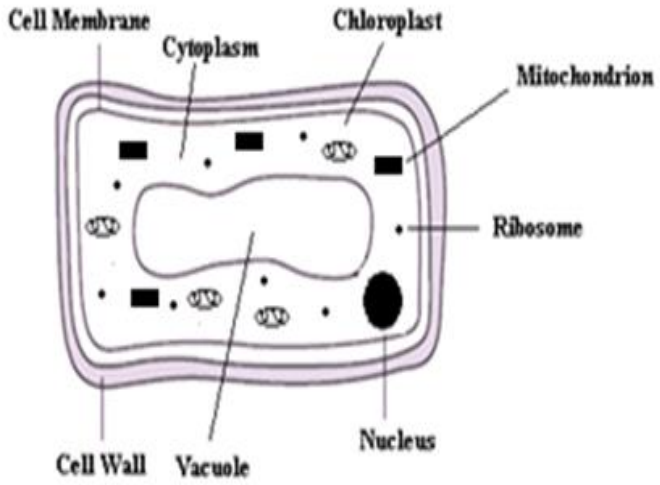
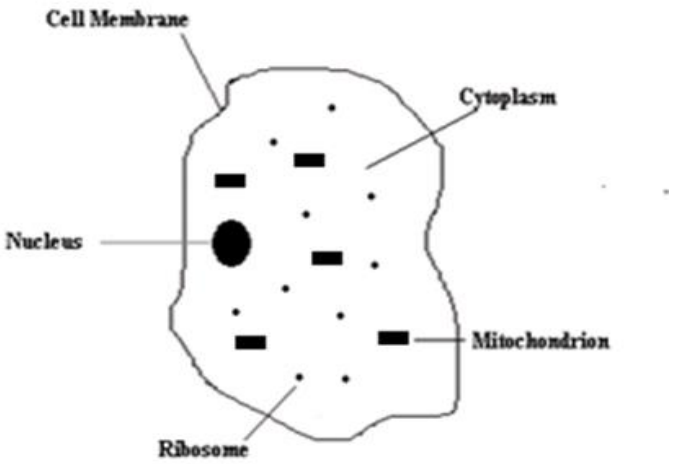
Cell Structure

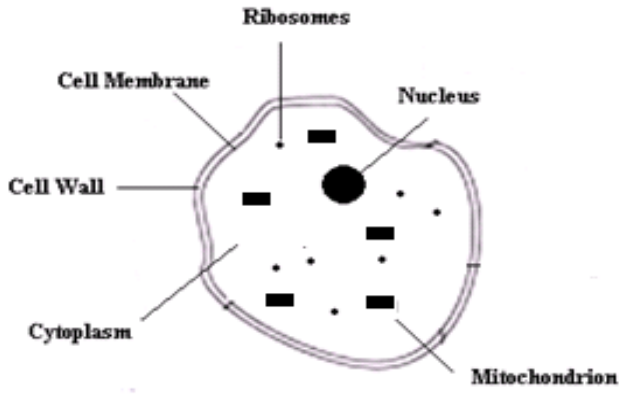
☐ *Identify animal, plant, fungal and bacterial cell ultrastructure and know the structures functions.*



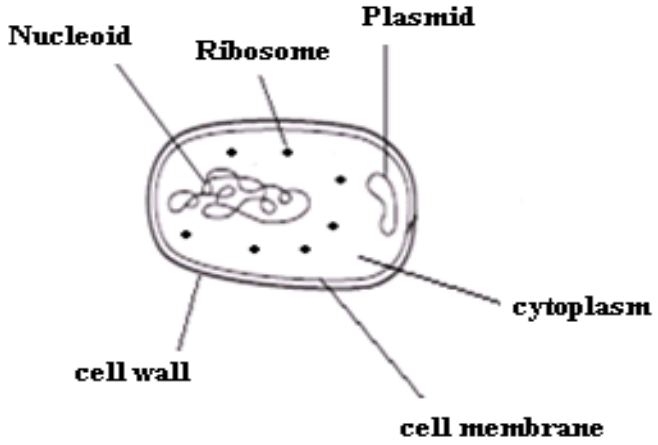
Plant cell



Animal cell



Fungal cell



Bacterial cell

Summary

Structure	**Function**	**Found in which cell type**
Cell wall	**Boundary** to the cell. Maintains the **shape** of the cell	Plant, fungal and bacterial cells
Mitochondria	Site of **aerobic respiration** (energy production (ATP))	Plant, animal and fungal cells
Chloroplast	Contains chlorophyll. Site of **photosynthesis**	Only plant cells
Cell Membrane	**Boundary** to cell. **Controls** entry and exit of materials.	Plant, animal, bacterial and fungal cells

