11-14 Cells – Key Words

Bringing medicines to *life*

Organismos → Sistemas → Órganos → Tecidos → Células

Organización

Ósmose

Difusión — **Transporte** — Células — **Organismos unicelulares** — Protozoa

Bacteria

Transporte activo

Orgánulos

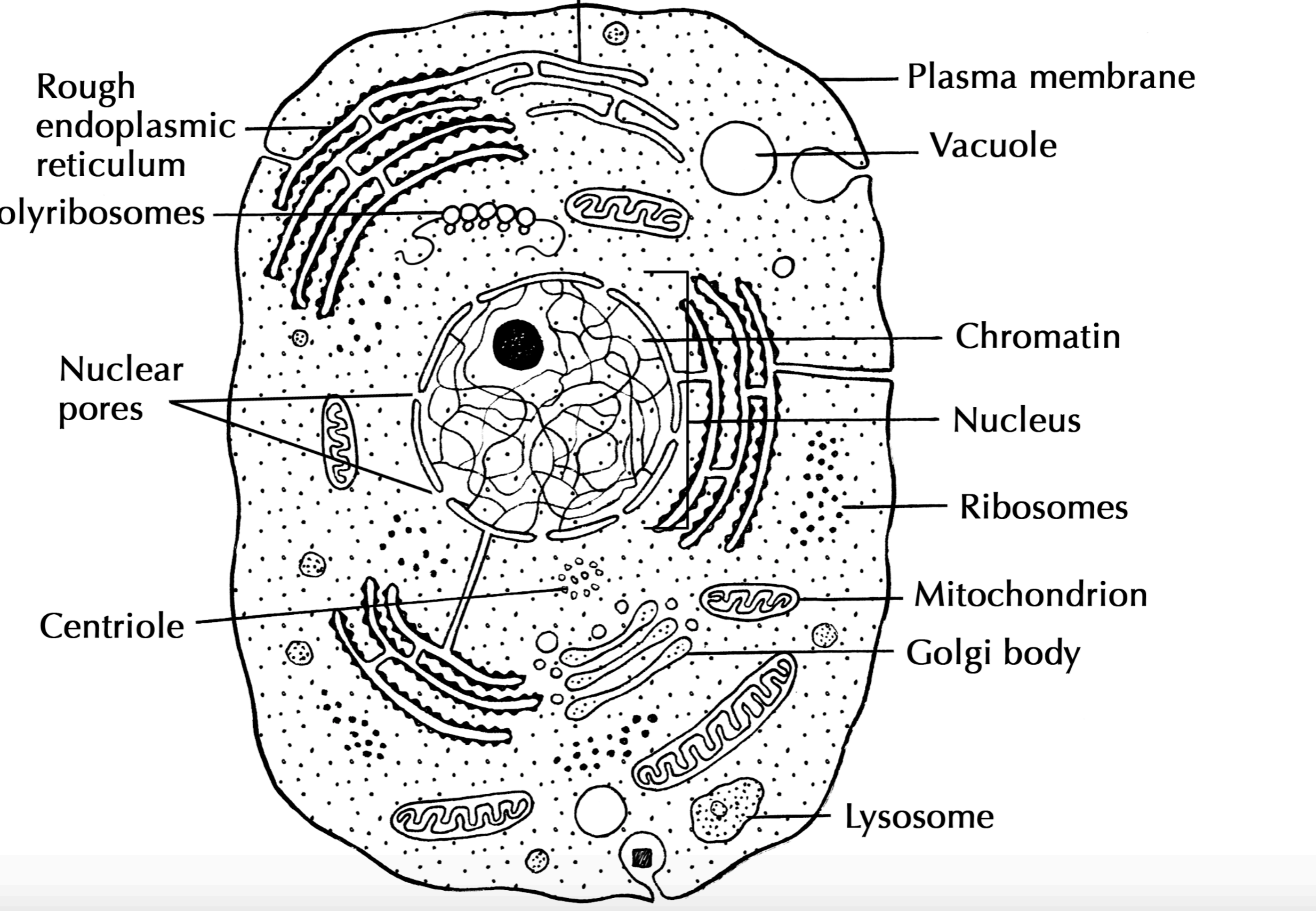
Lévedos

Célula Animal e de Plantas

Células de plantas

Membrana celular
Citoplasma
Mitocondria
Núcleo

Parede celular
Cloroplastos
Vacúolo


Rough endoplasmic reticulum
olyribosomes
Nuclear pores
Centriole
Plasma membrane
Vacuole
Chromatin
Nucleus
Ribosomes
Mitochondrion
Golgi body
Lysosome

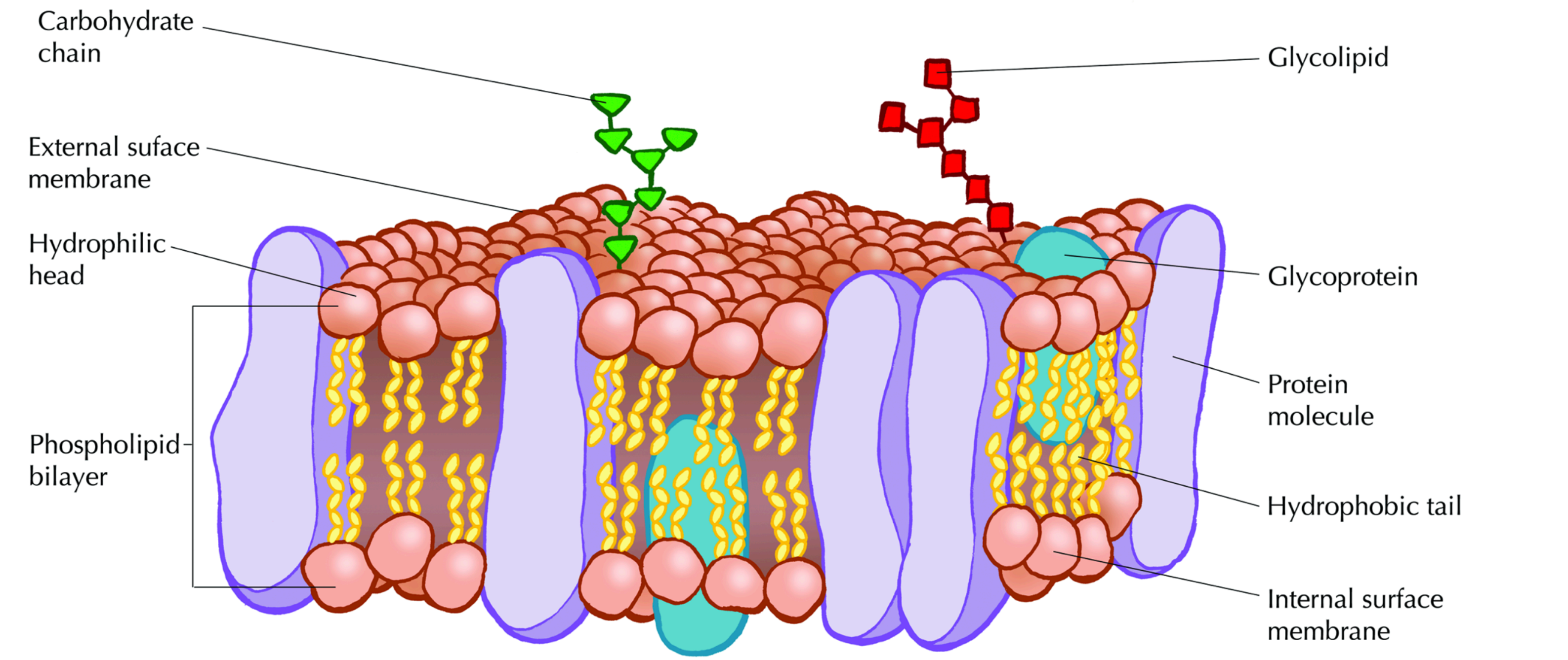
Component (see Figure 2.12)	Structure	Function
Phospholipid bilayer	Consists of two layers of phospholipids. Each phospholipid has a polar, hydrophilic (water-soluble) head as well as a non-polar, hydrophobic (water-insoluble) tail.	It is a semi-permeable structure that does not allow materials to pass through the membrane freely, thus protecting the intra and extracellular environments of the cell.
Membrane proteins	These are proteins found spanning the membrane from the inside of the cell (in the cytoplasm) to the outside of the cell. Membrane proteins have hydrophilic and hydrophobic regions that allow them to fit into the cell membrane.	Act as carrier proteins which control the movement of specific ions and molecules across the cell membrane.
Glycoproteins	Consist of short carbohydrate chains attached to polypeptide chains and are found on the extracellular regions of the membrane.	These proteins are useful for cell-to-cell recognition.
Glycolipids	Carbohydrate chains attached to phospholipids on the outside surface of the membrane.	Act as recognition sites for specific chemicals and are important in cell-to-cell attachment to form tissues.

