Cell Biology

Summary Notes 2

Name _____

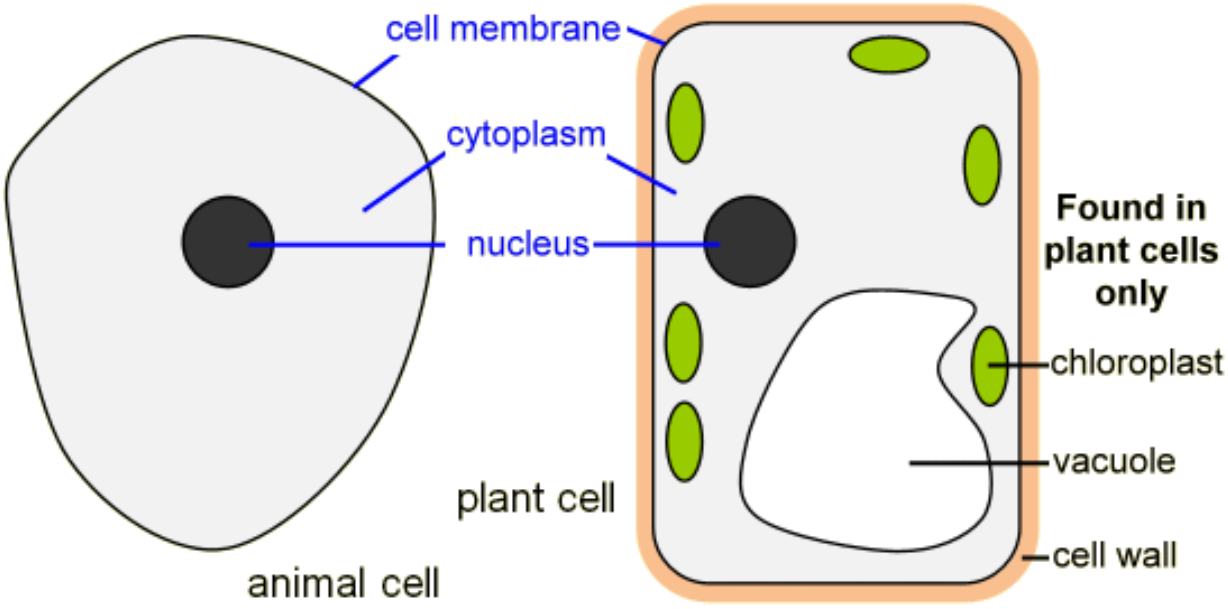
Class _____

These notes contain a summary of key facts. When revising, you will still need to refer to your jotter to remind yourself of the experimental and practical work you have done.

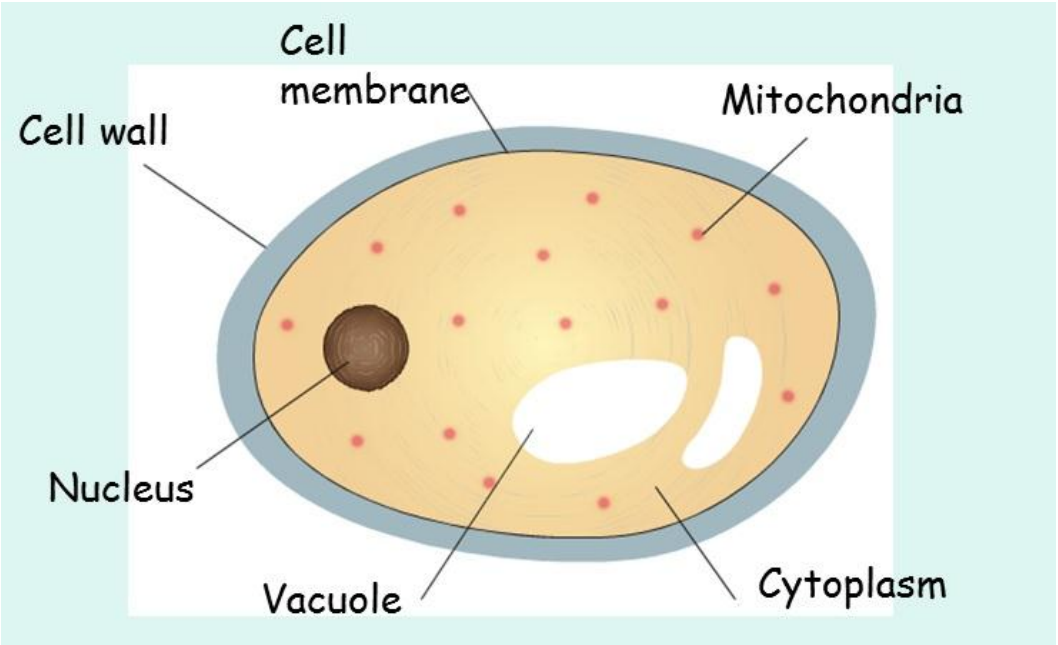
Cells and Cell Structure

- Cells are the building blocks of life.
- All living organisms are made up of cells.
- Cells need to be viewed through a microscope.