Vacuole	Changeable sized cavity **storing** water and/or food	Plant and fungal cells
Nucleus	Contains **DNA**, holding the genetic information to control cell activities	Plant, animal and fungal cells
Ribosome	Site of **protein synthesis**	Plant, animal, bacterial and fungal cells
Cytoplasm	Site of cell's chemical reactions	Plant, animal, bacterial and fungal cells
Plasmid	Circular piece of **genetic material** found in bacteria cell. Can be used to transfer a gene from one organism to another.	Only bacterial cells

Transport across cell membranes

☐ *State the components and the permeability of the cell membrane*

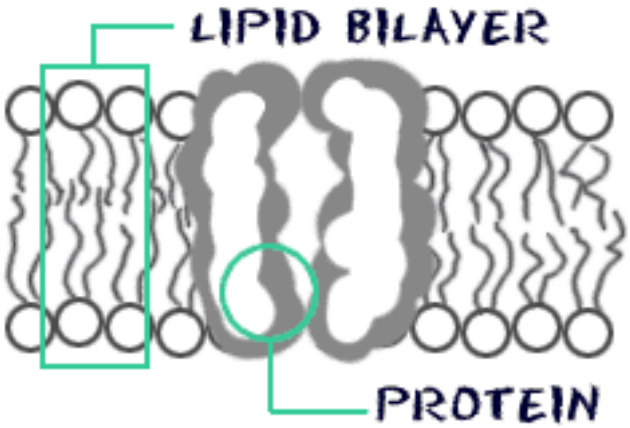
☐ *Describe passive transport and its energy requirements*

☐ *Describe diffusion and its importance*

☐ *Give the definition of osmosis*

☐ *Describe the changes in animal and plant cells when placed in solutions of different concentrations*

☐ *Describe active transport and its requirements*



The arrangement of the phospholipid molecules gives the membrane **fluidity** (allows it to move).

The protein molecule shown in the diagram forms a **channel** through the membrane, allowing the movement of small molecules in to and out of the cell. In the class we can use **visking tubing** as a membrane as it contains **pores**.

Diffusion is the movement of molecules from an area of **high concentration** to an area of **low concentration**. Molecules that move by diffusion are **glucose, oxygen and carbon dioxide**. Large molecules like **starch** cannot leave the cell by diffusion. Diffusion is important as it allows essential molecules like glucose and oxygen enter a cell, whilst removing waste molecules like carbon dioxide.

Osmosis is the movement of **water** from an area of **high water concentration** to an area of **low water concentration** through a **selectively permeable membrane**.

A cell would **decrease** in mass if it was placed in a solution containing a lower water concentration (hypertonic), as **water** molecules would leave the cell. An animal cell would **shrink** in this case and a plant cell would become **plasmolysed**.

A cell would **increase** in mass if it was placed in a solution containing a higher water concentration (hypotonic), as **water** molecules would enter the cell. A plant cell would **swell, become turgid** in this instance and an animal cell would **burst.**

A plant and animal cell would remain unchanged if it was placed in a solution containing equal water concentrations (isotonic).

Diffusion and osmosis are both **passive** processes, i.e., they don't need **energy,** the molecules move down a concentration gradient.

A **concentration gradient** exists when there is a difference in concentration between the inside and outside of a cell.

Active transport is the movement of molecules **against** a concentration gradient. The molecules move from an area of **low concentration** to an area of **high concentration**. Active transport requires **energy**. **Proteins** are found in the cell membrane and are responsible for moving molecules across the cell membrane by active transport.

