S3 Cell Biology – Summary Notes

Cells

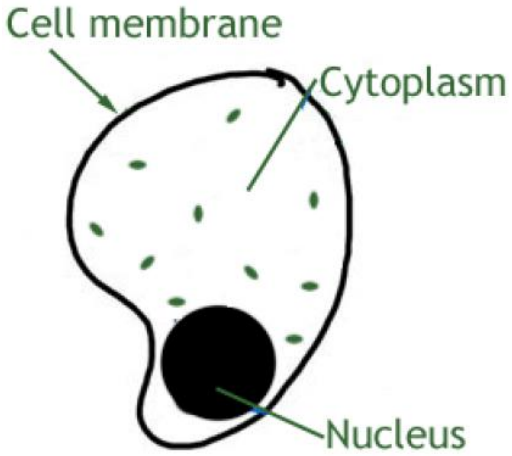
All living things are made up of cells.

They are the basic building blocks of life – some organisms are made of only one and others, like humans, are made of trillions.

Different types of cells contain different things.

Animal Cells

There are three main structures in an animal cell.



The nucleus – this controls all the cell's activities

The cell membrane – this controls what substances enter and exit the cell

The cytoplasm – the site of all the chemical reactions in a cell

Plant Cells

Plant cells are very important for life on earth!

Like animal cells, they are tiny and must be viewed under a microscope.

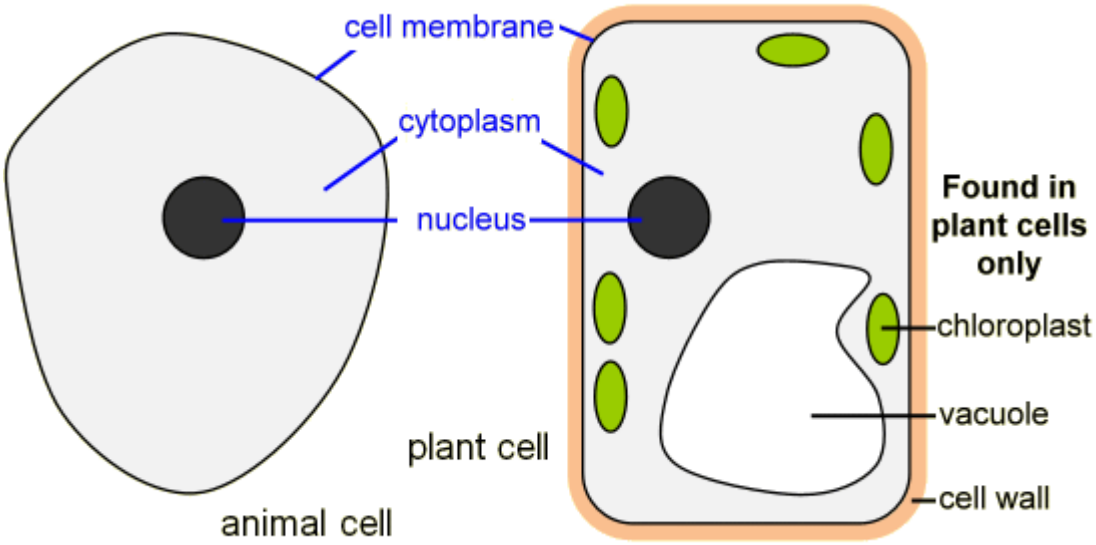
There are some similarities and some differences between animal and plant cells.

Like animal cells, plant cells contain a nucleus, cytoplasm and a cell membrane.

They have 3 additional structures:

- Cell wall
- Chloroplasts
- Vacuole

These all have a specific function that is vital for the survival of the plant.



The cell wall supports and strengthens the cell, giving it a rigid shape.

The cell wall is made of a special sugar called cellulose which humans cannot digest!

Chloroplasts are disc shaped structures found in the cytoplasm.

Chloroplasts contain a green pigment that traps light for photosynthesis.

The vacuole is a compartment in plant cells containing cell sap (water, salts, sugar).

The vacuole helps maintain water balance and pressure inside the cell.