Plant cells and Animal cells

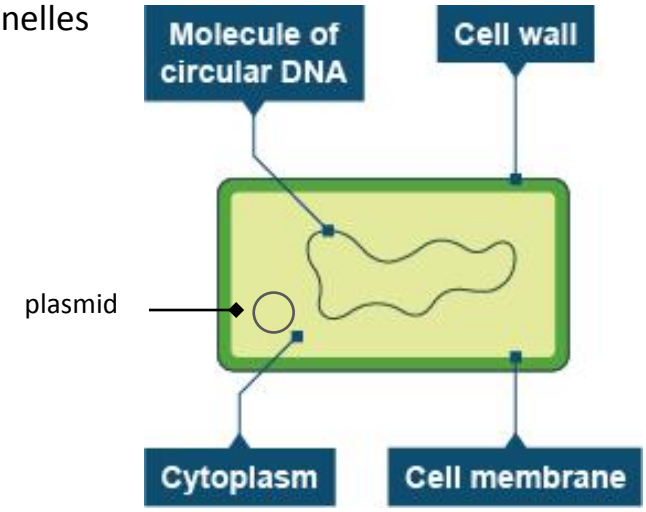


Fungal cell e.g. yeast



Bacterial Cell

Bacteria cells do not contain any organelles



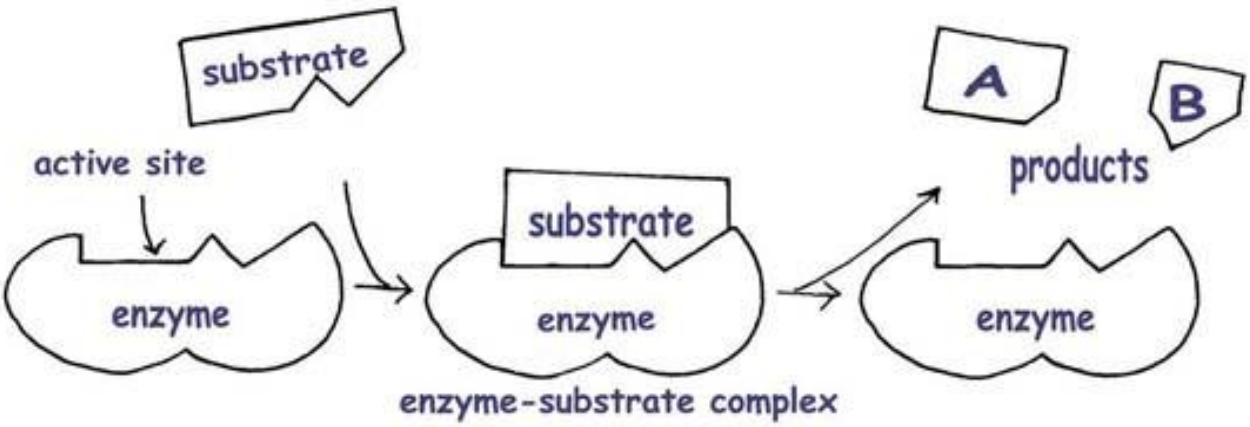
Cell structure	***Function***
Nucleus	Contains genetic information (DNA) in animal, plant and fungal cells
Plasmid	A small ring of DNA only found in bacterial cells
Cell membrane	Controls entry and exit of substances such as oxygen and carbon dioxide.
Cytoplasm	Liquid inside cells containing organelles, the site of various chemical reactions
Cell Wall	The outer layer of plant, fungal and bacterial cells which helps support the cell
Vacuole	Membrane bound sac that stores a solution of water found in plant and fungal cells
Mitochondrion	Main site of energy (ATP) production in aerobic respiration in animal plant and fungal cells
Chloroplast	The site of photosynthesis in plant cells
Ribosome	Site of protein synthesis in cells

Cell walls of plant, fungal and bacterial cells are not all the same. They are made of different chemicals.

Enzymes

- Enzymes are biological ***catalysts***.
- Enzymes are made by all living cells.
- Enzymes ***speed up*** cellular reactions and ***remain unchanged*** in the process.
- Enzymes are ***specific*** to their substrate.
- Enzymes are made from ***protein***.

Lock and Key

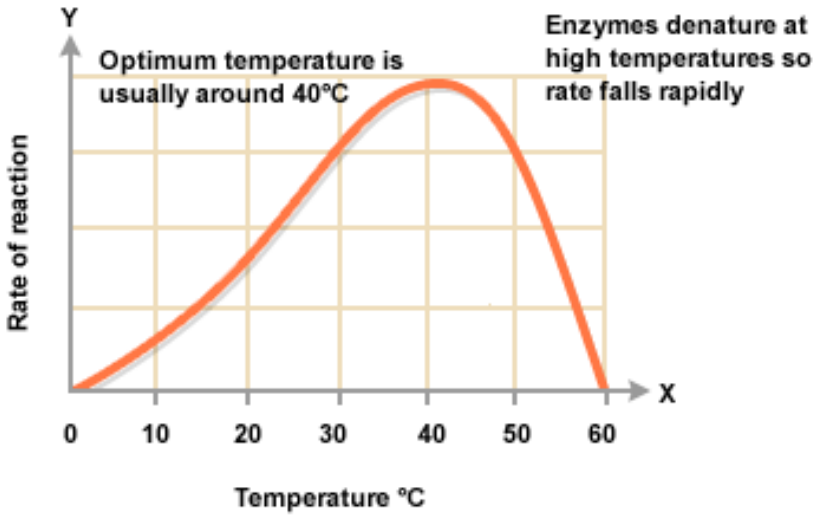


Enzymes fit to their specific substrate like a lock and a key. The place where an enzyme binds with its substrate is called the ***active site***. The enzyme remains unchanged in the reaction but the substrate is changed in to the ***products***.