Producing new cells; Mitosis

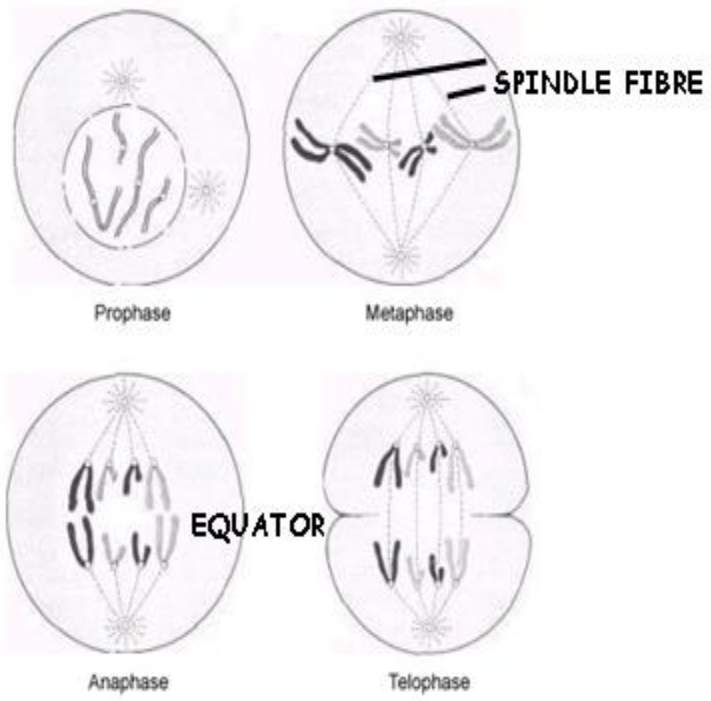
- ☐ Explain the role of mitosis in maintaining diploid cells
- ☐ Describe the sequence of events in mitosis, including the terms chromatids, spindle fibres and equator
- ☐ Describe how cells are produced by cell culture and the requirements
- ☐ State that mitosis is required for growth and repair.

Cell division in an important process which **increases** the number of **cells** in an organism.

The division of the nucleus is called **mitosis.**

Mitosis is important because;

- It produces new cells for **growth** and **repair**
- It is the way in which single-celled organisms **reproduce**.



Inside nearly all cells is a **nucleus**.

The nucleus **contains instructions** that control all cell activities.

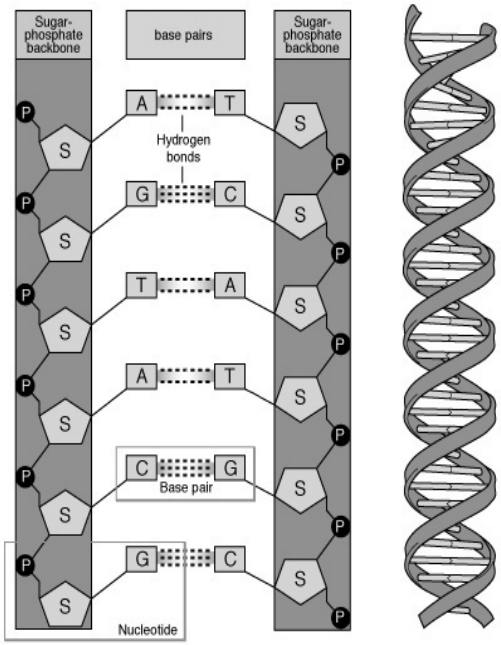
Mitosis is important as it ensure **no loss of genetic information** between cells as they divide. **Mitosis** maintains the chromosome complement of a cell as it ensures an **exact copy** of the cell is made after every division.

Stages of Mitosis

1. Chromosomes appear in the nucleus
2. The chromosomes shorten and thicken and appear as double threads (**chromatids**) joined at one point.
3. The membrane around the nucleus disappears and the chromosomes line up at the **equator** (centre) of the cell.
4. The chromatids are pulled apart by **spindle fibres** and move to opposite ends of the cell.
5. The nucleus membrane reforms round each group of chromatids and the cytoplasm divides.
6. The two new cells now go through a period of growth before mitosis starts again in each cell.

DNA and the production of proteins

- ☐ State the structure of DNA and its purpose
- ☐ Name the 4 DNA bases and identify the base pairing rule
- ☐ What is the genetic code and how does it link to amino acid sequence in proteins
- ☐ State the purpose of mRNA



DNA is a **double stranded** molecule. The two strands form a **helix**.

It is made up of a backbone of **deoxyribose sugar** molecules joined to a **phosphate** group.