Table 2.2: Structure and function of components of the cell membrane.

Figure 2.15: The effect of hypertonic, isotonic and hypotonic solutions on red blood cells.

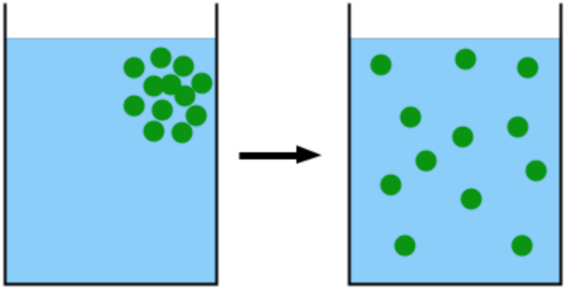
Hypertonic (concentrated)	**Isotonic**	**Hypotonic** (dilute)
The medium is concentrated with a lower water potential than inside the cell, therefore the cell will lose water by osmosis.	The water concentration inside and outside the cell is equal and there will be no nett water movement across the cell membrane. (Water will continue to move across the membrane, but water will enter and leave the cell at the same rate.)	The medium has a higher water potential (more dilute) than the cell and water will move into the cell via osmosis, and could eventuality cause the cell to burst.

Plant cells use osmosis to absorb water from the soil and transport it to the leaves. Osmosis in the kidneys keeps the water and salt levels in the body and blood at the correct levels.


Carbohydrate chain
Glycolipid
External suface membrane
Hydrophilic head
Glycoprotein
Protein molecule
Phospholipid bilayer
Hydrophobic tail
Internal surface membrane

1. Diffusion

Diffusion is the movement of substances from a region of high concentration to low concentration. It is therefore said to occur **down a concentration gradient**. The diagram below shows the movement of dissolved particles within a liquid until eventually becoming randomly distributed.



***Diffusion** is the movement of molecules from a region of higher concentration to a lower concentration. It is a passive process (i.e. does not require input of energy).*

Diffusion is a **passive process** which means it does not require any energy input. It can occur across a living or non-living membrane and can occur in a liquid or gas medium. Due to the fact that diffusion occurs across a concentration gradient it can result in the movement of substances into or out of the cell. Examples of substances moved by diffusion include carbon dioxide, oxygen, water and other small molecules that are able to dissolve within the lipid bilayer.

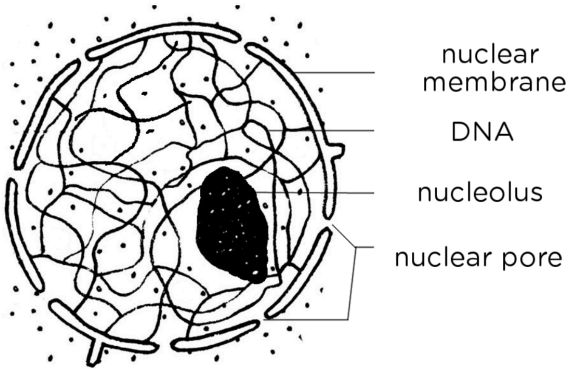
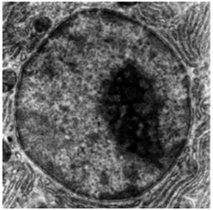
<table>
<tr><th>Schematic Diagram</th><th>Micrograph</th></tr>
<tr><td>

Figure 2.19: Diagram showing the basic structures of the animal cell nucleus.</td><td>
Figure 2.20: An electron micrograph of a cell nucleus showing a densely staining nucleolus.</td></tr>
</table>

DID YOU KNOW?

Mitochondria also contain DNA, called mitochondrial DNA, (mtDNA) but it makes up just a small percentage of the cell's overall DNA content. All mitochondrial DNA in humans is derived from the mother's side.

Functions of the nucleus

- The main function of the cell nucleus is to control gene expression and facilitate the replication of DNA during the cell cycle (which you will learn about in the next chapter).

2. Osmosis

When the concentration of solutes in solution is low, the water concentration is high, and we say there is a **high water potential**. Osmosis is the movement of water from a region of higher water potential to a region of lower water potential across a semi-permeable membrane that separates the two regions. Movement of water always occurs down a concentration gradient, i.e from higher water potential (dilute solution) to lower potential (concentrated solution). Osmosis is a passive process and does not require any input of energy. Cell membranes allow molecules of water to pass through, but they do not allow molecules of most dissolved substances, e.g. salt and sugar, to pass through. As water enters the cell via osmosis, it creates a pressure known as *osmotic pressure.*

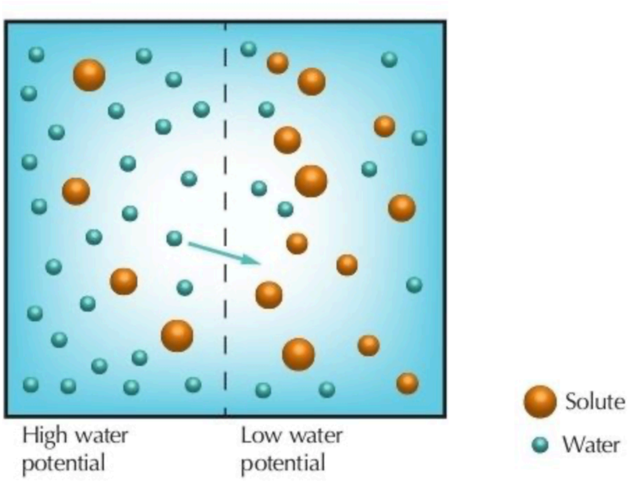


Figure 2.14: Osmosis is the movement of water from an area of high water potential to an area of low water potential across a semi-permeable membrane.

In biological systems, osmosis is vital to plant and animal cell survival. Figure 2.15 demonstrates how osmosis affects red blood cells when they are placed in three different solutions with different concentrations.

