughly!**

**DNA**: A genetic code

**Gene**: One instruction in the code telling a cell how to make a **specific protein**

**Allele**: A different version of a gene

**Chromosome**: Coiled up DNA

**Haploid number**: the number of **different** chromosomes in a cell (23 in humans)

**Diploid number**: the **total number** of chromosomes in a cell (46 in humans)

Each parent gives only **one** of each of the pairs of chromosomes to their gametes. A pair of chromosomes will have exactly the same genes on them but not necessarily the same alleles! This is the source of genetic variation in gametes.

Alleles for the same gene can be:

- **Dominant** – always affect the **phenotype** (allele represented with capital letter)
- **Recessive** – never affect the phenotype in the presence of a dominant allele (allele represented with lower case letter)
- **Co-dominant** – affect the phenotype equally in the presence of another co-dominant allele (both alleles have capital letters)

Inheritance

Inheritance patterns are always given using a **genetic diagram**. If this comes up you get loads of marks for it but only if you use the genetic diagram!



A **Genetic Diagram**

| | ♀ | ♂ |
|---|---|---|
| Parents' Phenotype: | Brown eyes | Brown eyes |
| Parents' Genotype: | B b | B b |
| Gametes: | B b | B b |

F1 Genotype:

| | B | b |
|---|---|---|
| B | B B | B b |
| b | B b | b b |

F1 Phenotype: 3 : 1 Brown eyes : blue eyes

| Greenhouse Gas | Source |
|---|---|
| Water Vapour | Humans haven't had much effect on this – it's a naturally occurring greenhouse gas |
| $CO_2$ | Released during combustion of fossil fuels |
| $NO_X$ | Released during combustion of fossil fuels |
| Methane | Produced by cows (yes, cow farts) and rice paddy fields. As agriculture becomes more and more intensive, methane emissions rise. |
| CFCs | Used to be used as coolants in fridges and propellants in aerosols. Now banned but there are still lots of old fridges in scrap yards leaking CFCs. |

The theory goes that the **greenhouse effect** is causing **global warming** which is bad. Global warming might cause:

- the polar ice caps to melt
- sea levels to rise
- the extinction of species living in cold climates
- changes in rainfall (both droughts and flooding)
- changes in species distribution (i.e. tropical species spreading, like mosquitoes)



Eutrophication

1. Nitrate enters a waterway (**sewage** or **fertiliser run-off**)
2. Nitrate causes **algal bloom**
3. Algae block out light for plants living on the waterway bed
4. These plants cannot photosynthesise and die
5. $O_2$ levels fall
6. Fish die
7. Dead fish and plants are decomposed by bacteria, using up more $O_2$ as they respire
8. pH levels fall as decomposition produces acids
9. Everything dies; waterway is incapable of supporting life