Enzymes can break their substrate down in to smaller products, or they can build their substrates up into larger products.

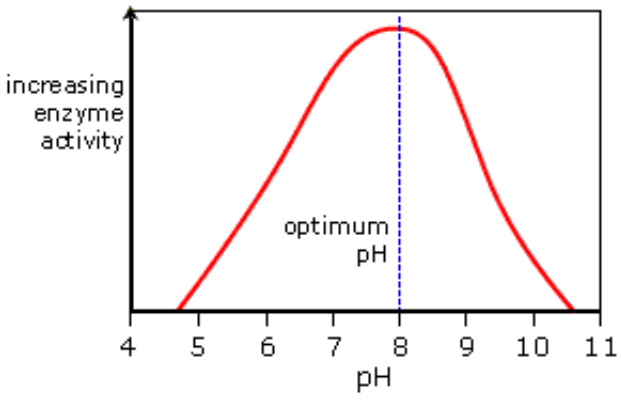
Enzymes and temperature

Enzyme activity can be increased with an increase in temperature. Human body enzymes tend to work best at human body temperature (37^{o}C). The temperature that an enzyme works best at is called the ***optimum*** temperature. If an enzyme is overheated it can change the shape of the protein. This means that the substrate will no longer fit the active site. This means the enzyme has become ***denatured***.



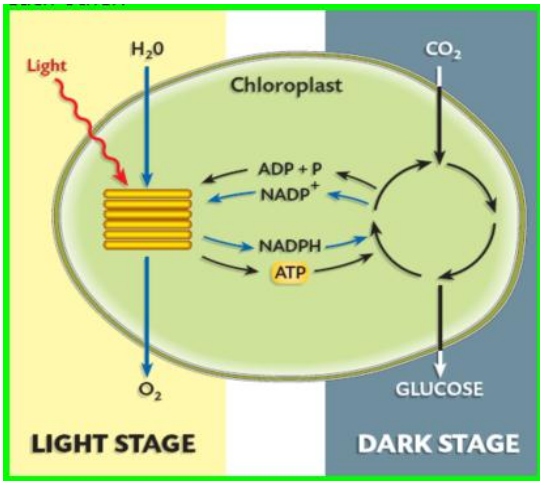
Enzymes and ph.

Enzyme activity can also be affected by pH. Most enzymes have an optimum pH around neutral but the stomach enzyme pepsin has an acidic optimum pH. A pH higher than the optimum can also ***denature*** an enzyme.



If enzymes are denatured, their shape changes and this will affect the ***rate*** of the reaction.

Photosynthesis



Photosynthesis is the process by which green plants make their own food. This is a 2-stage process. The overall ***word equation*** for photosynthesis is:

Carbon Dioxide + Water $\xrightarrow[\text{Chlorophyll}]{\text{Light energy}}$ Glucose + Oxygen

Stage 1: Light reactions

- The light energy from the sun is trapped by chlorophyll, in the chloroplasts and is converted into chemical energy in the form of ATP.
- Water is split to produce hydrogen and oxygen.
- Hydrogen attaches to hydrogen acceptor molecules.
- Oxygen diffuses out of the leave as a waste product.

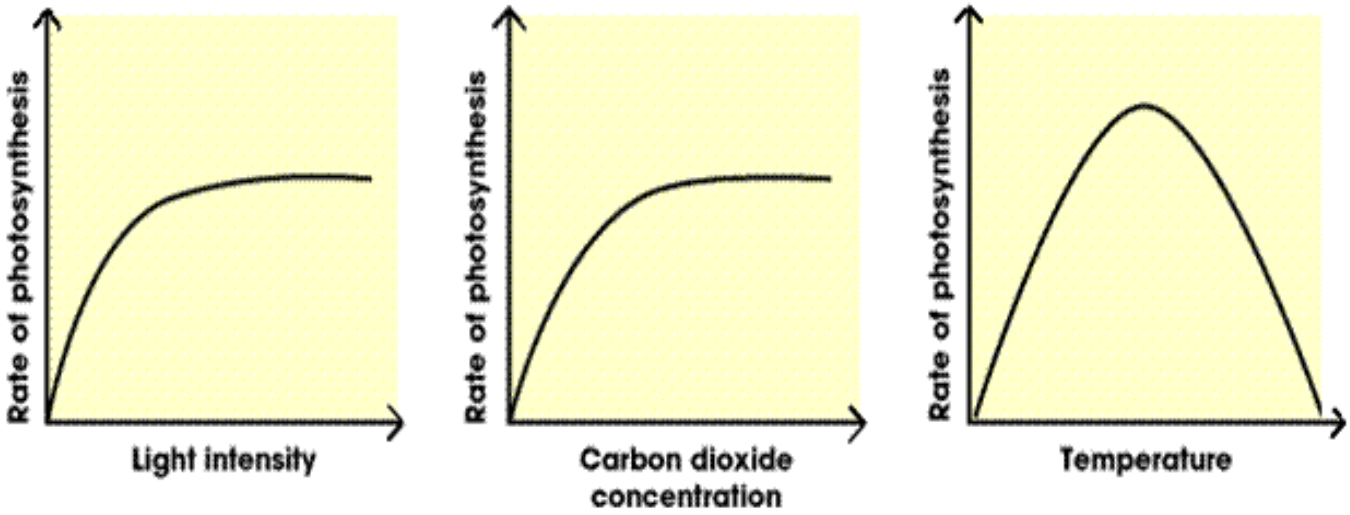
Stage 2: Carbon Fixation (The Calvin Cycle)

- A series of enzyme-controlled reactions
- Uses the hydrogen and ATP created during the light reactions
- Carbon dioxide from the air combines with hydrogen to produce ***glucose***

Glucose contains chemical energy which is available for use in respiration. The glucose can also be stored as starch for future use in respiration and used to form cellulose, a chemical in cell walls.

