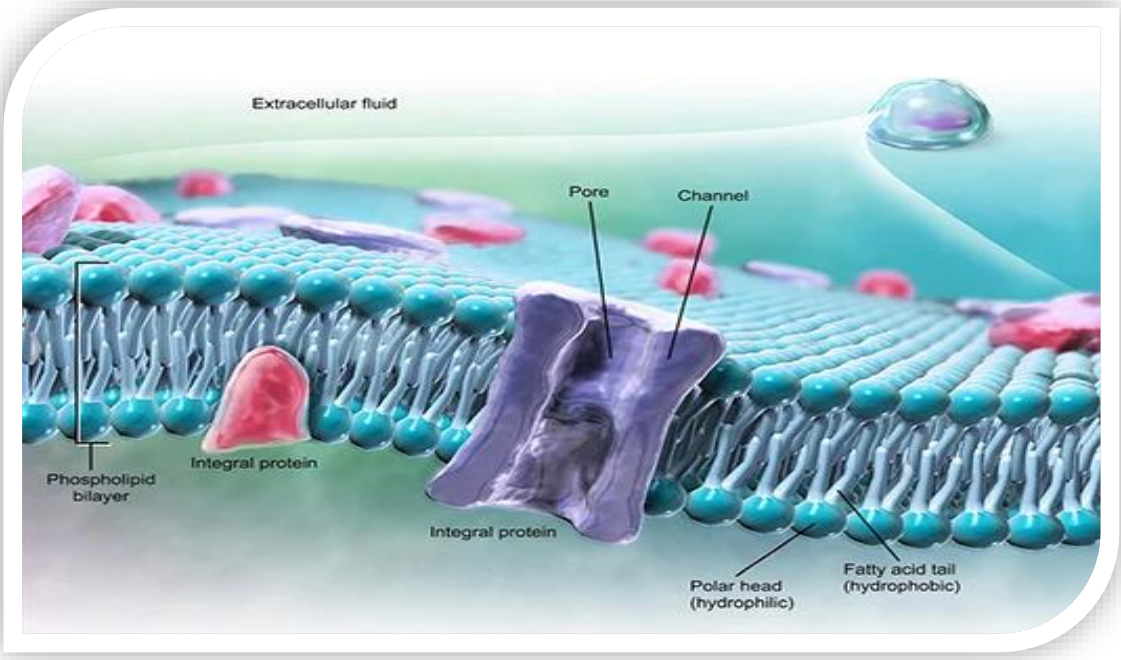
AL-Zahraa University for Women
College of Health and Medical Techniques
Anesthesia Department

Movement in and out of cells and cell division



Dr. Farah Amir

Assit. Lec. Fatima salim

Why is homeostasis important for cells?

Living cells depend on the movement of chemicals around the body. Chemicals such as oxygen, carbon dioxide and **dissolved food** need to be transported into and out of cells. This is done by the processes of **diffusion** and **osmosis** and **active transport**. These processes depend on the body's water and salt balance, which are maintained by **homeostasis**.

Diffusion

Is the net movement of particles from a region of their **higher** concentration to a region of their **lower** concentration down a concentration gradient, as a result of their random movement.

The constant random movement of particles (and their kinetic energy) allows diffusion to occur. Ultimately this means that particles will spread out.

Diffusion and digestion

Carbohydrates, proteins and fats are made up of large molecules that cannot be absorbed by the body.

Digestion breaks down large nutrient molecules into simpler forms such as glucose, amino acids and fatty acids that can be easily absorbed.