Calculating Cell Size

Cells are too small to be measured in millimetres (mm).

Instead we measure them in micrometres (µm).

1mm = 1000 µm
To convert mm into µm x1000
1µm = 1/1000mm
To convert µm into mm ÷1000

How to calculate average cell size

1. Count how many cells you can see going from one side to another
2. Divide the diameter of the field of view by the number of cells

Specialised Cells

Not all plant and animal cells are the same size!

Cells all share the structures we have looked at, but sometimes they don't look anything like each other!

Unicellular organisms are only made of one cell. That cell must do all the jobs needed to keep itself alive.

In multicellular organisms, most cells have a specific job they do.

This means they are often a particular shape or contain particular structures, which enables them to carry out that job.

You should look in your jotter for examples of specialised cells (e.g. red blood cell, sperm, nerve cell, chloroplast and muscle)

Cell Division

All cells are produced from other cells by the process of cell division.

This is when one cell splits into two new cells that are identical to the original.

Plants and animals need new cells for:

- Growth
- Repair
- Continuous replacement of dead or damaged cells e.g. skin cells.

Unicellular organisms use cell division as a form of reproduction.

Stages of Cell Division

1. The genetic information of the cell copies itself
2. Each copy is pulled to opposite sides of the cell
3. A new nucleus forms around the copies at each side
4. The cytoplasm of the cell splits in half and the 2 new daughter cells form

Cancer and Cell Division

Cancer happens when DNA inside a cell becomes damaged

This causes uncontrolled cell division.

The cells grow into a lump called a tumour

Some cells can break off and move through the blood, allowing the cancer to spread.

Cancer risk factors include:

- Smoking
- Diet
- Body weight
- Sun Exposure
- Alcohol consumption
- Genes
- Lifestyle
- Age

DNA

Chromosomes are found in the nucleus of the cell

These are **very long molecules of tightly coiled DNA.**

Humans have 46 chromosomes (23 matching pairs). One pair comes from your mum and one pair comes from your dad.

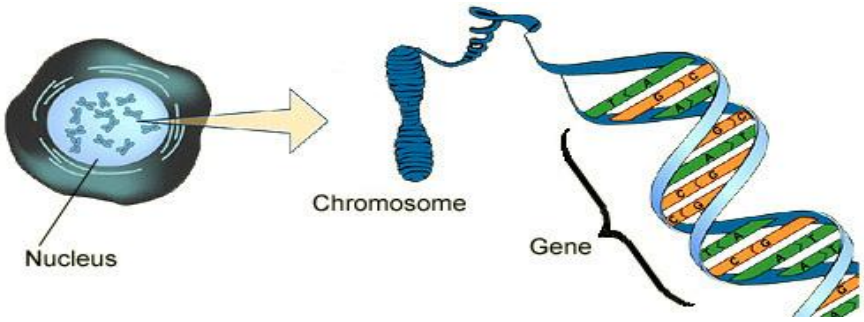
DNA stands for Deoxyribonucleic Acid

It is a special molecule that carries all of our genetic information.

This a small section of DNA that are found on a chromosome

There are lots of genes on a single chromosome.

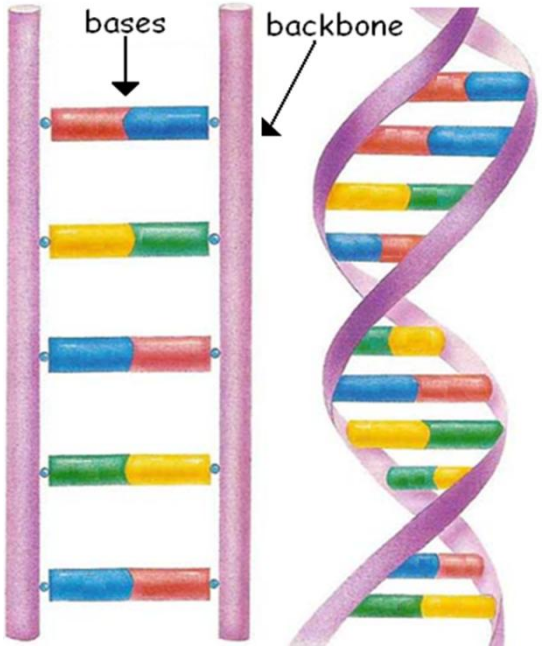
A gene carries the instructions to make a protein.