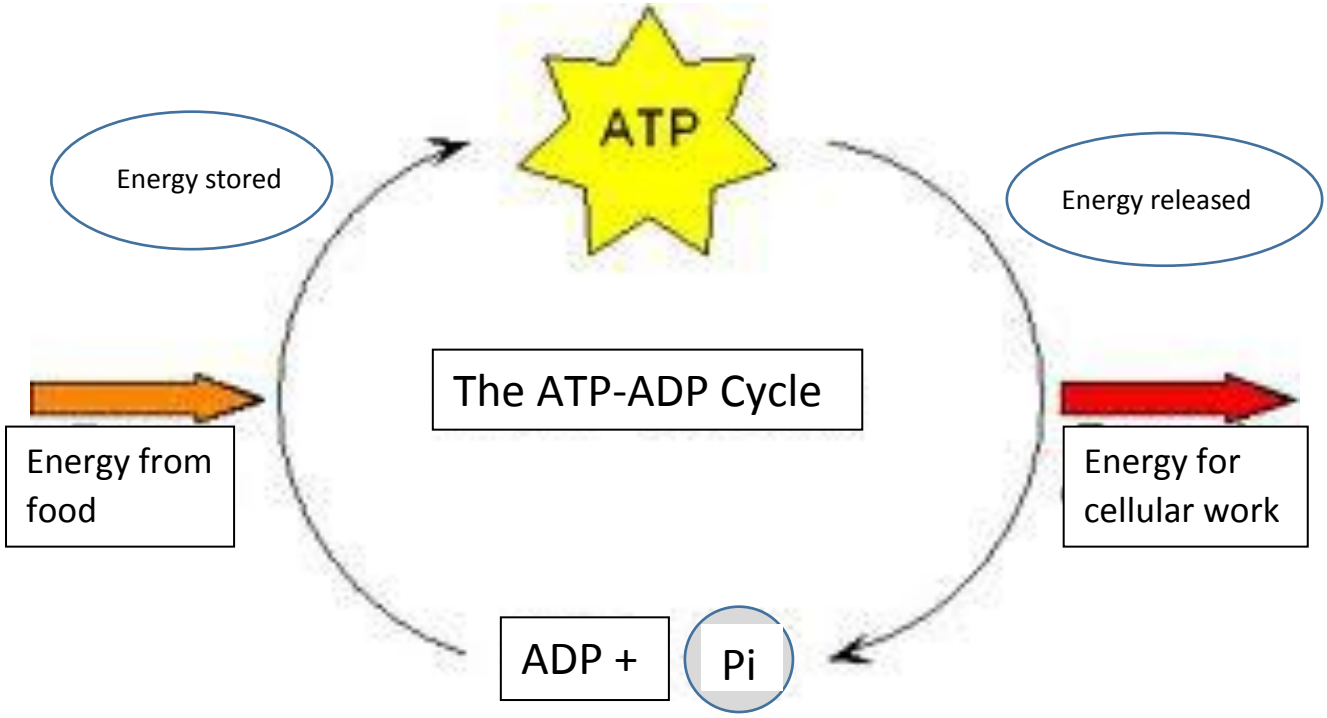
Limiting Factors

The rate of photosynthesis can be ***limited*** (slowed) by factors which are in short supply. This causes the growth of the plant to be limited. Low light intensity can limit photosynthesis as well as low carbon dioxide concentration and even low temperature.



Respiration

- Respiration is a series of enzyme controlled reactions that cause the release of chemical energy from glucose.
- The energy released from the breakdown of glucose is used to generate ATP by combining ADP with an additional inorganic phosphate (Pi).
- The energy released from the breakdown of ATP can be used for muscle contractions, cell division, protein synthesis and nerve transmissions.



Aerobic respiration

Glucose + Oxygen ⟶ Carbon Dioxide + Water + Energy

Aerobic respiration is a two-step process:

1. **Breakdown of glucose**- a glucose molecule is split in to another molecule called pyruvate, producing 2 molecules of ATP. This takes place in the cytoplasm.
2. **Breakdown of pyruvate**- pyruvate is broken down further in the mitochondria to produce carbon dioxide and water. 36 ATP molecules are also generated in the

second stage => 38 ATP in total. The second stage can ***only take place in the presence of oxygen***.