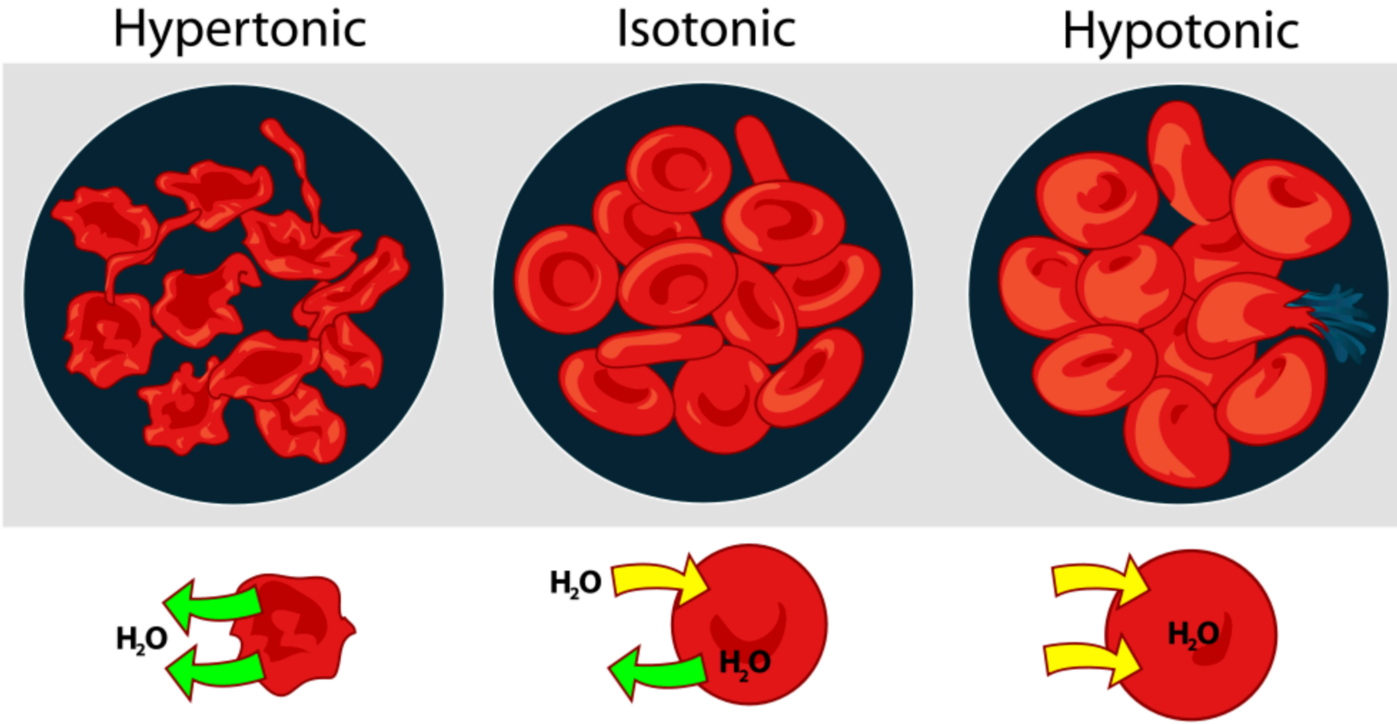
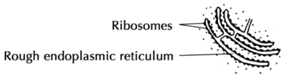
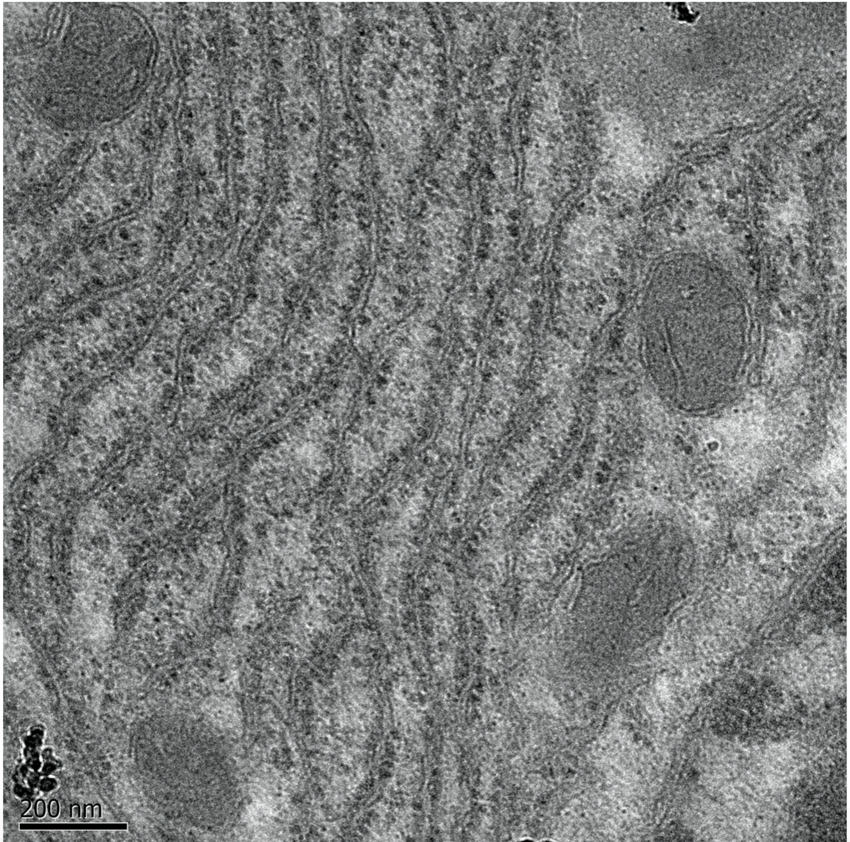


Figure 2.15: The effect of hypertonic, isotonic and hypotonic solutions on red blood cells.

Rough endoplasmic reticulum





Predicting the direction of osmosis

Aim

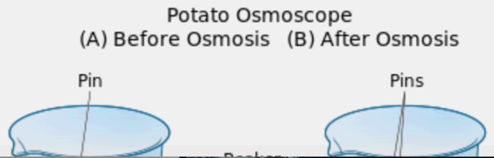
To predict the direction of osmosis.

Apparatus

- 1 x 500 ml beaker
- 1 x large potato
- potato peeler/scalpel
- 2 x pins
- concentrated sucrose/sugar solution. To obtain this, add 100 g of sugar to 200 ml of water.

Method

1. Peel off the skin of a large sized potato with a scalpel/potato peeler.
2. Cut its one end to make the base flat.
3. Make a hollow cavity in the potato almost to the bottom of the potato.
4. Add the concentrated sugar solution into the cavity of the potato, filling it about half way. Mark the level by inserting a pin at the level of the sugar solution (insert the pin at an angle into the cavity at the level) (Figure 2.16 A).
5. Carefully place the potato in the beaker containing water.
6. Observe what happens to the level of the sugar solution in the potato.
7. After 15 to 20 minutes, mark the level by inserting the second pin at the level of the sugar solution (insert as the first pin) (Figure 2.16 B).