DNA structure

DNA is made up of two parts, a backbone and bases.

It contains two strands which wind around each other, and we call this shape a ‘double helix’.



DNA bases

There are 4 different DNA bases – A, T, C and G.

A always pairs with T and G always pairs with C

DNA profiling

DNA profiling is used in solving crimes, in paternity cases and to assess health risks.

This is only possible as everyone has unique DNA, unless you have an identical twin.

The UK has something called the ‘National DNA database’ where suspects’ DNA samples are stored, even if that person is then found innocent.

Inheritance

We have two copies of every gene.

One copy comes from our mother the other comes from our father.

Alleles are different forms of the same gene (e.g. blue and brown for the eye colour gene).

Alleles

Some alleles are **dominant** – you only need one copy in the genotype for it to show in the organism's appearance (phenotype).

Some alleles are **recessive** – you need two copies in the genotype for it to show in the organism's appearance (phenotype).

Inherited Disorders

These are genetic disorders that people are born with

Examples include cystic fibrosis and Huntington 's disease

Gene Therapy

Gene therapy is an experimental technique that uses genes to treat or prevent disease.

It is a promising treatment option for a number of diseases including inherited disorders, some types of cancer, and certain viral infections.

The technique remains risky and is still under study to make sure that it will be safe and effective. Gene therapy is currently only being tested for the treatment of diseases that have no other cures.

There are several different approaches to gene therapy

- Replacing a faulty gene that causes disease with a healthy copy of the gene.
- Deactivating a faulty gene.
- Introducing a new gene into the body to help fight a disease
- The new gene is delivered into the cell using a **vector** (this is usually a virus that can infect the cell).

Enzymes

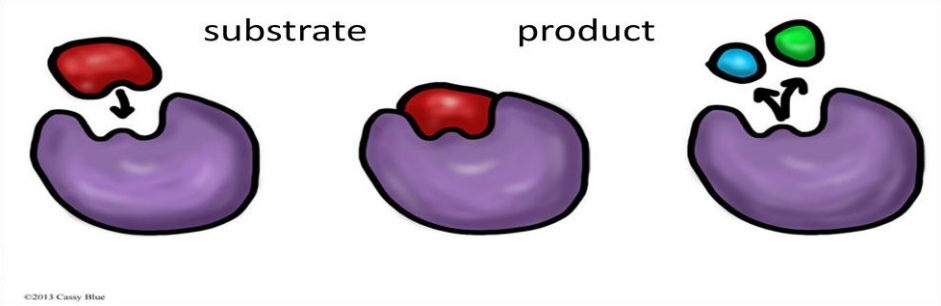
Enzymes are found in ALL living cells.

They are made of protein.

They speed up chemical reactions and because of this we call them **biological catalysts**.

The substance an enzyme works on is called the **SUBSTRATE**.

The substance an enzyme makes is called the **PRODUCT**.



Rennet is an enzyme used when making cheese.

It works on milk, speeding up the clotting process (making lumps) and produces curds and whey.

Enzymes can either break down substrates into smaller molecules or build them up into bigger ones.

Enzymes are **specific**, as one enzyme can only speed up one reaction.

Enzymes are not changed by the reactions they speed up, meaning they can be used over and over again in cells.

Microorganisms

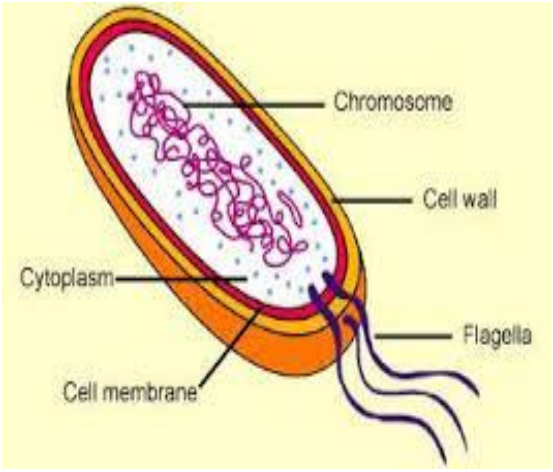
These are tiny living organisms that can only be seen using a microscope.