<u>Anaerobic respiration</u> If no oxygen is available:

In plants:

Glucose ⟶ ethanol + CO_2

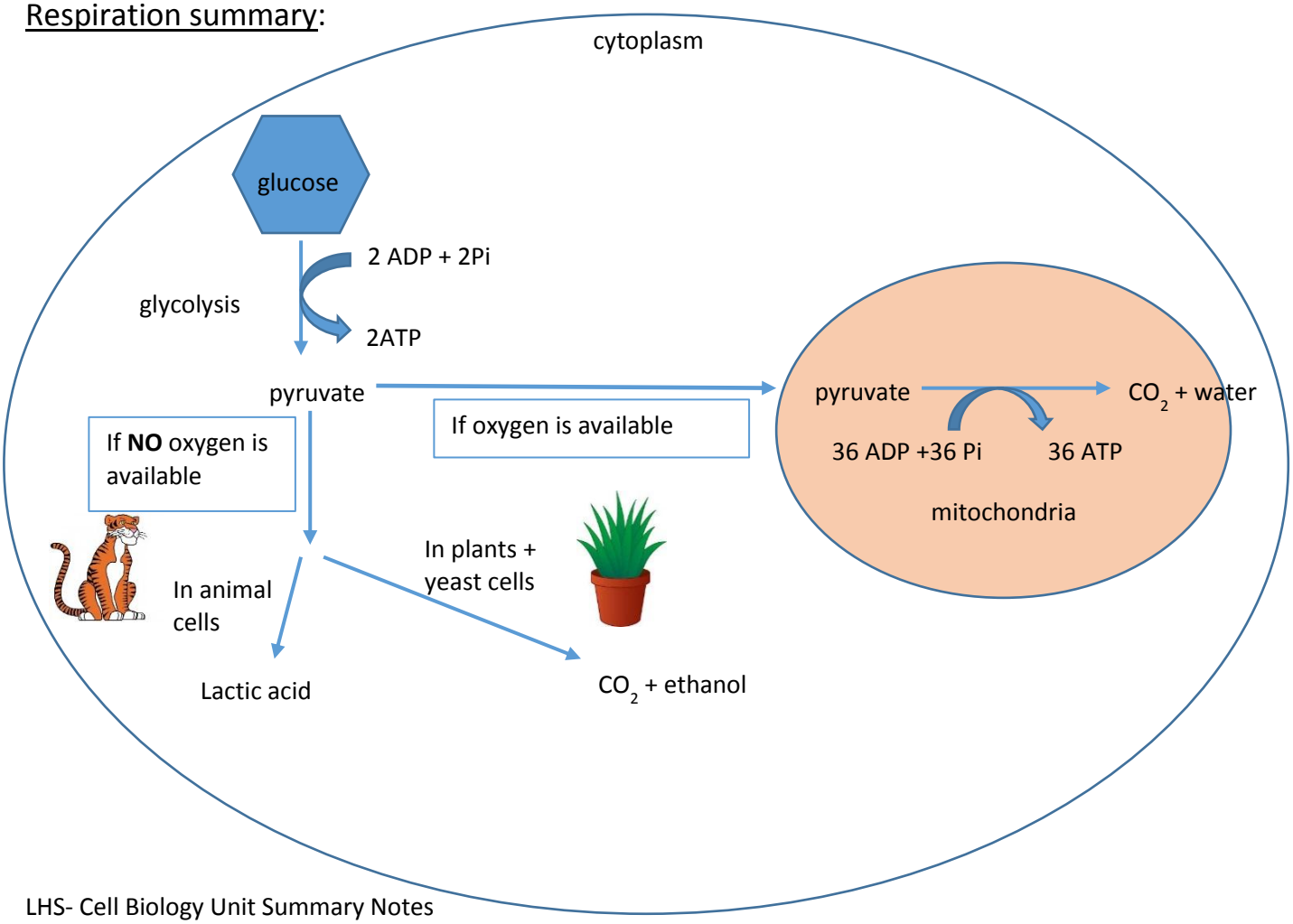
In Animals:

Glucose ⟶ lactic acid

Yeast is a fungal cell which can be used for baking and brewing because when it ferments (anaerobically respires) it produces carbon dioxide to cause dough to rise and ethanol to make beer alcoholic.

Anaerobic respiration only generates **2 molecules** of ATP for every molecule of glucose broken down.

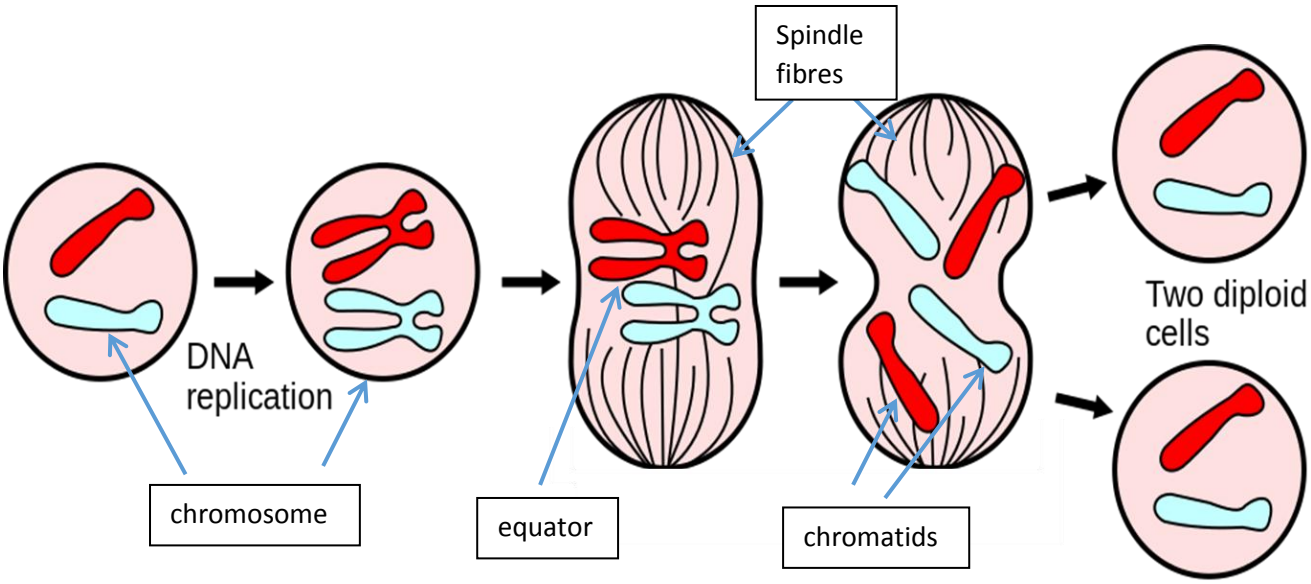
<u>Respiration summary</u>:



Cells which need a lot of energy have a high number of mitochondria e.g. muscle cells, nerve cells and sperm cells.

Mitosis

- Mitosis is the process of cell division.
- Mitosis is important for growth and repair.



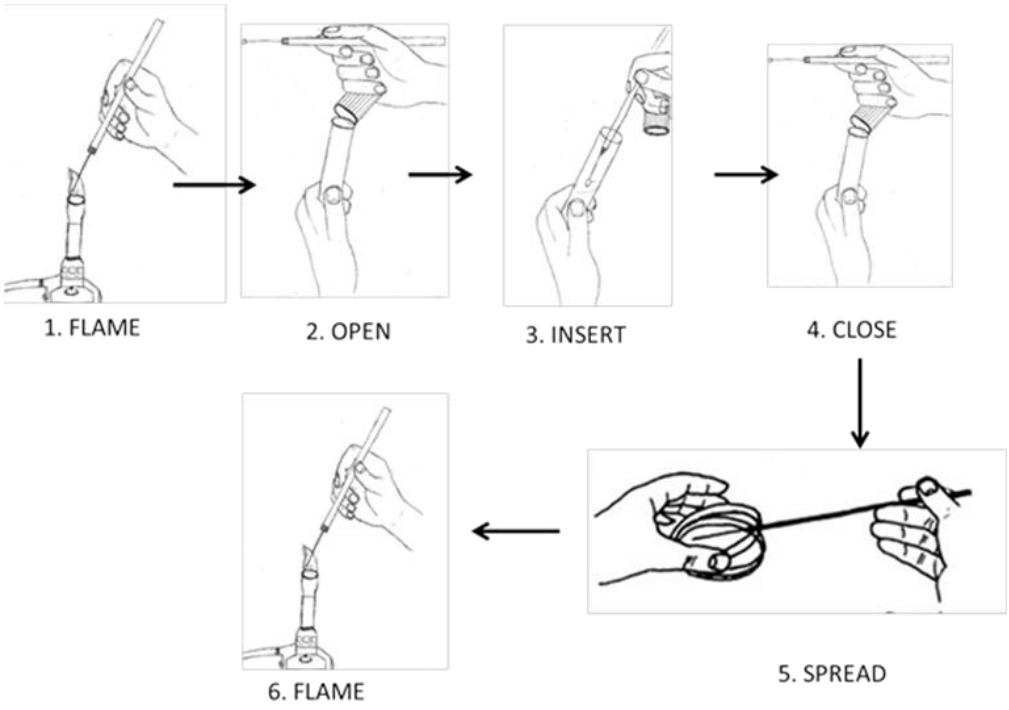
1. Chromosomes shorten, thicken and become visible. (doubled DNA)
2. Chromosomes line up at the equator.
3. Spindle fibres pull chromatids apart toward the poles.
4. New nuclear membranes form
5. Cytoplasm divides.

Most cells in the body have a ***diploid chromosome complement***. This means they have 2 matching ***sets*** of chromosomes. Mitosis is important to make sure new cells also have 2 complete matching sets of chromosomes.

Producing Cells by Cell Culture

Aseptic technique:

- A procedure or an experiment which is carried out under sterile conditions
- All apparatus must be sterilised prior to using- using either chemical or heat sterilisation (***autoclave***)
- The bench surface must be disinfected using a chemical treatment
- Hands should be washed thoroughly and hair kept away from the sample



Cell Culture Conditions:

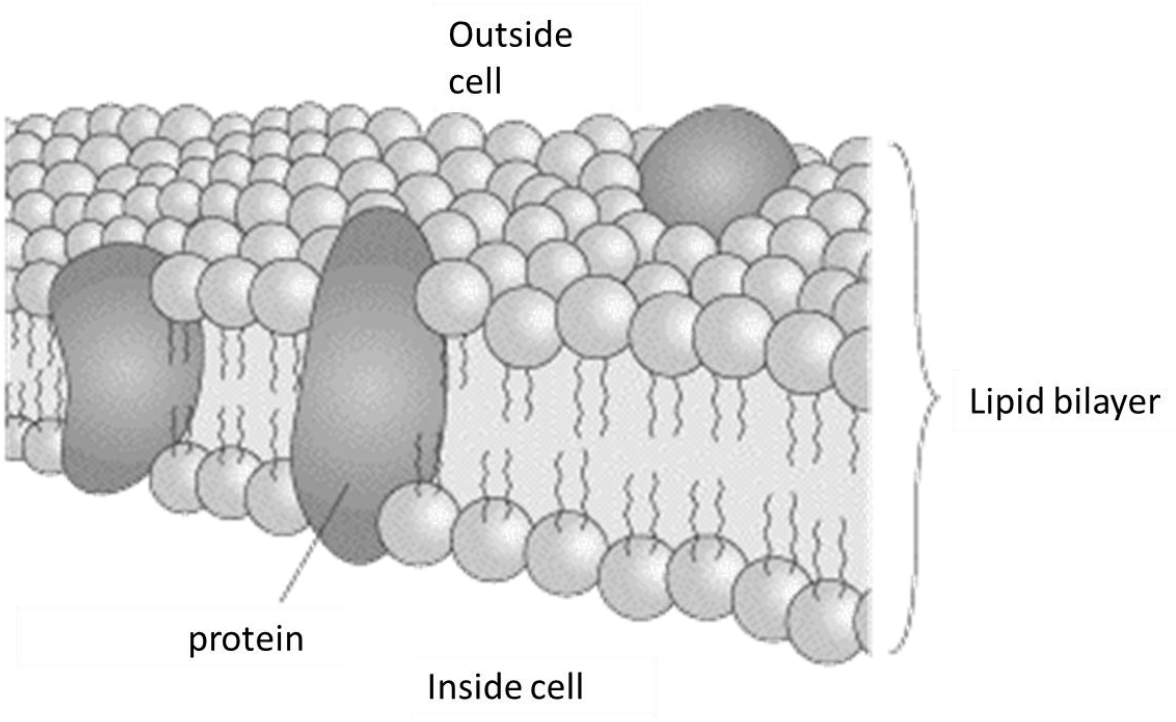
To grow cells in the laboratory you must provide the correct conditions:

- Suitable growth media containing all the nutrients required by the cell to grow e.g. amino acids, salts, water etc.
- Suitable temperature i.e. 30^{o}C (for bacteria) or 37^{o}C (for human cells)
- Source of oxygen
- Sterile conditions to prevent contamination with unwanted microorganisms

Transport across the cell membrane

The cell membrane

- The cell membrane is made of lipids and proteins and is selectively permeable



Passive transport does not require energy and moves molecules along a concentration gradient. There are 2 types of passive transport in cells:

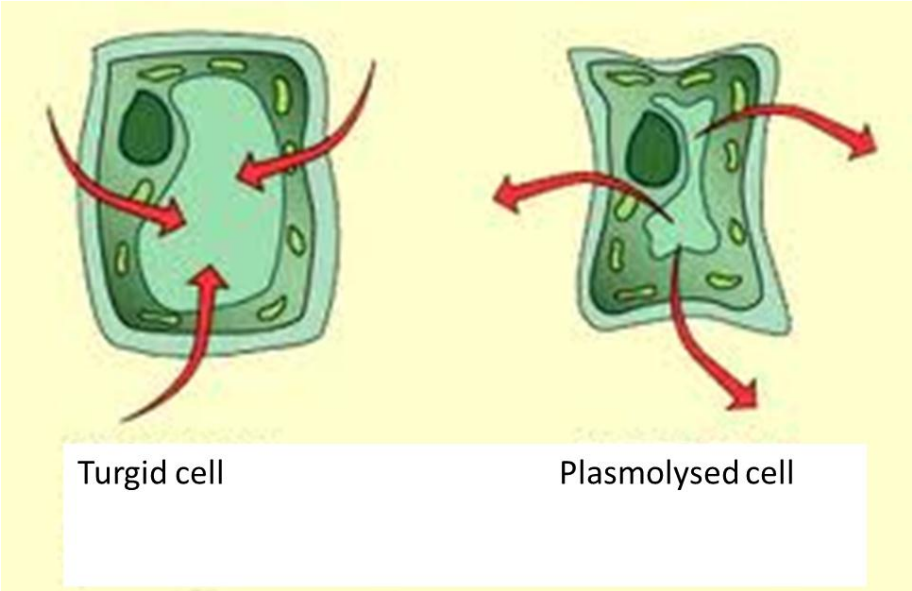
Diffusion

- the movement of substances from a ***high concentration*** to a ***low concentration*** down a ***concentration gradient***. Oxygen, carbon dioxide and glucose can travel by diffusion. Diffusion is important because cells can gain raw materials (eg glucose and oxygen) and remove waste products (eg CO_2).

Osmosis

- the movement of ***water*** molecules from an area of high water concentration to an area of lower water concentration ***through a selectively permeable membrane***. Plants receive water into their roots by osmosis.

A plant cell placed in pure water will swell and become ***turgid*** as it fills with water. A plant cell placed in a strong salt solution will lose water by osmosis and so become ***plasmolysed***.



An animal cell placed in pure water would gain water by osmosis and eventually burst, having no cell wall to prevent it. An animal cell placed in a strong salt solution will lose water by osmosis and shrivel up.

Active Transport

- a process that moves molecules ***against*** a concentration gradient and so requires energy in the form of ATP. Nerve cells carry out active transport to maintain high concentrations of different ions (eg sodium and potassium ions) inside the cell compared with outside the cell.

DNA and protein synthesis

- DNA is the code for making proteins.
- DNA is a large molecule contained inside the nucleus of a cell.
- Genes are made up of DNA.
- Each gene is a code for a different protein.
- DNA is a double stranded helix made up of four bases – A, T, G and C.
- A always pairs with T and C always pairs with G- these are ***complimentary base pairs***.
- Each triplet of DNA bases codes for 1 specific amino acid
- The sequence of DNA bases determines the amino acid sequence in the protein.

