SL IB Biology

Your notes

Organelles & Compartmentalisation

Contents

Cell Organelles

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Cell Organelles

Compartmentalised cell structure

- Eukaryotic cells have a more **complex ultrastructure** than prokaryotic cells
- The cytoplasm of eukaryotic cells is divided up into **membrane-bound** compartments called **organelles**. These compartments are either bound by a **single** or **double membrane**
- Due to the absence of a membrane the following structures are **not considered organelles**
  - Cell wall
  - Cytoskeleton
  - Cytoplasm
- Eukaryotic cells have a number of **compartmentalised organelles** including:
  - The nucleus
  - Vesicles
  - Ribosomes
  - The plasma membrane
- The **compartmentalisation** of the cell is **advantageous** as it allows:
  - Enzymes and substrates to be localised and therefore available at higher concentrations
  - Damaging substances to be kept separated, e.g. digestive enzymes are stored in lysosomes so they do not digest the cell
  - Optimal conditions to be maintained for certain processes e.g. optimal pH for digestive enzymes
  - The numbers and location of organelles to be altered depending on requirements of the cell

Eukaryotic Animal Cell Structure Diagram

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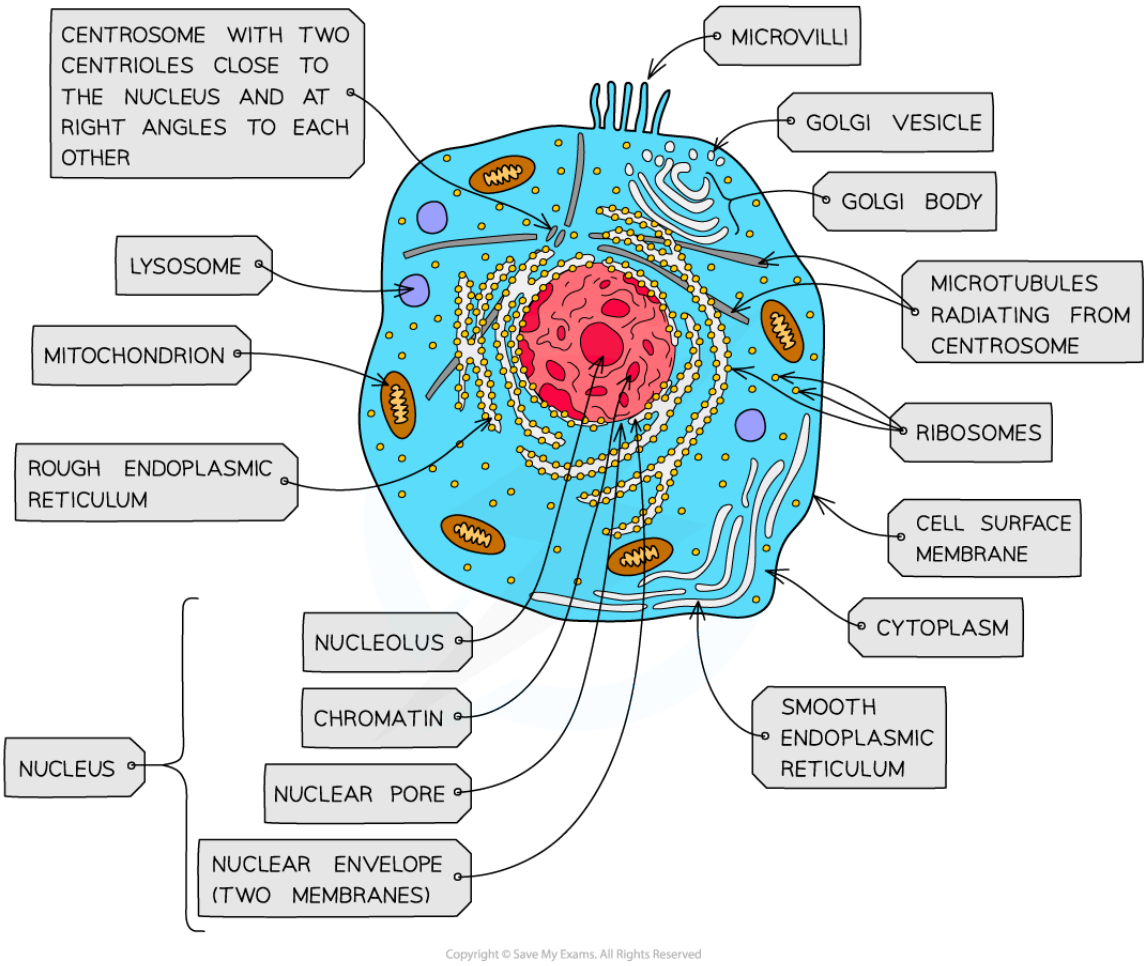

The ultrastructure of an animal cell shows a densely packed cell of compartmentalised organelles