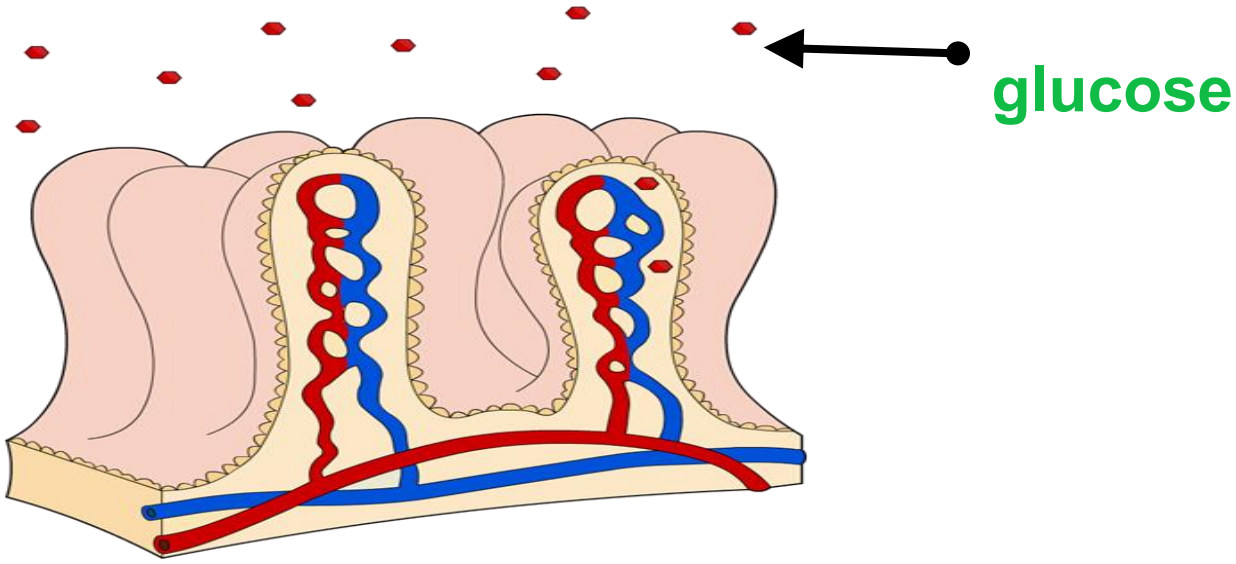
In which part of the digestive system is most food absorbed?

Small food molecules are usually absorbed in the small intestine, diffusing across the intestine wall and into the bloodstream.

Diffusion and the small intestine

Fats, fat-soluble vitamins and glucose can move into the bloodstream by diffusion.

These small molecules diffuse from the small intestine into the blood, moving from higher to lower concentration.



There are certain factors that affect the rate of diffusion:

Surface area

The larger the surface area, the higher the rate of diffusion. This is because more molecules at a given time will be diffusing .

Temperature

The higher the temperature, the higher the rate of diffusion. This is because molecules are faster and have more kinetic energy with higher temperatures .

Concentration gradients

The higher the concentration gradient, the higher the rate of diffusion .

Distance

The shorter the distance, the higher the rate of diffusion. This is quite self-explanatory. The shorter the distance the particles have to move, the quicker the process is going to be .

Osmosis

Concept of osmosis

Osmosis is the net movement of **water** molecules from a region of **high water potential** (dilute solution) to a region of **low water** potential (concentrated solution) through a partially permeable membrane.

Think of osmosis as the diffusion of water across a partially permeable membrane. When we are talking about water, we cannot use the term 'concentration' anymore because a concentration denotes the amount of substance dissolved in water.

Because water cannot be dissolved in water, we need to use another term instead: **Water potential.**

For a very dilute solution, because it has a lot of water, it has a high water potential.

For a very concentrated solution, because it has less water, it has a low water potential.

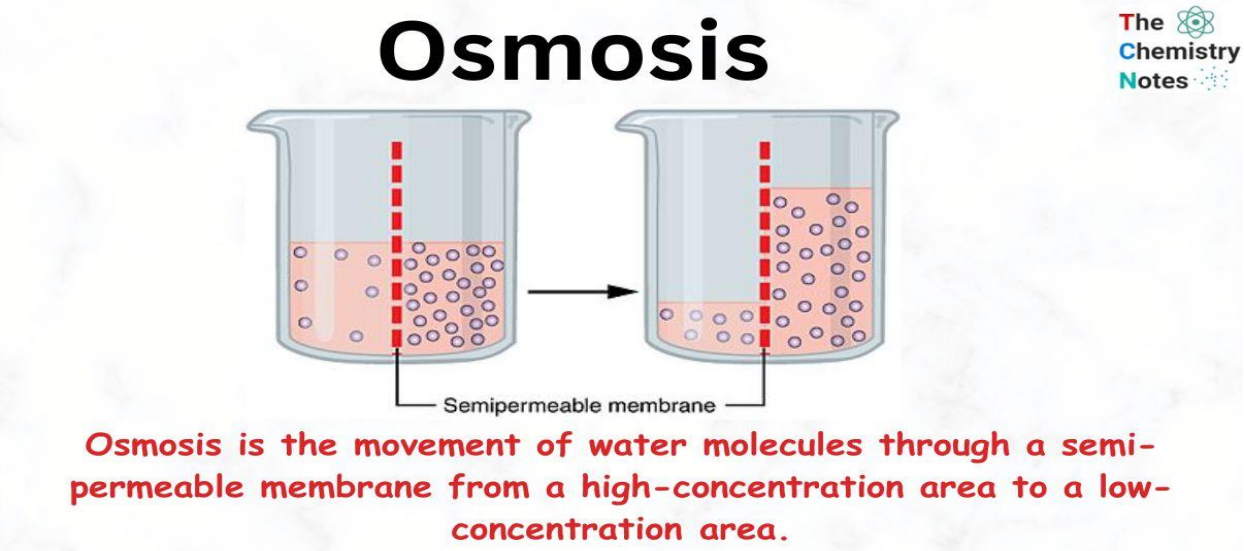
Osmosis and digestion

In order to remain healthy, animal cells need to maintain homeostasis in water balance. This means that the water concentration both inside and outside the cell are equal.