DNA is too large to move outside of the nucleus to carry the genetic code to a ribosome (for protein synthesis). So another type of molecule called messenger RNA is needed. (mRNA).

DNA	***RNA***
Double stranded	Single stranded
A pairs with T	A pairs with U

Messenger RNA copies the code of DNA inside a nucleus then carries this code out to a ***ribosome*** where the base sequence determines the amino sequence of the newly formed protein. Amino acids are held together by ***peptide bonds***.

The variety of protein shapes and functions depends on each individual sequence of amino acids.

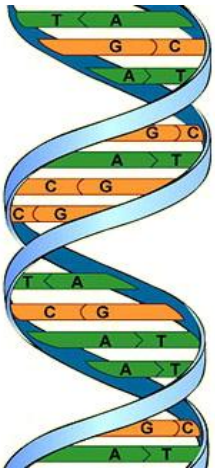
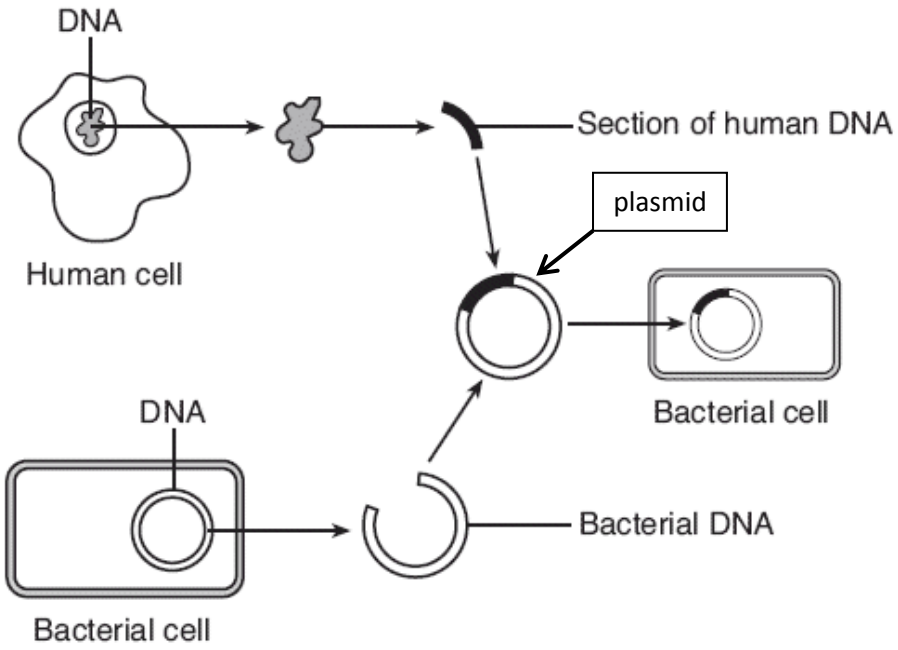


Figure 1: Double helix structure of DNA- held together by complimentary base pairs.

Type of Protein	Function
Enzyme	Speed up chemical reactions
Hormones	Chemical messengers which travel through the blood to their target organ
Antibodies	Produced by your immune system to fight disease (found in your blood)
Structural proteins	Like hair/skin/nails- protect various parts of the body

Genetic Engineering

Human genes can be inserted into a bacterial cell plasmid. This causes the bacterial cell to make the human protein. This process can be used to make ***insulin*** for treatment of diabetes.



1. Section of DNA containing required gene from human chromosome is identified.
2. This gene is extracted.
3. Plasmid is extracted from bacteria cell and human gene inserted into it.
4. Modified plasmid (containing human gene) is inserted back into bacterial cell.
5. Transformed bacterial cells are grown in fermenters and desired product i.e. insulin is produced.
6. Product i.e. insulin is purified before use as a treatment.

Self Assessment Check-list: What are the areas you know and understand well? Which sections do you need to revise again, in a different way? Are there any areas you need further help with to understand?

Key Area	Section				
1. Cell Structure	Structures and their functions				
2. Transport across the membrane	Structure of membrane				
	Diffusion				
	Osmosis				
	Active transport				
3. Producing New Cells	Purpose of mitosis				
	Stages of mitosis				
	Cell culture and aseptic technique				
4. DNA and the production of proteins	Structure of DNA				
	Role of mRNA in making protein				
5. Proteins and Enzymes	Variety and function of proteins				
	Properties of enzymes				
	Conditions that affect enzymes				
6. Genetic Engineering	Stages of genetic engineering				
7. Photosynthesis	Light Reactions				
	Carbon Fixation				
	Fates of glucose				
	Limiting Factors				
8. Respiration	Aerobic Respiration	Breakdown of glucose			
		Breakdown of pyruvate			
	Anaerobic Respiration				

Revision Strategies:

There are many ways to revise. You should try out various methods until you find a few that work for you. Some methods you can try are:

- Create mind maps/spider diagrams
- Create flow charts
- Write a glossary
- Create a buddy book for each topic
- Make flash cards of key words
- Get a friend to quiz you

Use the following space to write down revision strategies you've tried and found successful. You can also use it to set yourself targets for your revision. Remember not only to work HARD but also work SMART. Make sure what you are doing is working for YOU.