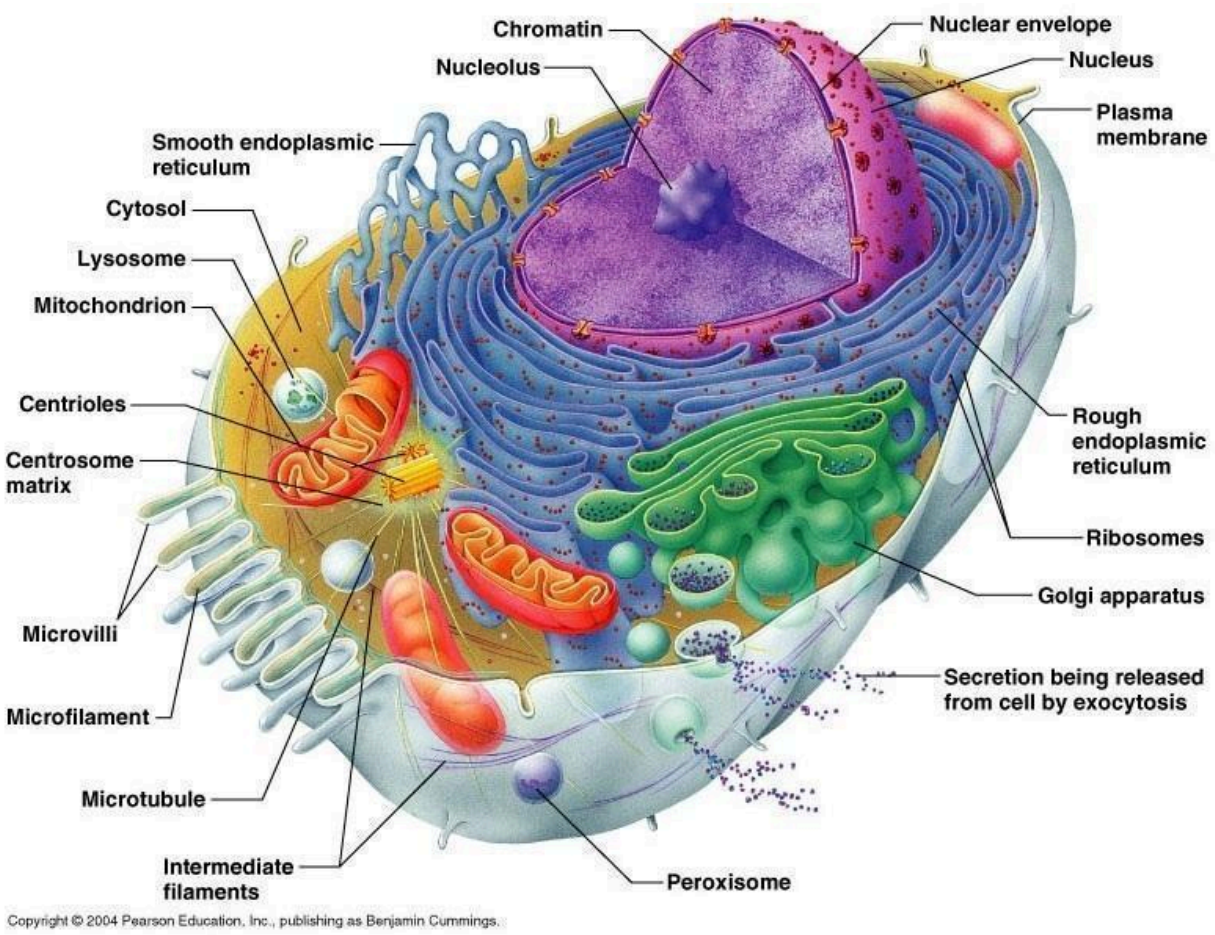
CAIE Biology A-level

Topic 1: Cell Structure

Notes

All living organisms are made of cells. Cells use ATP from respiration for energy-requiring processes. There are several different types of cells, some of them sharing some common features. Humans are made up of **eukaryotic cells**. All eukaryotic cells contain a nucleus and membrane-bound organelles. A more detailed structure of cells called the **ultrastructure** can be obtained by using a microscope.

