The cell

Concept of cell

The cell is the basic structural, functional and biological unit of all living things. For this reason, it is considered the smallest collection of matter that can live; the **smallest form of life**.

Classification of cells

There are **two types** of cells according to the presence of or not of a nucleus, and to its internal organisation:

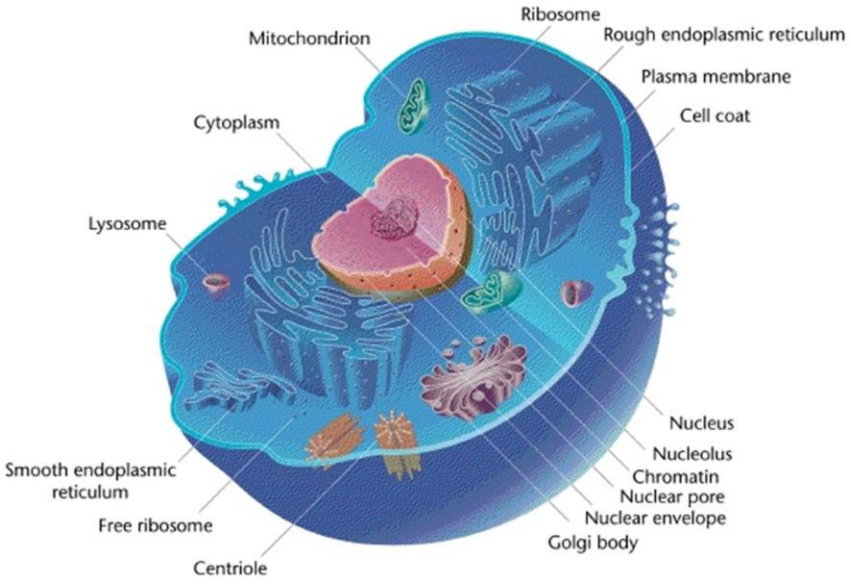
Prokaryotic cells are simple cells that **do not have a true nucleus.** They have simple organelles, but lack membranous organelles and they have a cell wall.

Eukaryotic cells are those which **do have a true nucleus**. They are larger than prokaryotes, do not always have a cell wall, and have **organelles** with a specialised function.

The eukaryotic animal cell

There are two types of eukaryotic cells, plant and animal. In this unit we are going to study **animal cells,** as we will later talk about human tissues, organs and systems, which are indeed made of animal cells.

Structure of the eukaryotic animal cell



Cell or plasma membrane: It is formed by a phospholipid bilayer that surrounds the cytoplasm. It functions as a selective **barrier** which separates the cell's contents from its surroundings. It **controls** the exchange of materials such as nutrients and waste products between the two.

The plasma membrane is a **partially permeable** membrane, allowing some substances to cross freely, but not others. The molecules which can go through this membrane are of **small** size. Big molecules or those with the incorrect electrical charge will not be allowed to pass through the membrane and when needed, they will cross the membrane by a especial transport system.

Cytoplasm: The cytoplasm is the cellular content excluding the nucleus. It is formed by an **aqueous solution** with organelles embedded in it.

Mitochondrion: The mitochondrion is an elongated-shaped organelle enclosed in an envelope of two membranes. It is the site for **cellular respiration**, the process by which the cell obtains **energy** (ATP).

Endoplasmic reticulum: The endoplasmic reticulum (ER) is a series of connected flattened sacs and membranous tubules. If the endoplasmic reticulum has ribosomes attached, it is called **rough ER**, and if not, **smooth ER**. Its function is the production of several substances, such as lipids in the smooth ER and proteins in the rough ER.

Ribosomes: Ribosomes are tiny organelles found free in the cytoplasm or attached to the membranes of the endoplasmic reticulum. Ribosomes are made of RNA (ribonucleic acid) and proteins, and are the site for **protein synthesis**.

Golgi apparatus: It is a series of flattened stacks of membrane-bound sacs (disclike compartments called cisternae), surrounded by small vesicles. In these vesicles, lipids and proteins synthesized in the ER are chemically changed and prepared for **secretion** (export to the outside of the cell).