In the large intestine water is absorbed back in the body cells by osmosis. This also makes the feces solid.

Good bacteria in the large intestine produce vitamins like Vitamin K which is also reabsorbed by osmosis.

These bacteria also produce flatus, a mixture of nitrogen and carbon dioxide, with small amounts of the hydrogen, methane.



Active transport

Active transport is the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration using energy from respiration .

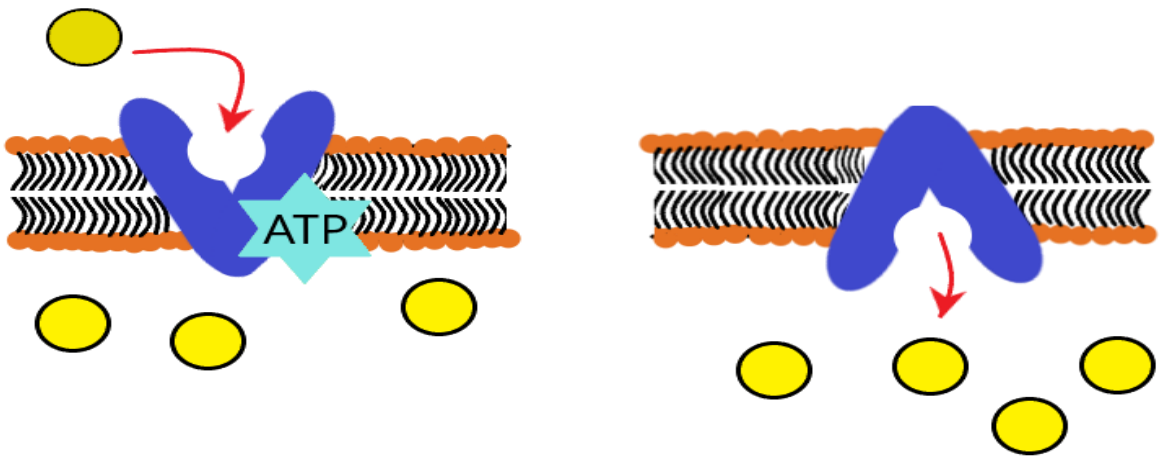
Active transport is used in cases where diffusion or osmosis cannot be relied upon. For example, what if a cell wanted to absorb extra nutrients from outside the cell despite having a higher concentration of those nutrients inside the cell? Diffusion wouldn't work because the concentration gradient is going the opposite way. These situations are encountered frequently in :

Plant root hairs

Villi epithelial cells

Active transport uses energy to oppose the concentration gradient and forcefully transport molecules against it.

In the cell membranes of all cells, there are certain embedded protein molecules that carry out this process. The protein basically 'captures' the molecules from one side of the cell, and it changes shape in a way to transport the captured molecules to the other side of the cell. Energy (from respiration) is required to alter the protein shape (referred as ATP in the diagram).



Diffusion	Osmosis	Active Transport
Passive process	Passive process	Active process
Does not require energy	Does not require energy	Requires energy
Moves substances down a concentration gradient	Moves substances down a concentration gradient	Moves molecules against a concentration gradient
Moves substances from a high to a low concentration	Moves substances from a high to a low concentration	Moves substances from a low to a high concentration
	Movement of water only	

Cell Division

A single cell divides many times and forms a multi celled organism. Unicellular bacteria and protozoa divide and increase in number. The injured tissues are replaced by new cells through cell division. Thus cell division is one of the most important activities in all organisms. In this lesson you will study about the two kinds of cell division and the processes involved in them.

Majority of cells in a multicellular organism grow and then can divide. However,the cells like the nerve and muscle cells of animals and guard cells of plants do not divide.

The process of cell division is almost same in all organisms. A cell passes through phases of growth after which are able to duplicate their chromosomes before they divide. These phases in the life of a cell constitute the cell cycle.