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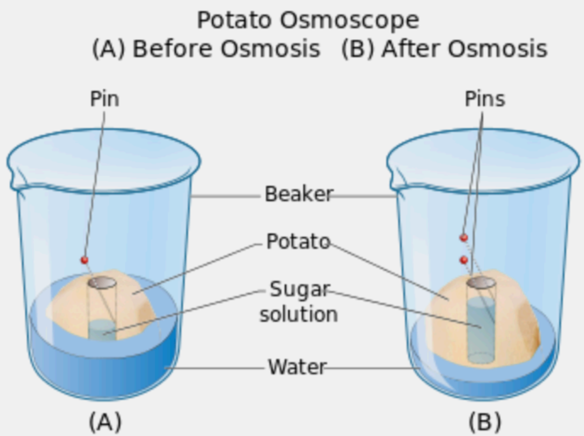


Figure 2.16: Using a potato to investigate osmosis.

Questions

1. What do you observe happening to the level of the solution inside the potato?
2. What conclusion can you draw based on your observation?
3. What conditions were met in this experiment that makes this type of transport different to diffusion?

3. Facilitated diffusion

Facilitated diffusion is a special form of diffusion which allows rapid exchange of specific substances. Particles are taken up by carrier proteins which change their shape as a result. The change in shape causes the particles to be released on the other side of the membrane. Facilitated diffusion can only occur across living, biological membranes which contain the carrier proteins. A substance is transported via a carrier protein from a region of high concentration to a region of low concentration until it is randomly distributed. Therefore movement is *down a concentration gradient*.

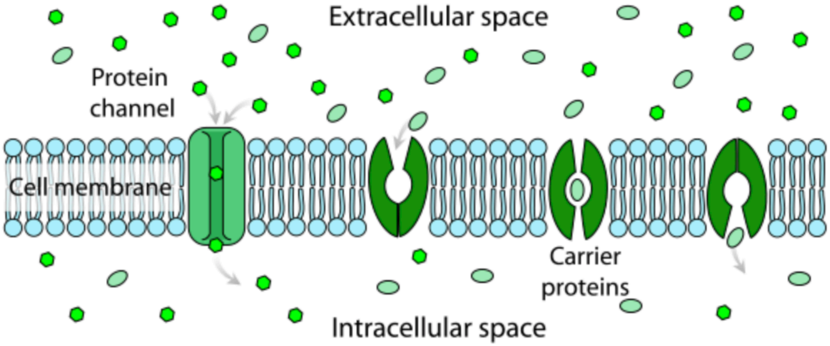
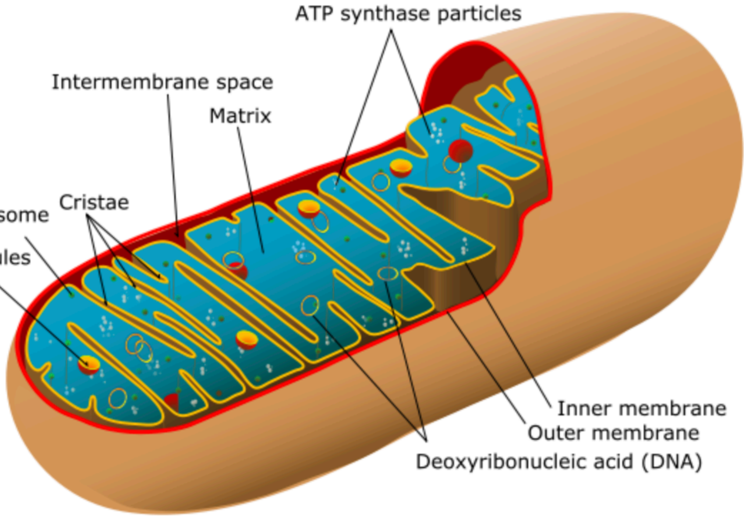
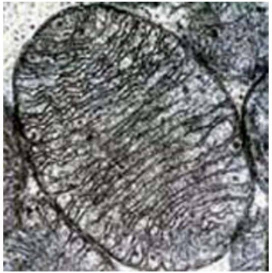


Figure 2.17: Facilitated diffusion in cell membrane, showing ion channels and carrier proteins.

Examples of substances moved via facilitated diffusion include all polar molecules such as glucose or amino acids.

Schematic Diagram	Micrograph
 *Figure 2.21: The major structures of the mitochondrion in three dimensions.*	 *Figure 2.22: Electron micrograph of a mitochondrion.*

The table below relates each structure to its function.

4. Active transport

Active transport is the movement of substances *against* a concentration gradient, from a region of *low concentration* to *high concentration* using an input of energy. In biological systems, the form in which this energy occurs is **adenosine triphosphate (ATP)**. The process transports substances through a membrane protein. The movement of substances is selective via the carrier proteins and can occur into or out of the cell.

NOTE

ATP and ADP are molecules involved with moving energy within cells. You do not need to know these names in full and will learn more about them later.

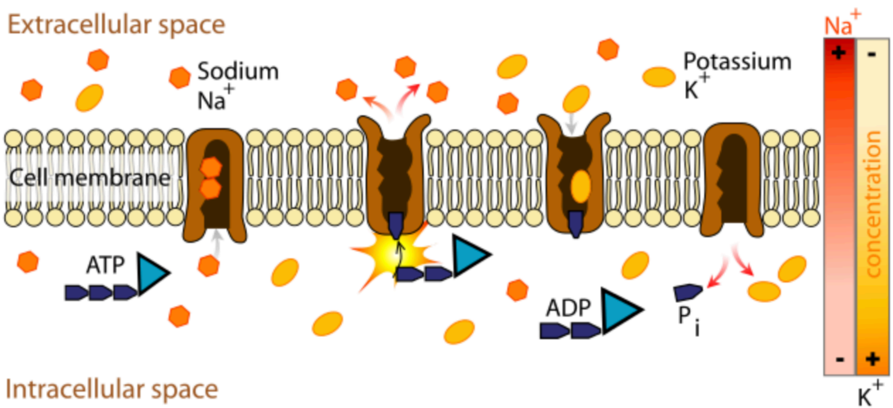
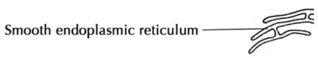
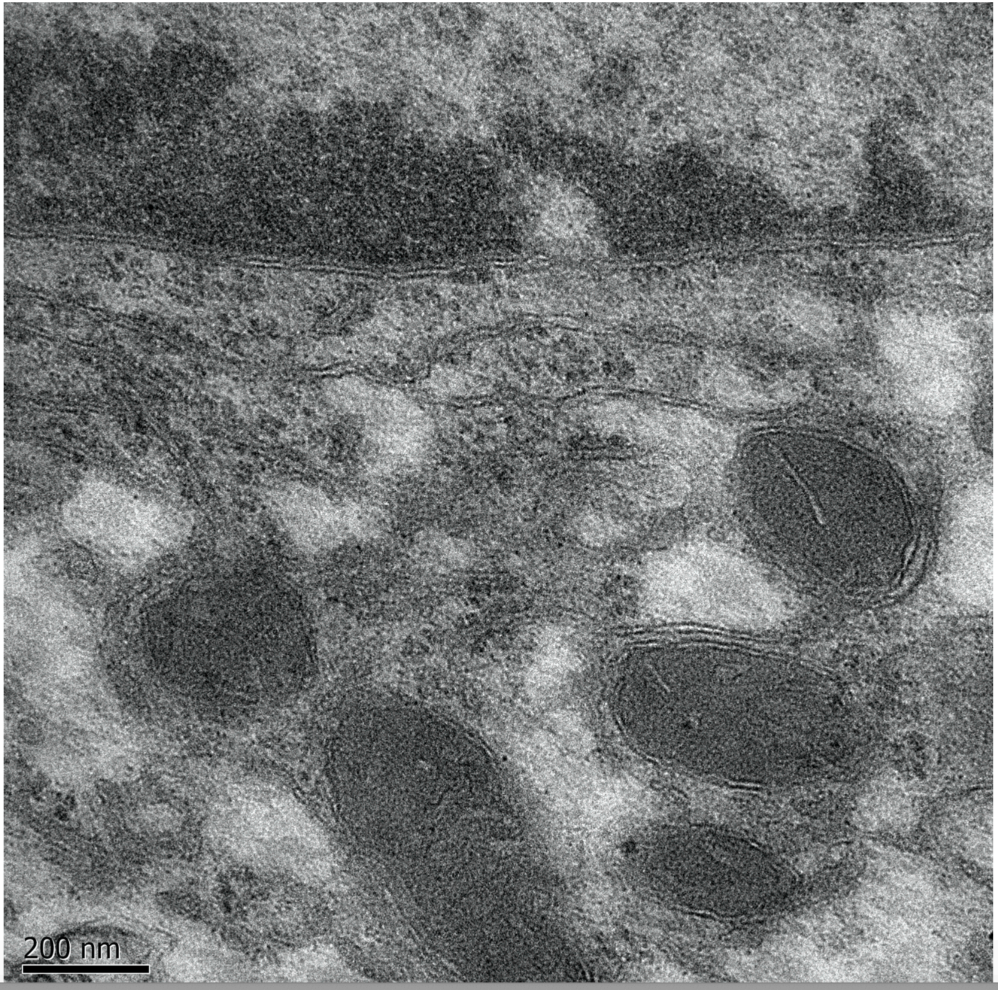