Ultrastructure of eukaryotic cells:



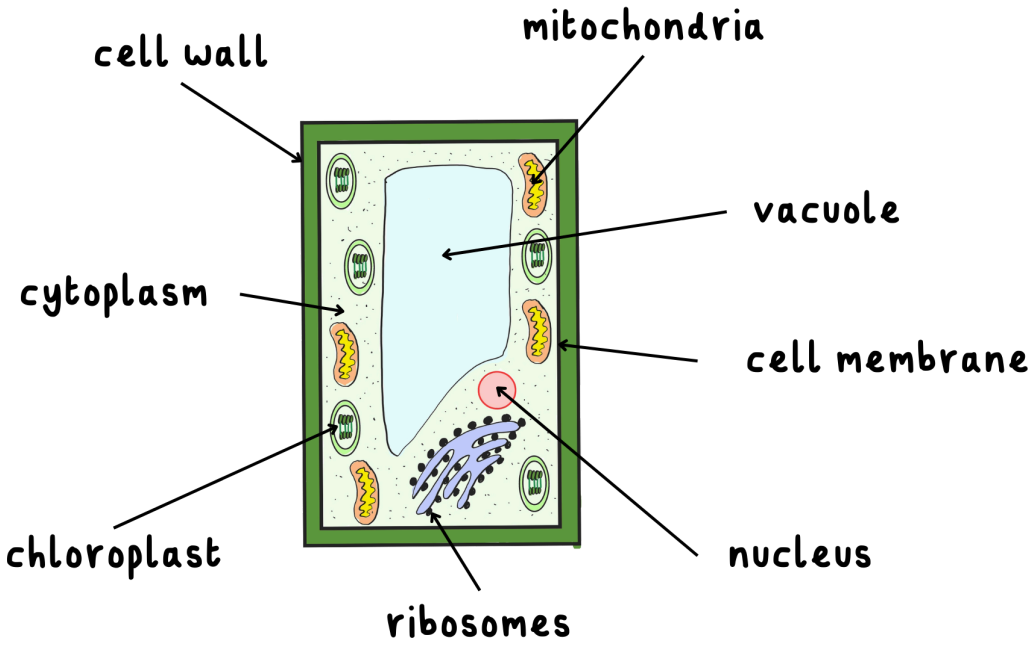
The following are organelles that may be found in animals and plant cells:

Organelles	Properties and function of organelles
Nucleus	- Surrounded by a **double membrane called the nuclear envelope** containing **pores** which enable molecules to enter and leave the nucleus. - The nucleus contains **chromatin** and a **nucleolus** which is the site of ribosome production.
Rough endoplasmic reticulum	- A **series of flattened sacs** enclosed by a membrane with ribosomes on the surface. - RER **folds and processes proteins** made on the ribosomes.
Smooth endoplasmic reticulum	- A system of **membrane-bound sacs**. - SER **synthesises and processes lipids.**
Golgi apparatus	- A series of **fluid-filled, flattened and curved sacs** with vesicles surrounding the edges. - The Golgi apparatus **processes and packages proteins and lipids**. It also **produces lysosomes**.
Mitochondria	- Usually **oval-shaped, bound by a double membrane called the envelope**. - The inner membrane is folded to form projections called **cristae,** with a matrix on the inside containing all the enzymes needed for **respiration.** - Mitochondria within eukaryotic cells contain **small circular DNA and 70S ribosomes.**
Centrioles	- **Hollow cylinders** containing a ring of **microtubules** arranged at right angles to each other. - Centrioles are involved in **cell division** and are absent from most plant cells.
Ribosomes	- **composed of two subunits** and are **the site of protein synthesis**
Lysosome	- a vesicle containing **digestive enzymes** bound by a **single membrane**
Cell surface membrane	- surrounds the cell and **controls the movement of substances into and out of the cell.**

Cilia (Animal cells only)	- Some animal cells may contain **cilia** on their surface membrane. - These are **small hair-like structures** composed of **microtubules** in a **'9+2' formation**. - This allows the cilia to move, enabling the **movement of substances along the surface of the cell.**
Microvilli (Animal cells only)	- **finger-like projections of the cell membrane** which increase the cell's surface area. - They line organs like the small intestine to maximise nutrient absorption.