The two strands are joined via **bases**. There are **4** bases (**adenine, thymine, cytosine and guanine**).

The bases **always** pair as follows;

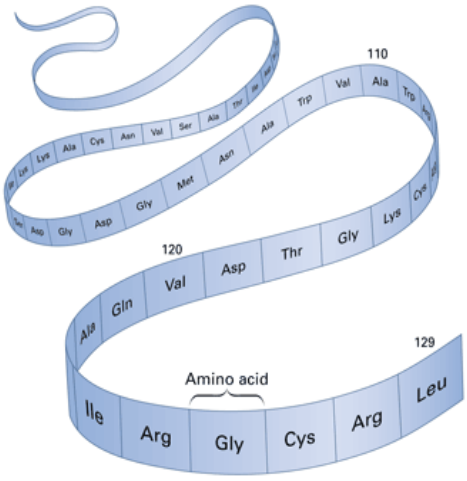
ADENINE=THYMINE

CYTOSINE=GUANINE.

The sequence of bases is called the **GENETIC CODE**.

The sequence of **bases** determines the production of a protein in a cell.

Consider the DNA to be the recipe to make a protein, and the ingredients to make the protein are in the cells cytoplasm. The building blocks for a protein are called **amino acids**.



Each amino acid is coded for by 3 bases on the DNA molecule, for example, think of the DNA strand shown below.

AGG-TCG-AAT-CCG

AGG would correspond to a particular amino (for example leucine), **TCG** for a different amino acid (tyrosine) and so on. So from this DNA sequence, a protein could be produced as follows;**Leucine - tyrosine - histidine - proline**

Protein synthesis takes place in the cytoplasm on a cell structure called a **ribosome**.

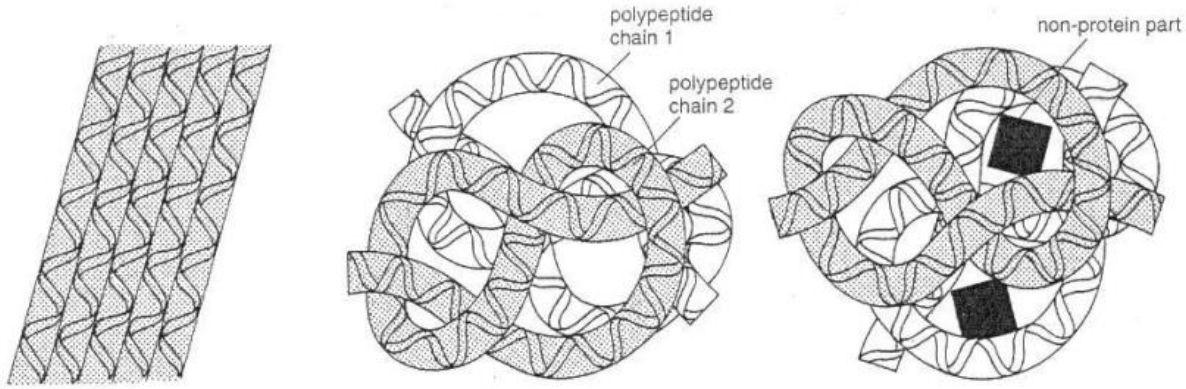
Since the genetic code is held by the DNA contained within the nucleus, a messenger molecule is required to carry the genetic message from the nucleus to the ribosome. This molecule is called **messenger RNA (mRNA).**

The **mRNA** takes a copy of the genetic code from the DNA and carries it to the **ribosome**, where the protein is assembled from amino acids.