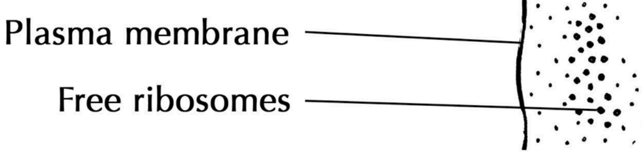
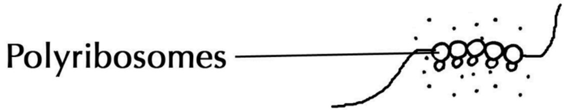
Figure 2.18: The sodium-potassium pump is an example of primary active transport.

Examples of substances moved include sodium and potassium ions as shown in Figure 2.18

Smooth endoplasmic reticulum

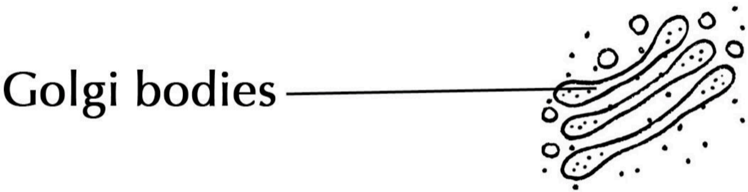




 Figure 2.23: Free ribosomes found within cytoplasm.	 *Figure 2.24: Diagram of several ribosomes joined together on a strand of mRNA to form a polyribosome.*

Golgi body (ESG56)

The Golgi body is found near the nucleus and endoplasmic reticulum. The Golgi body consists of a stack of flat membrane-bound sacs called cisternae. The cisternae within the Golgi body consist of enzymes which modify the packaged products of the Golgi body (proteins).

Schematic Diagram	**Micrograph**
 *Figure 2.25: Diagram showing Golgi bodies found in animal cells.*	 *Figure 2.26: TEM Micrograph of Golgi body, visible as a stack of semicircular black rings near the bottom.*

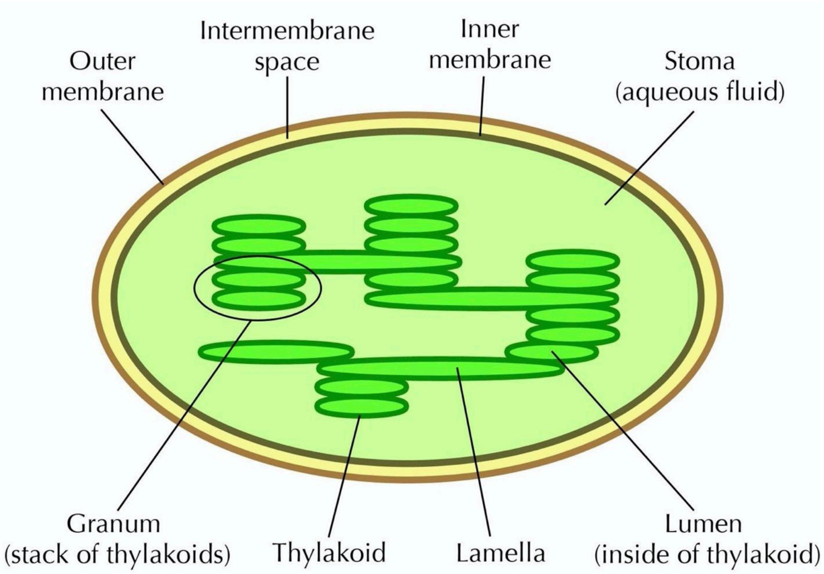
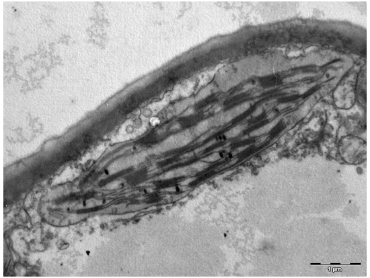
Plastids (ESG5B)

Plastids are organelles found only in plants. There are three different types:

1. **Leucoplasts**: White plastids found in roots.
2. **Chloroplasts**: Green-coloured plastids found in plants and algae.
3. **Chromoplasts**: Contain red, orange or yellow pigments and are common in ripening fruit, flowers or autumn leaves.

Figure 2.29: Plastids perform a variety of functions in plants, including storage and energy production.

NOTE

Schematic Diagram	Micrograph
 *Figure 2.30: Structure of chloroplast.*	 *Figure 2.31: Electron micrograph of chloroplast with grana and thylakoids.*

Method

1. Peel off the outer most layer of an onion carefully, using a pair of forceps.
2. Place the peeled layer in a watchglass containing water. Make certain that the onion peel does not roll or fold.
3. Using a scalpel or a thin blade, cut a square piece of the onion peel (about $1\ \mathrm{cm}^2$).
4. Remove the thin transparent skin from the inside curve of a small piece of raw onion and place it on a drop of iodine solution on a clean slide.
5. Cover the peel with a coverslip ensuring that no bubbles are formed.
6. Using a piece of tissue paper wipe off any excess iodine solution remaining on the slide.
7. Observe the onion skin under low power of the microscope and then under high power.
8. Draw a neat diagram of 5-10 cells of the typical cells you can see.

Figure 2.32: Onion cells stained with methylene blue.

4. Use a coverslip to cover the slide gently.
5. Place one or two drops of stain on the side of the cover slip.
6. Use a piece of tissue to remove the excess dye.
7. Observe the cheek cells under low power magnification and then under high power magnification.