The two most common types of microorganisms used in industry are bacteria and fungi.

Structure of a Bacterial Cell

Unlike other cells, bacteria do not have a nucleus.

Instead they have one large loop of DNA.



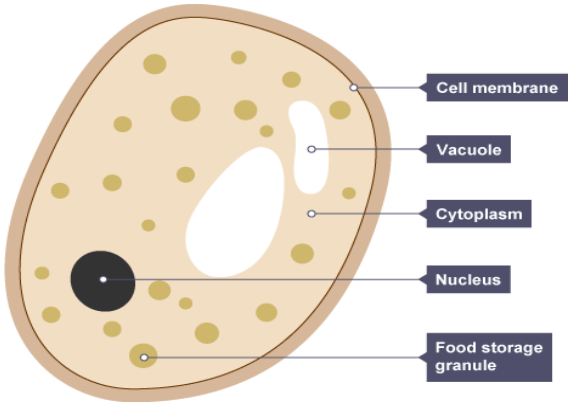
In industry, bacteria are used to turn milk into yoghurt and cheese.

Bacteria convert the sugar in the milk (**lactose**) to **lactic acid**. This clots (thickens) the milk.

Fungal cells

Fungal cells do have a nucleus.

They also contain a vacuole for storing water.



Microorganisms in Industry

Microorganisms have many properties which make them a good choice for use in industry:

1. Rapid growth
2. Diverse use of food sources
3. Wide range of products produced
4. Microorganisms are used to produce bread, beer, wine, yoghurt and cheese.

They can also be used to make fuel (biofuel)

Yeast

Yeast are single-celled fungus that are used in the baking and brewing industries.

Yeast break down sugar to produce carbon dioxide gas and ethanol (alcohol) in a process called **fermentation**.

Fermentation word equation:

Yeast is used to make bread, wine and beer!

Photosynthesis

Animals have to **EAT** food to gain energy

When you trace any food back to the start, there is always a green plant.

Plants get their energy from sunlight!

They use this energy to build a small sugar called glucose, and store this as a larger sugar called starch.

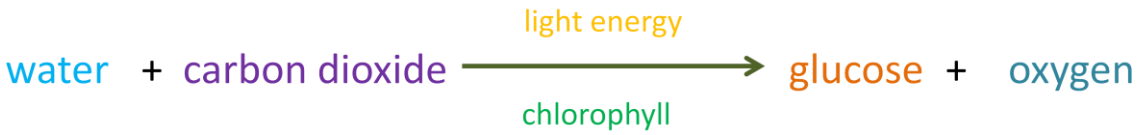
This process is called photosynthesis.

Plants take in water through their roots and carbon dioxide from the air.

They trap light energy from the sun using a green pigment called chlorophyll found in chloroplasts.

The plant makes glucose (sugar) and oxygen gas is released as a by-product.

Photosynthesis Word Equation



Limiting Factors in Photosynthesis

Three factors can limit the speed of photosynthesis:

- Light intensity
- Carbon dioxide concentration
- Temperature

When any of these factors are limiting, the cell makes less glucose than it would under **optimum** conditions.

Respiration

The process used by cells to release the chemical energy stored in food.

The chemical energy in food can be measured by burning the food, which releases the energy as heat

Chemical energy ⟶ Heat energy

The energy that had been stored in the food was released and was used to heat up the water.

In living cells the energy is released in a much more controlled way, called **respiration**.

Aerobic Respiration (WITH OXYGEN)

In your body the food you eat is broken down into a tiny sugar called glucose.

The cells of your body use **oxygen** to break down the glucose and get energy via **aerobic respiration**.

Water and carbon dioxide are formed in this process and released from the cell.