The cell cycle

You can use the term mother or parent cell for the cell that undergoes division and the daughter cells for the ones that are the result of this division. Before each daughter cell undergoes division, it must grow to the same size as its mother cell.

We can distinguish two main phases in the life of a cell.

(i) Interphase - Non-dividing period (Growth phase)

(ii) Dividing phase - Also called M-phase (M for mitosis or meiosis)

(i) Interphase - (Inter = in between)

The interval between two successive cell divisions is termed interphase (phase at which the cell is not dividing). It is the longest period in the cell cycle. The interphase is subdivided into three main periods - G1 , S and G2.

G 1 (Gap-1) Phase i.e. First phase of growth – This is the longest phase.

Lot of protein and RNA are synthesised during this phase.

S or synthetic Phase - It comes next. Lot of DNA is (synthesised).

A chromosome contains a single double helical strand of DNA molecule. After S-phase each chromosome becomes longitudinally double except at centromere, and thus, it has two molecules of DNA and two chromatids. Thus each chromatid contains one molecule of DNA. The two chromatids are joined by a centromere (which does not divide at this stage) to form a single chromosome.

G2 (GAP 2) phase - More protein including the histones are synthesised in this phase. Cytoplasmic organelles such as mitochondria and golgi bodies get duplicated. Centriole also divides into two centrioles contained in a single centrosome.

(ii) M-phase or dividing phase - Represented by the symbol M (Mitosis or meiosis. Mitosis occurs so that during this period the chromatids

separate and form daughter chromosomes. The daughter chromosomes go to daughter nuclei and cytoplasm divides forming two identical daughter cells.

Kinds of cell division

There are two kinds of cell division- mitotic cell division and meiotic cell division.

1- .**Mitotic** : Cell division is for growth and replacement of older cells by new cells where in the two daughter cells are identical and similar to mother cell in all respects. Mitotic cell division occurs in haploid as well as diploid cells.

2 **.Meiotic** cell division occurs in the gonads for sexual reproduction to produce gametes. The resultant cells, egg (in female) and sperms (in male), possess half the chromosome number of that present in the parent cell. Meiotic cell division takes place only in diploid cells responsible for production of haploid spores or gametes.

Mitosis (mitos = thread) Mitosis is divided into 4 phases or stages termed as

(i) Prophase (ii) Metaphase

(iii) Anaphase (iv) Telophase

These phases refer to the changes taking place in the nucleus

Prophase : It shows three subphases :

(i) Early prophase

(a) Centriole divides and each of the two centrioles start moving

towards opposite poles of the nucleus of the dividing cell.

(b) Chromosomes appear as long threads, and start coiling.

(c) Nucleus enlarges and becomes less distinct

(ii) Middle prophase

(a) Chromosome condensation is complete and they become short and thick

(b) Each chromosome is made up of two chromatids held together at their centromeres.

(c) Each chromatid contains newly replicated daughter DNA molecule.

(iii) Late Prophase

(a) Centrioles reach the opposite poles of the dividing cell.

(b) Some spindle fibers extend from pole to the equator of the dividing cell.

(c) Nuclear membrane disappears

(d) Nucleolus is not visible.

Metaphase

(a) chromosomes are brought towards the equator of the cell, with the help of spindle fibers.

b) Each chromosome becomes attached to the two spindle fibres by centromere.

Whereas each centromere is joined to the opposite poles.

(c) The sister chromatids are not yet separated. (Fig. 4.13b) because the centromere has not divided

Anaphase

(a) Centromeres of all the chromosomes divide and then each chromatid becomes a chromosome.

(b) Spindle fibers contract and pull the centromeres to the opposite poles.

(c) As the chromosomes are pulled by spindle fibers to opposite poles by their centromeres, they acquire various shapes such as V, J or I depending upon the position of centromere.

(d) Half the number of chromosomes move towards one pole and the other half to the opposite pole.

(e) Cytokinesis begins as the cleavage furrow starts from the periphery towards the center in animal cells, and in plants, cell plate appears in the center that grows centrifugally towards periphery.

Telophase

(a) Chromosomes uncoil to form a chromatin network as in the parent nucleus.

(b) New nuclear membrane is formed around each daughter nucleus

(c) Nucleolus reappears again in each newly formed daughter nucleus.

Cytokinesis

It is the process of the division of cytoplasm of a dividing cell into two. It is initiated in the beginning of telophase and is completed by the end of telophase. The mechanism of cytokinesis is different in plant and animal cells. In an animal cell, invagination of plasma membrane proceeds from the periphery of the cell towards the interior. In plant cell phragmoplast (cell plate) begins to form in the center of cell and then expands towards the periphery.