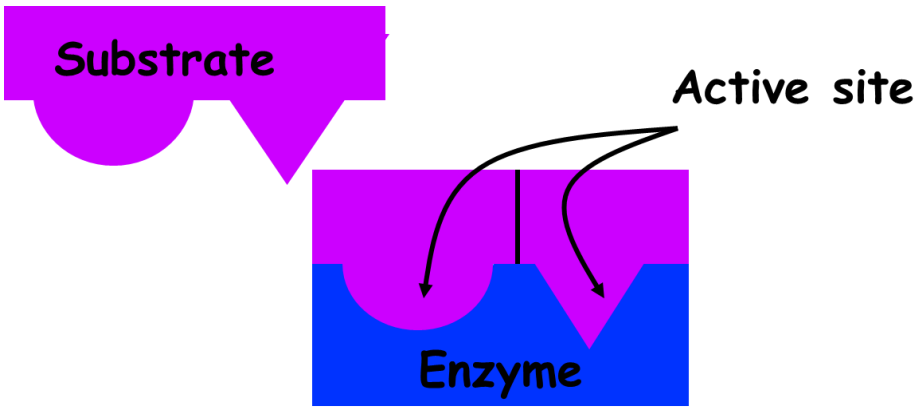
Proteins and enzymes

- ☐ *Explain the connection between amino acid sequence and protein structure and function*
- ☐ *Give the functions of some proteins to include structural, enzymes, hormones, antibodies and receptors.*
- ☐ *Describe the role of an enzyme and their properties*
- ☐ *Give the function of the active site in terms of substrate specificity*
- ☐ *Define the term optimum in relation to enzymes*
- ☐ *Identify factors that affect enzyme activity*
- ☐ *Explain why denaturation occurs*

Proteins are made from amino acids and depending on how they are arranged they form different structures and can then perform different jobs.



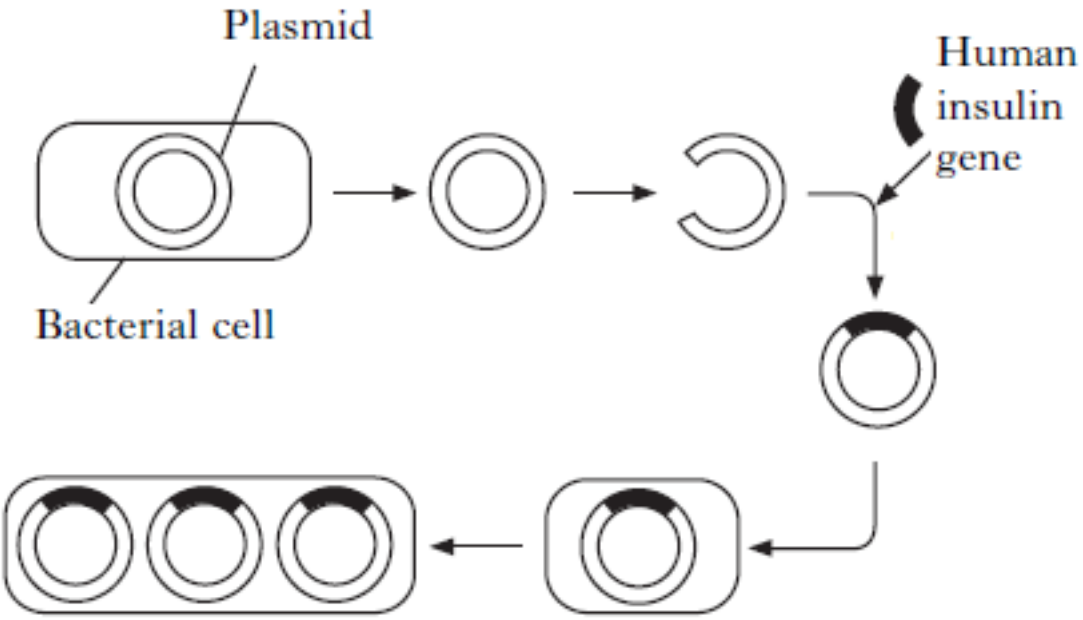
Structural proteins include cellulose which forms part of the cell wall. Other proteins form enzymes which are biological catalysts which speed up reactions, catalase breaks down hydrogen peroxide to form oxygen and water. Enzymes are used in biological washing powders to attack stains and remove them from the cloth. Enzymes are specific this means that they only work on one substrate and have optimum conditions where they work best for example temperature (37°C) and pH. Enzymes have an active site and this allows it to join together with the substrate. Some proteins are hormones which are chemical messengers that travel to specific parts of the body. Antibodies are also proteins and these are specific molecules that attach to and destroy viruses.



Genetic engineering

- *Give the definition of genetic engineering*
- *Identify the stages involved in genetic engineering*

Genetic engineering is the process of transferring genetic information from one cell to another. Genes code for proteins and if transferred into a bacterial cell the bacterial cell will produce that particular protein. The protein can then be removed and purified and used by humans. This is how insulin to treat diabetics is made as the bacteria are able to produce large quantities quickly. The bacteria are said to be genetically modified organisms.