Lysosomes: These are membrane-bound vesicles that contain digestive enzymes. They carry out the digestion of large molecules or old organelles.

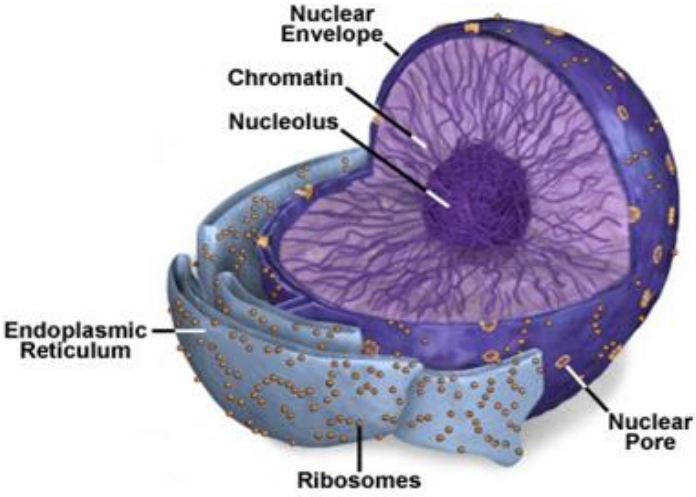
Cytoskeleton: System of protein filaments that form complex networks in the cytoplasm of the cell. It gives a cell shape and it is very important in cell division or mitosis.

Centrioles: Centrioles are small hollow cylinders made up of bundles of microtubules. They direct the **movements** of the cytoskeleton and are involved in cell division or mitosis

Nucleus: The nucleus, which is usually spherical, is found in the centre of the cell. It contains the **genetic material** (**DNA**) with the information to **control** the cell.

Parts of the nucleus

Inside the nucleus we can distinguish the following structures:



- Ø The **nuclear envelope** is a double membrane perforated by **nuclear pores** that allow the exchange of substances between the nucleus and the cytoplasm.
- Ø The **nucleoplasm** is the content of the nucleus. It is composed of a **solution** where we can find the chromatin and the nucleolus.
- Ø The **nucleolus** is a roughly spherical darkly-stained structure that we can find inside the nucleus. It is the site of **ribosome synthesis**.
- Ø **Chromatin** is composed mainly of coils of **DNA** (deoxyribonucleic acid) bound to proteins called **histones**, found within the nucleoplasm inside the nucleus. This DNA contains the **genetic or hereditary material** of the cell.
- Ø When a cell is going to **divide** to produce two daughter cells, the chromatin filaments condense into shorter, thinner structures called **chromosomes**. Human cells have **46** chromosomes, except for gametes, which have 23.

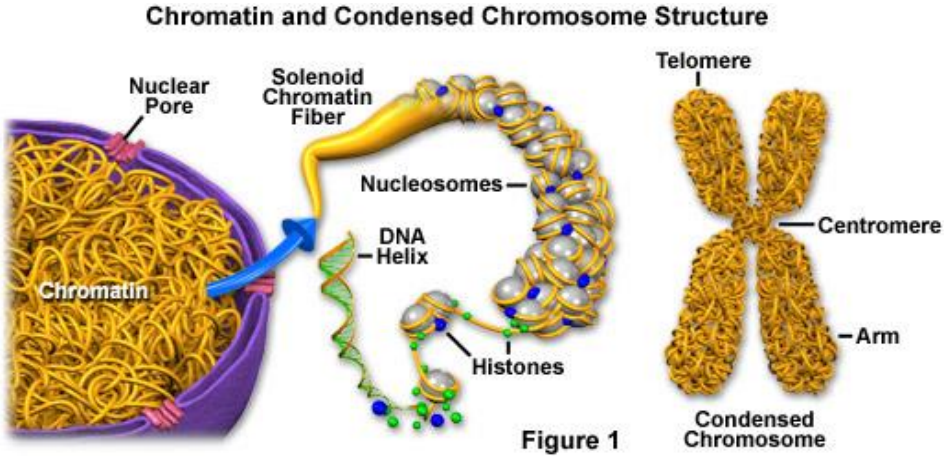
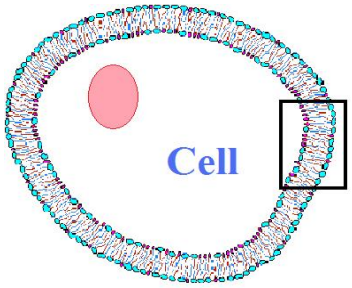