Questions

1. What are the shapes of epidermal cells of the onion peel and the human cheek cells?
2. Why is iodine used to stain the onion peel?
3. What is the difference between the arrangement of cells in onion cells and in human cheek cells?
4. Why is a cell considered the structural and functional unit of living things?

Figure 2.33: Cheek epithelial cells.

Examining animal cells under the microscope

Aim

To study the microscopic structures of human cheek cells under a compound microscope.

Apparatus

- clean ear bud
- clean slide
- methylene blue
- dropper
- water
- tissue paper
- forceps
- microscope

Method

1. Place a drop of water on a clean glass slide.
2. Using a clean ear bud, wipe the inside of your cheek. The ear bud will collect a moist film.
3. Spread the moist film on a drop of water on a clean glass slide, creating a small smear on the slide.
4. Use a coverslip to cover the slide gently.
5. Place one or two drops of stain on the side of the cover slip.
6. Use a piece of tissue to remove the excess dye.
7. Observe the cheek cells under low power magnification and then under high power magnification.

Questions

1. What are the shapes of epidermal cells of the onion peel and the human cheek cells?
2. Why is iodine used to stain the onion peel?

2.5 Summary (ESG5D)

The discovery of cells:

- All living organisms are made of cells.
- Cells are very small therefore magnifying instruments such as lenses and microscopes are used to view them.
- By using a light microscope the simple features of cells can be studied. The light microscope uses a beam of light focused by various glass lenses.
- Electron microscopes have higher power of magnification than the ordinary light microscope, therefore allowing us to see very small structures inside the cells. These microscopes use a beam of electrons focused by electromagnets to magnify objects instead of light rays and lenses.
- Robert Hooke (1665) used a light microscope to examine non-living cork cells.
- Antonie van Leeuwenhoek was the first person to observe living cells using a microscope.
- The development of cell theory was from the study of microscopic cells.

Cell structure and function

- All cells have the same basic structure. They are all surrounded by a cell membrane and contain cytoplasm and organelles.
- Cells have different sizes, shapes and structures in order to carry out specialised functions.
- The cell membrane is made of phospholipids and proteins and controls substances which move in and out of the cell.
- The structure of the cell membrane is referred to as the Fluid Mosaic Model.

- The nucleus is made up of a nuclear membrane with nucleopores, chromatin material and the nucleolus inside the nucleoplasm.
- Mitochondria release chemical potential energy (ATP) for the cell during cellular respiration.
- Ribosomes are important for protein production.
- Cytoplasm is used for storage and circulation of various materials.
- Endoplasmic reticulum transports substances from one part of the cell to another.
- The Golgi body modifies, secretes, packages and distributes various organic molecules (proteins and lipids) around the cell.

4. Active transport

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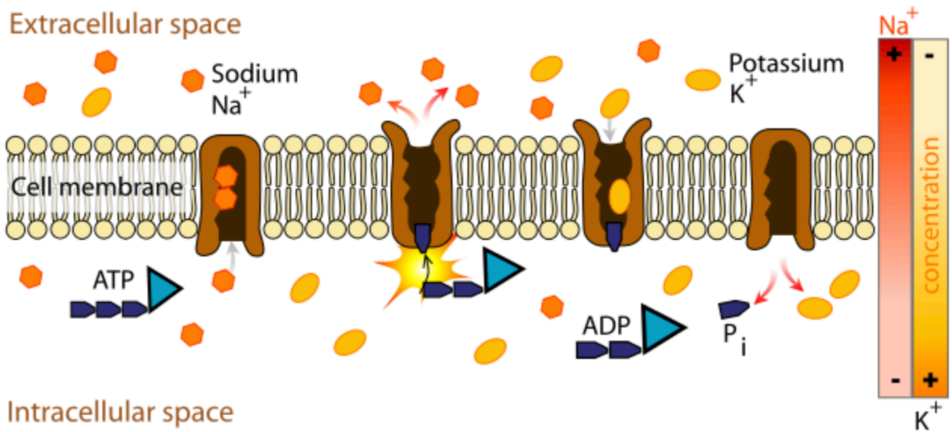
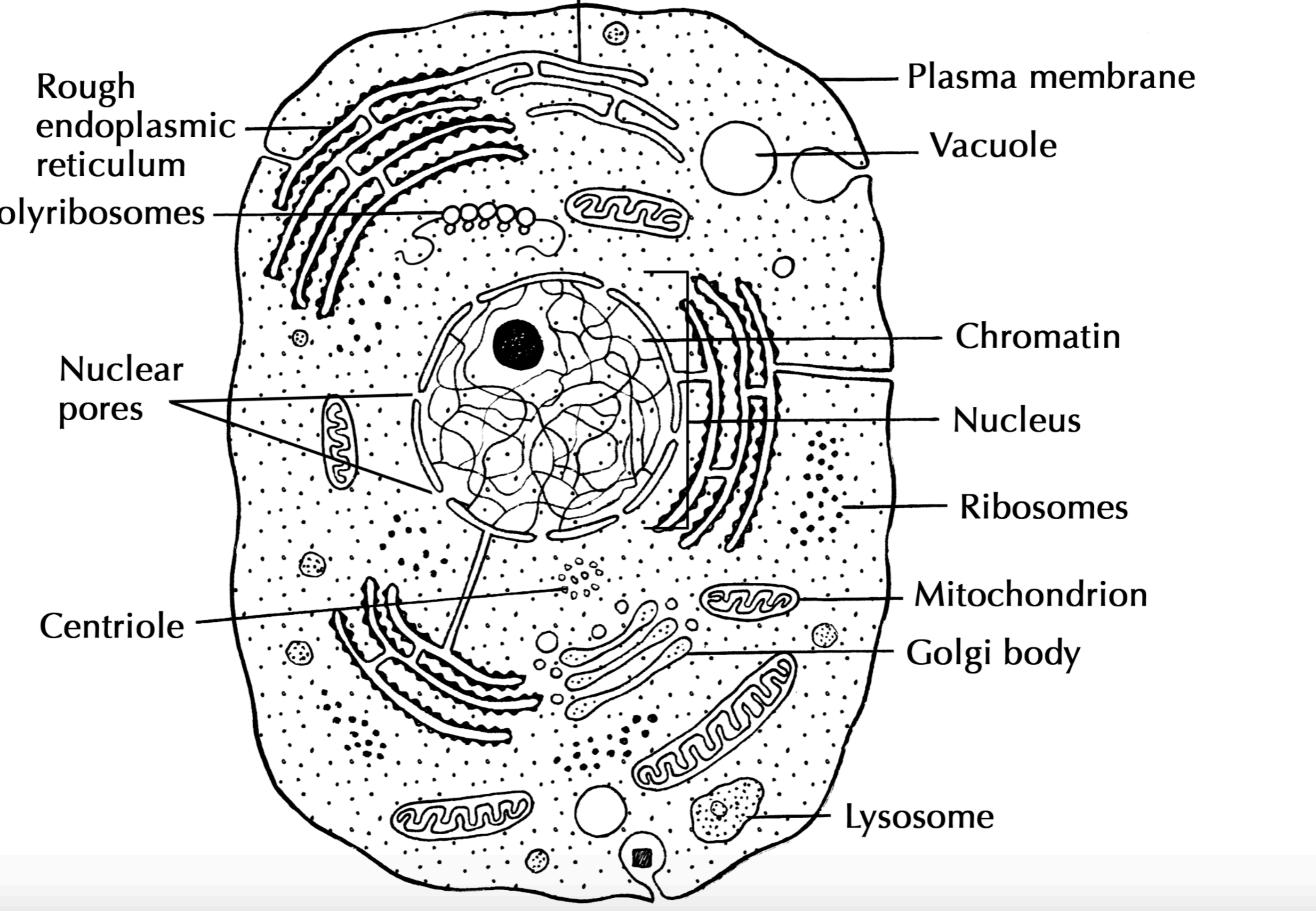


Figure 2.18: The sodium-potassium pump is an example of primary active transport.