1. Human gene is identified and cut out of chromosome

2. Plasmid is removed from bacterial cell and cut open

3. Gene is inserted into plasmid

4. Plasmid is put back into bacterial cell

5. Bacterial cell multiplies and produces the protein coded for by the gene

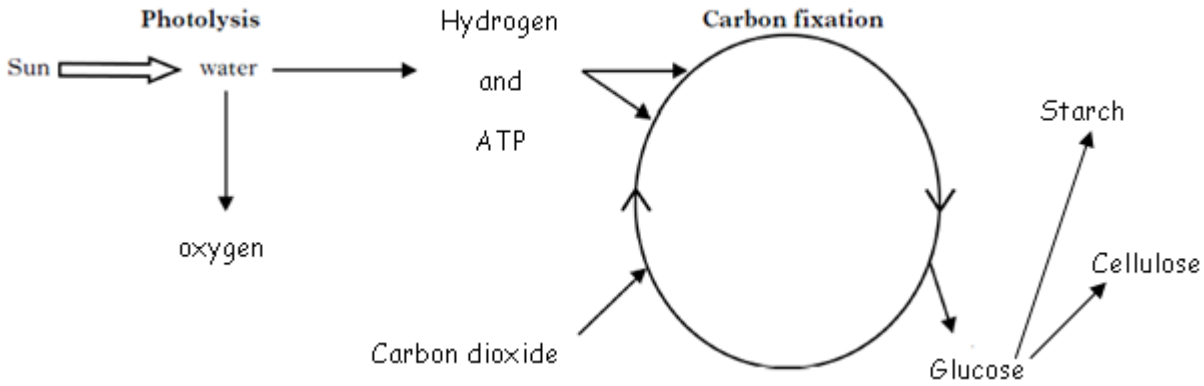
Photosynthesis

- *Name and describe the first stage of photosynthesis*
- *Name and describe the second stage of photosynthesis*
- *Name the storage and structural carbohydrates produced from glucose*
- *Identify the factors that can limit photosynthesis and state the effect they have on cell growth*

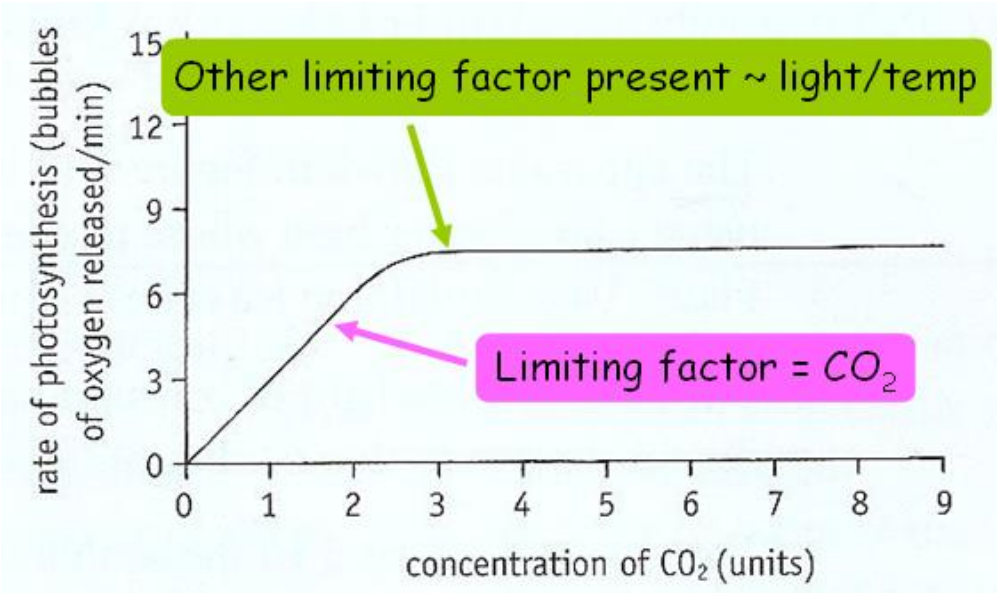
Photosynthesis is the chemical process where plants use light energy from the sun to make glucose.