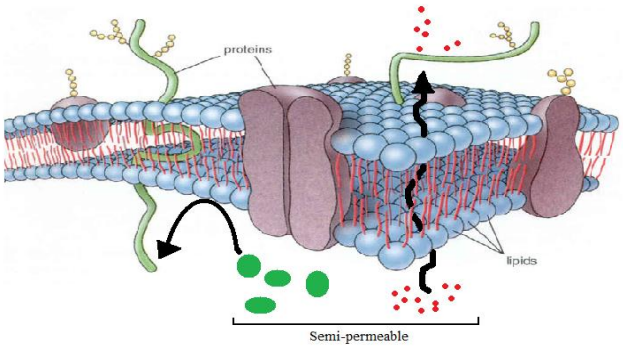
Figure 1

Mechanisms of transport across the plasma membrane

In the previous section we saw that the content of the cell is surrounded by a partially permeable membrane called the plasma membrane. This barrier is essential for transporting and regulating the materials that go in and out of the cell. As already mentioned, this plasma

membrane has selective permeability; that is, it allows some substances to cross it more easily than others.
There are different mechanisms by which molecules may be transported across the plasma membrane. Small molecules go across the plasma membrane by diffusion, osmosis, or active transport. And larger molecules cross the membrane usually by endocytosis and exocytosis.





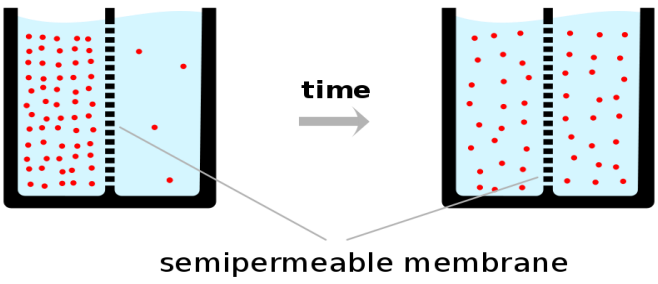
Diffusion:

Molecules and ions in a liquid or gas are constantly moving and tend to spread out into the available space. If we place a membrane separating pure water from a solution of dissolved dye in water, and assuming the membrane is permeable to the dye molecules, the dye molecules will move randomly but they will tend to diffuse to the side where there is just pure water until they are evenly spaced and reach equilibrium.

If there is a region of high concentration, and another of low concentration, there is a concentration gradient between these regions. A substance will diffuse from where it is more concentrated to where it is less concentrated, or down its concentration gradient.

Diffusion is the movement of particles within a gas or liquid from a region of high concentration to a low concentration (down a concentration gradient) until an equilibrium is reached.

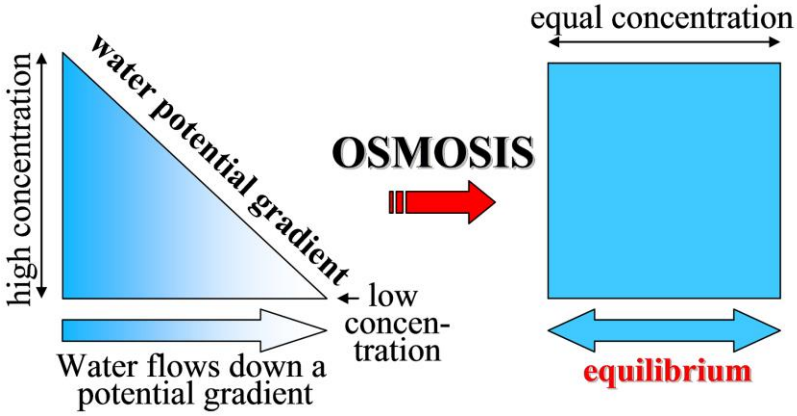
In a cell, when diffusion takes place, we talk about **passive transport**, as the cell does not have to spend energy for diffusion to happen.