Eukaryotic Plant Cell Structure Diagram

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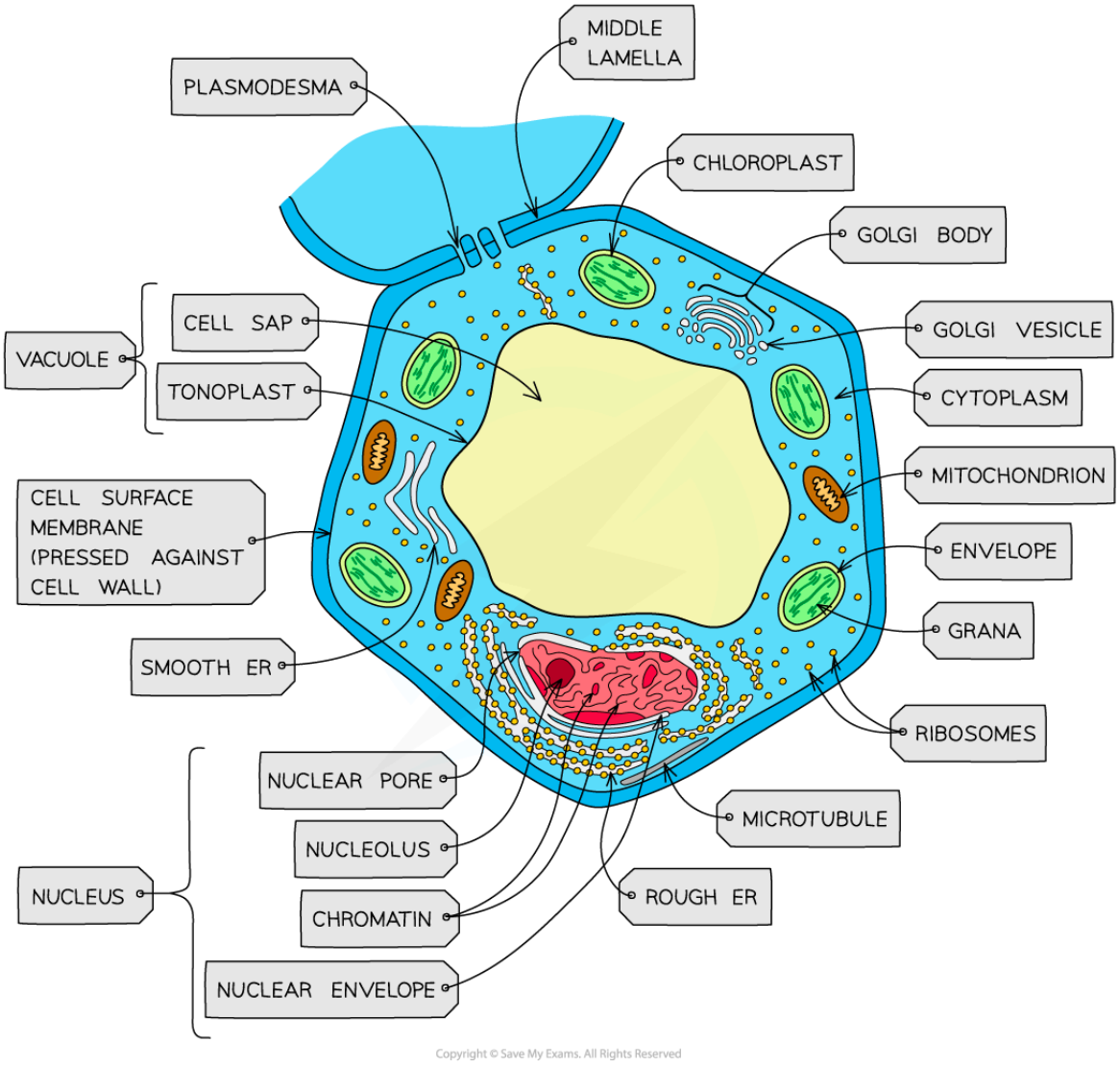


Plant cells have a larger, more regular structure in comparison to animal cells which also contains compartmentalised organelles

Organelle Adaptations

- In complex cells **organelles** can become **specialised** for **specific functions**
- These specialised organelles have **specific adaptations** to help them carry out their functions
- For example, the **structure of a organelle** is adapted to help it carry out its **function** (this is why each organelle looks very **different** from each other)
- The separation of organelles from the rest of the cell, via a membrane (sometimes double), is important as it allows the organelle to carry out its own chemical reactions without interference from the rest of the cell

NOS: Students should recognise that progress in science often follows development of new techniques


Your notes

- Study of the function of individual organelles has become possible following the invention of **ultracentrifuges** and methods of using them for **cell fractionation** had been developed
  - In order to study cells at a molecular level we need to be able to separate out each compartment and study them individually in a process called cell fractionation
  - To do this a **pure sample** is needed (containing only the specific organelle being studied)
  - This process involves **breaking up** a suitable sample of tissue and then **centrifuging** the mixture at **different speeds**
  - Cell fractionation can be split into three stages:
    - **Homogenisation** - the cell sample is broken up using a **homogeniser** which is a blender-like machine
    - **Filtration –** the homogenate (containing the homogenised cells) is then filtered through a gauze
    - **Ultracentrifugation –** the filtrate is placed into a tube and the tube is placed in a **centrifuge**
      - A centrifuge is a machine that separates materials by **spinning**
      - This speed can be altered to separate different components of the cell based on their molecular weight
      - Until this was invented, research into separate organelles was limited