$$\underbrace{CO_2 + H_2O}_{\text{raw materials}} \xrightarrow[\text{chlorophyll}]{\text{light}} \underbrace{\text{glucose } (C_6H_{12}O_6) + O_2}_{\text{products}}$$

Photosynthesis takes place in two stages, the light reactions called photolysis where light energy from the sun which is trapped by chlorophyll is used to split water (H_2O) into hydrogen and oxygen and releases energy as ATP (high energy molecule). Oxygen is given off as a by product. ATP and hydrogen are needed for the second enzyme controlled stage called carbon fixation where CO_2 is joined together with the hydrogen using the ATP (from photolysis) to form glucose. Glucose is a carbohydrate and can be used by the plant for respiration, growth, or stored as starch (storage carbohydrate) or converted to cellulose (structural carbohydrate) and used to form part of the cell wall.



A limiting factor is one which can slow a process down if it is short supply, so all of the raw materials for photosynthesis are limiting factors as is temperature because is an enzyme controlled process. Graphs can illustrate the effect of a limiting factor. Even if two of the three required conditions are present the lack of the third will stop the rate of photosynthesis increasing.



Respiration

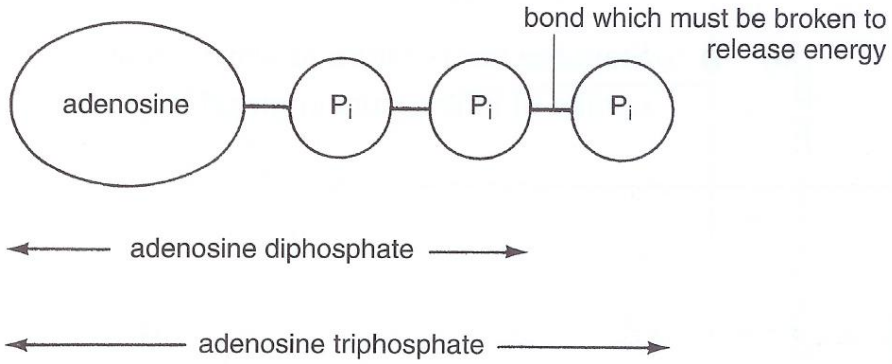
- *Identify the source of energy in a cell and the reaction which releases this energy*
- *Explain the structure and role of ATP and how it releases energy*
- *State the cellular activities that use energy*
- *Define aerobic respiration and fermentation and state the locations where they occur*
- *Describe the steps involved in aerobic respiration and fermentation in animals and plants*
- *Compare aerobic and anaerobic respiration in terms of energy yield and products in both plant and animal cells*

Aerobic respiration is the enzyme-controlled chemical process where glucose is

broken down in the presence of oxygen to release energy (ATP) to allow the body to do work and carbon dioxide and water are released as end products.

Glucose + oxygen ⟶ ENERGY (ATP) + carbon dioxide + water

When glucose is broken down the energy is used to generate ATP from ADP and Pi. The chemical energy stored in ATP can be used by the cell by breaking it back down to ADP and Pi. This is a reversible reaction.



The energy is used to carry out work in the cell such as muscle cell contraction, cell division, protein synthesis and transmission of nerve impulses.

Respiration can also take place in the absence of oxygen and is known as anaerobic respiration. In animal cells lactic acid is produced and in yeast cells the process is called fermentation and ethanol (alcohol) and carbon dioxide is produced. Aerobic respiration is more efficient and produces 38 molecules of ATP per glucose in comparison to 2 ATP produced during anaerobic respiration or fermentation. All of these processes are enzyme controlled and so temperature has an impact.

Animal cells (anaerobic respiration) **glucose ⟶ lactic acid**

Yeast (fermentation) **glucose ⟶ ethanol (alcohol) + CO_2**

Aerobic respiration takes place in two stages glycolysis which occurs in the cytoplasm and involves the breakdown of glucose into pyruvic acid with the release of 2 ATP. This stage is also common to anaerobic respiration. The second stage of aerobic respiration is called the kerb's cycle and occurs in the mitochondria of a cell. During this cycle Pyruvic acid is converted in a series of

enzyme controlled reactions into carbon dioxide and water. Whilst this is happening an additional 36 molecules of ATP are released.

Aerobic respiration is more efficient than anaerobic respiration producing an energy yield of 38 ATP in comparison to 2 ATP.