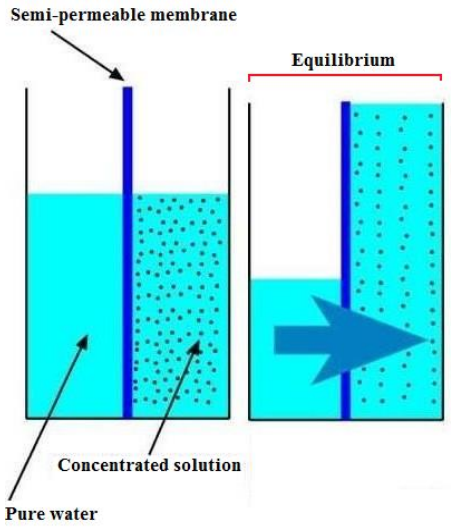


Osmosis, a special case of passive transport:

Osmosis is the diffusion of water molecules from a region of higher concentration of water to a region of lower concentration of water, down a water potential gradient, through a partially permeable membrane.

It is a form of diffusion in which only water molecules move. The tendency of water molecules to move from one place to another is measured as the water potential.

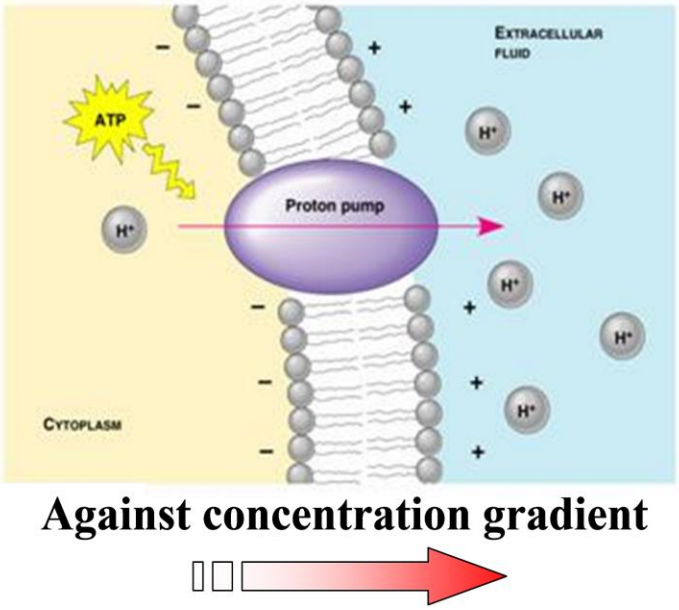




Active transport:

As we have seen earlier, particles move from one place to another by diffusion, but only until equilibrium is reached. If there is no concentration gradient between the two places no diffusion will occur. Sometimes cells need substances which are found in less concentration outside than inside the cell.

In active transport, protein molecules (called carriers) in the plasma membrane pick up and carry particles across the membrane, in the opposite direction of diffusion (against a concentration gradient). It is an energy-consuming transport, as the substance must be moved against its natural tendency to diffuse.
Active transport is a method by which particles are moved against a concentration gradient. This movement requires energy (ATP) and involves protein carriers in the plasma membrane.



Moving large molecules across membranes: endocytosis and exocytosis:

Some particles are too big to cross a membrane by diffusion or by active transport. In these cases, an infolding or extension of the cell membrane will engulf the molecule and form a vesicle to transport it.
Endocytosis and exocytosis are active processes involving the bulk transport of materials through membranes. This can be either into the cell, endocytosis, or out of the cell, exocytosis.