The following organelles are only present in plant cells:

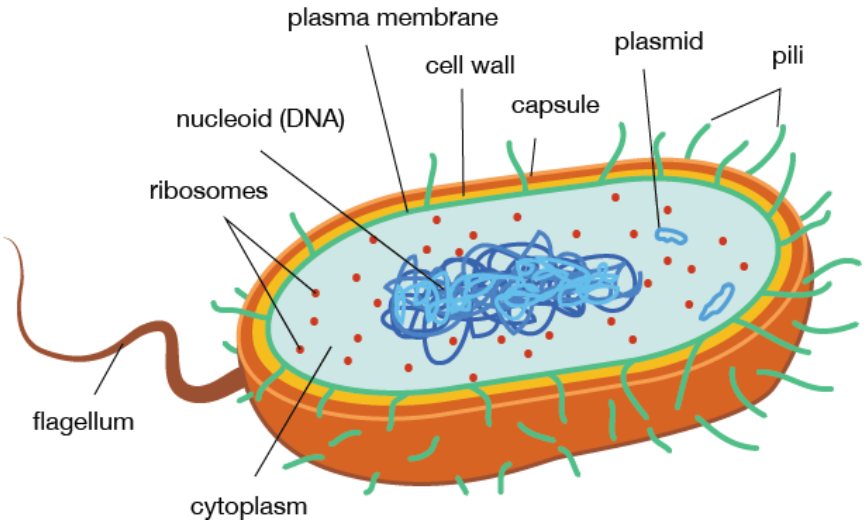
Organelles	Properties and function of organelles
Vacuole	- A fluid-filled sac present in plant cells, surrounded by a membrane called the **tonoplast**. - It contains mineral salts, sugars, amino acids, waste substances and pigments. - Its role is to colour the cell to **attract pollinating insects**, act as a **temporary food store** and **provide support through turgidity**.
Cell wall	- Made of **cellulose microfibrils**. - Its role is to **strengthen** the cell and **prevent bursting** due to osmosis.
Chloroplasts	- **Small flat organelles** which are surrounded by a **double membrane**. - It contains **thylakoid membranes** which are **stacked up to form grana** and are linked together by **lamellae**. - Chloroplasts are the **site of photosynthesis.** - Chloroplasts within eukaryotic cells contain **small circular DNA and 70S ribosomes.**
Plasmodesmata	- Small channels that pass through the cell wall of adjoining plant cells to **allow communication** between cells.



Prokaryotic cells such as bacteria contain:

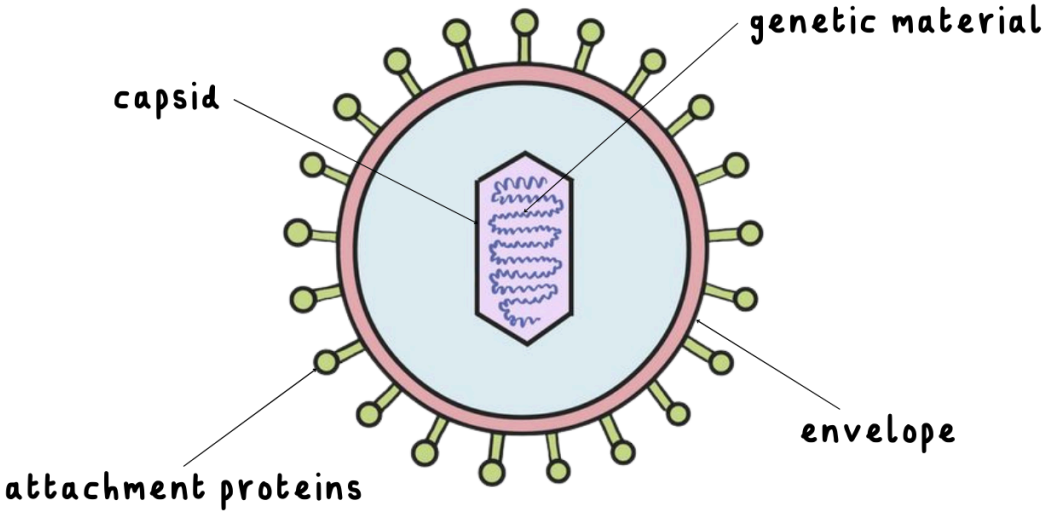
Organelles	Properties and function of organelles
Cell wall	Rigid outer covering made of **peptidoglycan**
Capsule	Protective slimy layer which helps the cell to **retain moisture** and **adhere** to surfaces
Plasmid	Circular piece of DNA
Flagellum	A tail like structure which **rotates to move the cell**
Pili	Hair-like structures which attach to other bacterial cells
Ribosomes	Site of **protein production**

Prokaryotic cells are **unicellular** and are typically **1–5µm in diameter**, which is much smaller than eukaryotic cells. They **do not contain membrane-bound organelles** (such as a nucleus, mitochondria, or chloroplasts), and their **ribosomes are smaller (70S)** than ribosomes in the cytoplasm of eukaryotic cells (80S).



Viruses:

Viruses are **non-living** structures which consist of **nucleic acid** (either DNA or RNA) enclosed in a protective protein coat called the **capsid,** sometimes covered with a phospholipid layer called **the envelope** derived from the host cell membrane.



Differences between prokaryotic and eukaryotic cells:

Prokaryotic cells	Eukaryotic cells
Circular DNA	**Linear** DNA
No nucleus so DNA is **freely floating in the cytoplasm**	Contains a **nucleus** so **DNA is inside it**
Peptidoglycan cell wall	**No** cell wall (**animals**) **Cellulose** cell wall (**plants**) **Chitin** cell wall (**fungi**)
Doesn't contain **membrane-bound organelles**	**Many membrane-bound organelles**
Smaller ribosomes **(70S)**	**Larger** ribosomes **(80S)**

Microscopy

Microscopy is the most important technique used in biology as it enables us to see and examine organisms and structures which cannot be seen with the naked eye. **Magnification** is how much larger the image is than the actual object whereas **resolution** is the ability to distinguish two separate points as distinct. **Magnification can be calculated by dividing the size of the image by the size of the real object.**

Sample preparation

Fixation - use chemicals to preserve cell structures in as close to their natural state as possible

Dehydration - use ethanol to remove water from the specimen

Staining - use stains to colour the specimen. Different types of tissue will pick up different stains which help create a contrast and allow you to differentiate between different organelles.

Mounting - mount onto a microscope slide making sure there is a coverslip placed on top.

There are two types of microscopes:

- **Light microscopes**- these are good for observing samples in a lab as they are **cheap** and **portable**. They have a **lower magnification and resolution** than electron microscopes, however.
- **Electron microscopes**- these are **good for examining organelles in high detail**. They have a **high magnification and resolution**, but samples must be placed in a **vacuum** and prepared first. This technique can be very **expensive**.

Rules for scientific drawings

- Ensure you are using a **sharp pencil**
- Draw **continuous lines**
- Use **plain white paper**
- Make sure the drawing takes up **as much of the paper as possible**
- **No shading**
- Label lines **shouldn't cross over** each other
- Label lines should be **straight** and drawn with a **ruler**
- Label lines should **not have arrow heads**
- Include a **title** for the drawing
- State the **magnification**