Cell Compartmentalisation


Your notes

Separating The Nucleus & Cytoplasm

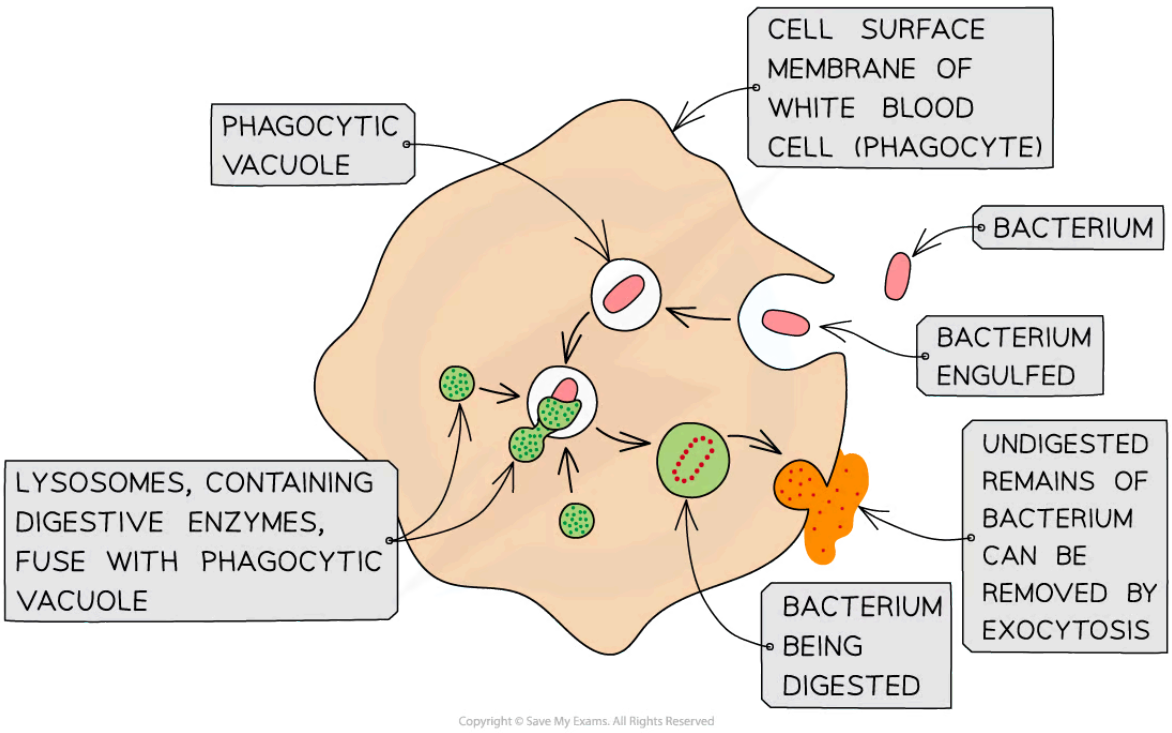
- The **nucleus** is one of the key organelles that distinguishes eukaryotic cells from prokaryotic cells
- It allows many cell processes to take place more efficiently than in prokaryotes
  - Gene transcription and translation are two process that occur in both eukaryotes and prokaryotes
  - In **prokaryotes** these processes take place **simultaneously** which allows for rapid responses to an environmental stimuli
  - In **eukaryotes** these processes occur **separately** due to the **compartmentalisation of the nucleus**
    - During transcription, mRNA is formed using a template strand of DNA; the mRNA needs some modification before it can be used for translation
    - **Modification** can take place in isolation within the nucleus before it comes into contact with a ribosome (this is where translation occurs) unlike in prokaryotes where the mRNA immediately meets a ribosome
    - This step **reduces the chance of errors occurring in the mRNA code** and therefore in the resulting protein following translation

Compartmentalisation In The Cytoplasm

Your notes

- The **cytoplasm** is not considered an organelle, but it's **separation from organelles** via their membranes is an advantage for the cell
- Organisation of the eukaryotic cell into discrete membrane-bound organelles allows for the **separation of incompatible biochemical processes**
- This ensures that pathways requiring specific **enzymes or metabolites** run smoothly and are not at risk from interference from other cell structures or chemicals
  - Such reactions can coexist within one organelle by **localising conflicting reactions**, for example in plant cells a type of enzyme called nitrogenase (used for nitrogen fixation) is particularly sensitive to oxygen so it is positioned in an anaerobic part of the cytoplasm away from aerobic reactions
  - Lysosomes require lytic enzymes which could be harmful to the cell if they were not contained by the lysosome membrane
  - During endocytosis a **phagocytic vacuole** forms around potentially toxic and harmful substances, such as bacteria; this keeps the contents separate from the cytoplasm and rest of the cell until a lysosome can safely digest the material

Endocytosis and Phagocytosis Diagram



The formation of a phagocytic vacuole ensures harmful substances, such as bacteria, are kept separate from the cytoplasm and the rest of the cell