Plasma membrane
Rough endoplasmic reticulum
Vacuole
olyribosomes
Chromatin
Nuclear pores
Nucleus
Ribosomes
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Centriole
Golgi body
Lysosome

- Endoplasmic reticulum transports substances from one part of the cell to another.
- The Golgi body modifies, secretes, packages and distributes various organic molecules (proteins and lipids) around the cell.
- Vacuoles are used for storage. In plant cells these are large, whilst in animal cells, if present, are very small.
- Lysosomes are mainly found in animal cells.
- Centrioles are only found in animal cells.
- The cell wall is found only in plant cells and is made up of cellulose. The cell wall gives the plants shape, support and protection.
- Plastids are found only in plant cells. There are three types of plastids:
    - chloroplasts contain chlorophyll and their function is the production of food by photosynthesis
    - chromoplasts give colour to fruits and flowers
    - leucoplasts are white and are used mainly for starch storage

Events during Meiosis

Diploid Cell (2N): From a preceding mitotic division, the Oogonium (Spermatogonium) enters meiosis with DIPLOID (2N) chromosomes but TETRAPLOID (4N) DNA. Chromosomes then duplicate to produce SISTER CHROMATIDS (or HOMOLOGOUS DYADS).

Prophase I: Dyad pairs align to create "TETRADS", non-sister chromatids connect and trade sections at a "CHIASMA", a process called "CROSSING OVER".

Metaphase I: SPINDLE FIBERS attach to each dyad at the KINETOCHORE. Tension from spindle fibers aligns the tetrads at the cell equator.

Anaphase I: Chiasmata break apart and sister chromatids begin migrating toward opposite poles.

Telophase I: CLEAVAGE FURROW forms beginning the process of CYTOKINESIS (cell division). Resulting daughter cells are HAPLOID (1N).

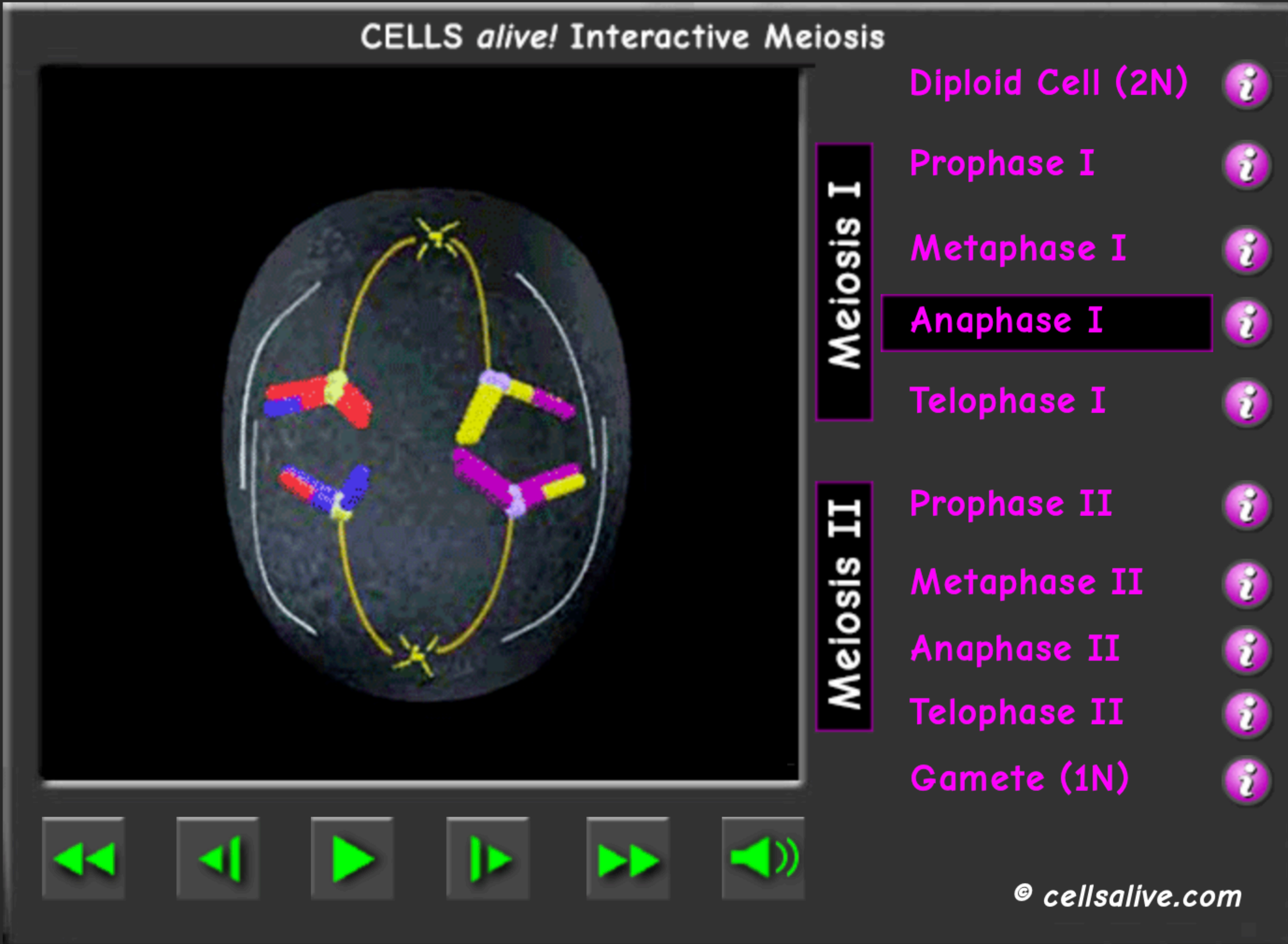
Prophase II: Spindle formation begins and centrosomes begin moving toward poles.

Metaphase II: Tension from spindle fibers aligns chromosomes at the metaphase plate.

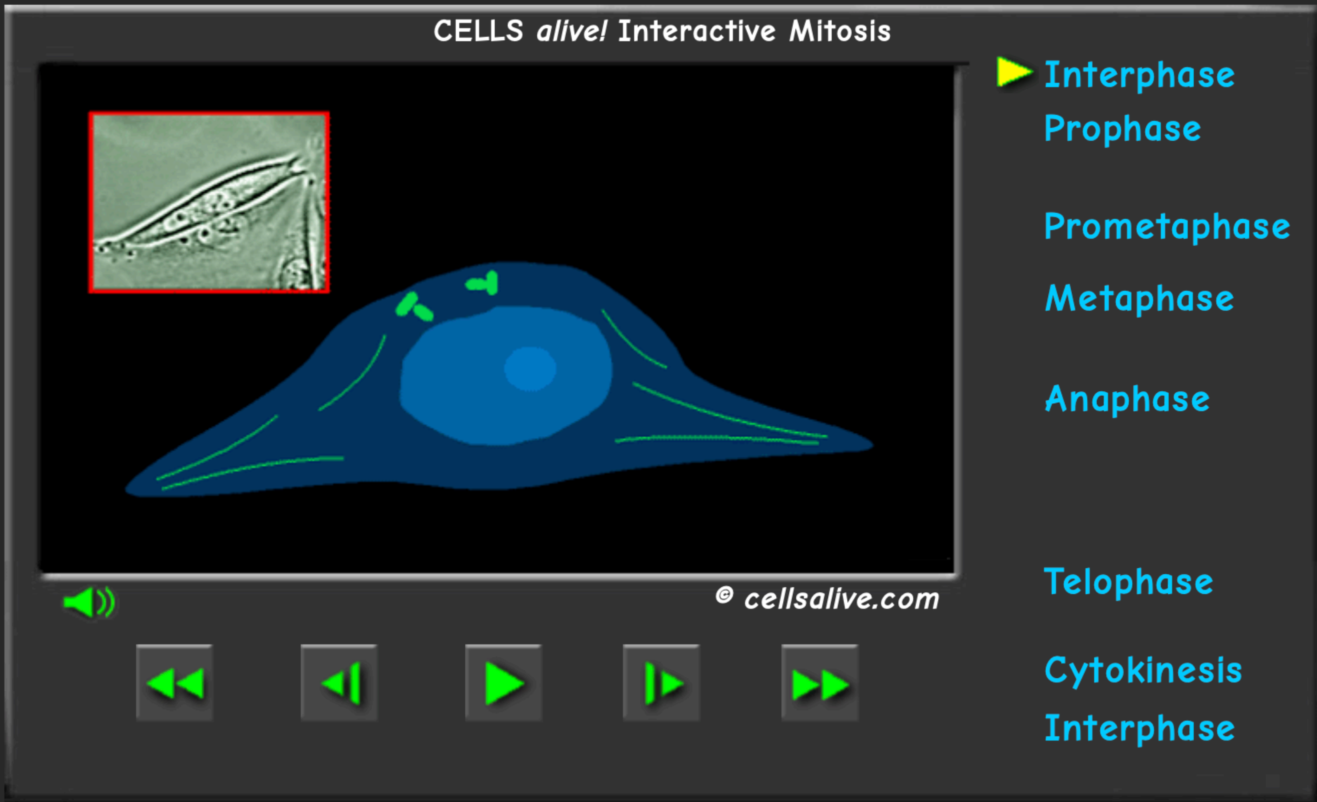
Anaphase II: CHROMATIDS separate and begin moving to the poles.

Telophase II: CLEAVAGE FURROW forms beginning CYTOKINESIS.

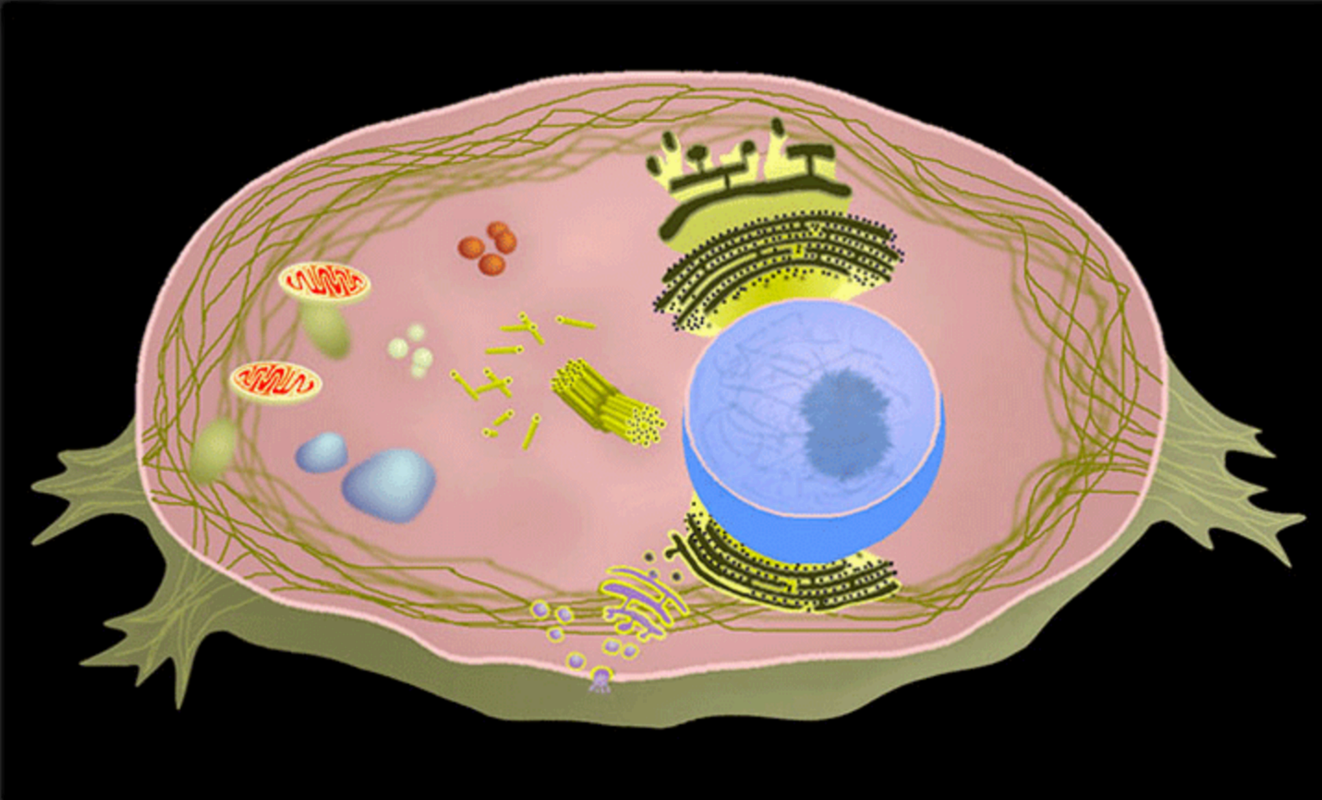
Gamete (1N): NUCLEAR ENVELOPES form and chromosomes disperse as CHROMATIN. Meiosis has produced 4 DAUGHTER CELLS, each with 1N chromosomes and 1N DNA. Later, in fertilization, male and female 1N gametes will fuse to form a 2N ZYGOTE.


CELLS alive! Interactive Meiosis
Diploid Cell (2N)
Meiosis I
Prophase I
Metaphase I
Anaphase I
Telophase I
Meiosis II
Prophase II
Metaphase II
Anaphase II
Telophase II
Gamete (1N)
© cellsalive.com

Animal Cell Mitosis



CELLS *alive!* Interactive Animal and Plant Cells



Animal Cell | Plant Cell | © cellsalive.com

Nucleus	Golgi		
Nucleolus	Lysosome	Mitochondrion	Smooth Endoplasmic Reticulum
Cytosol	Peroxisome	Vacuole	Rough Endoplasmic Reticulum
Centrosome	Secretory Vesicle	Cell Wall	Ribosomes
Centriole	Cell Membrane	Chloroplast	Cytoskeleton