**Introduction:**

Human physiology is the study of human organs and of the cells that make them up. An understanding of human physiology is helpful in a variety of fields, such as medicine, fitness, and biology

**What is physiology?**

• Physiology tests how organs and systems within the body work, how they communicate, and how they combine their efforts to make conditions favorable for survival.

• The study of physiology is, in the other word, the study of life. It asks questions about the internal workings of organisms and how they interact with the world around them.

The major systems covered in the study of human physiology are as follows:

Circulatory system, Digestive/excretory system, Endocrine system, Musculoskeletal system, Nervous system, Renal/urinary system, Reproductive system and Respiratory system.

**Cell physiology**:

The cell is the basic living unit of the body. Each organ is an aggregate of many different cells held together by intercellular supporting structures. Each type of cell is specially adapted to perform one or a few particular functions.

**Organization of the Cell**

A typical cell, as seen by the light microscope it is consist of two major parts are the nucleus is separated from the cytoplasm by a nuclear membrane, and the cytoplasm is separated from the surrounding fluids by plasma membrane. the nucleus and the cytoplasm. The different substances that make up the cell are collectively called protoplasm. ***Protoplasm*** is composed mainly of five basic substances: water, electrolytes, proteins, lipids, and carbohydrates.

**Physical Structure of the Cell**

The cell is not only a bag of fluid, enzymes, and chemicals; it also contains highly organized physical structures, called intracellular organelles. The physical nature of each organelle is an important as the cell’s chemical constituents for cell function. The most important organelles and other structures of the cell are shown in figure (1)



Figure 1: internal organelles in the cytoplasm.

**Cell Membrane**

The cell membrane (also called the plasma membrane), which envelops the cell, is a thin, elastic structure only 7.5 to 10 nanometers thick. It is composed of proteins and lipids

**Chemical composition of CM:**

Is composed of **lipid & protein,** which are mixed together and give the shape of model (figure 2) The ratio of lipid to protein is variable depending of the type and function of cell. Ex: nerve cell has high lipid contains were as membrane of RBC are high protein.

***Lipid contain:*** *cholesterol & phospholipid.*

The function of cholesterol is to give fluidity to cell membrane and prevent cell down.

Phospholipid has duple layer and two reactions.

1- Hydroph**i**lic reaction of the head of the phospholipid.

2- Hydroph**o**bic reaction of the tail of the phospholipid.

The head because they are hydrophilic there are directed to the location were water is present (extra cellular fluid).

the tails because they are hydrophobic there are directed to the interior (intra cellular).



**Figure 2: cell membrane composition**

***Proteins:*** is a globularmasses floating in the lipid bilayer. Most of which are glycoproteins.

Two types of proteins: **Integral proteins** that protrude all the way through the membrane and **peripheral proteins** that are attached only to one surface of the membrane and do not penetrate all the way through.

The membrane occasionally perforated to form membrane pore; the diameter is between 7-10 A˚. These pores used to transport materials across membrane.

**Membrane proteins have several functions to cell and there are many types**:

1. Structural proteins.

2. Carrier proteins

3. Pump proteins

4. Channel proteins

5. Enzyme proteins

**6.** Receptor proteins

**7.** Glycoproteins



**Transport of materials across plasma membrane**

There are many methods for transport:

1- Diffusion.

2- Osmosis.

3- Active transport.

4- Transport of very large molecules.

**1-Diffusion**.

Passive transport: Movement of molecules across cell membrane from the region of higher concentration to areas of lower concentration. (*Downhill movement)*. It doesn’t need energy of transport. This type of transport includes:

***a).* simple diffusion**: movement of molecules through the pore according to concentration gradient. The size of these molecule should be less than the size of pore, ***ex***: Na, K H2O, Ca. They all have less than 7 A˚.

***b)***. **Facilitated Diffusion** (carrier \_ mediated transport): this is transport of material have size large than the size of pore. This is done by using carrier protein on the cell membrane, there are specific carriers for specific material. That transport also “*downhill movement”*. Figure 3 illustrate types of diffusion.



**Figure 3: Types of diffusion**

**Factors that influence passive transport:**

1- Solubility: fat soluble materials are transport passively thought cell membrane

2- Size of molecules

3- Charge of molecules

4- Concentration gradient.

5- Surface area of diffusion.

**1-Osmosis:**

Transport of solvent through a semipermeable membrane from region of low solute concentration to higher one.

 Two solutions that have the same concentration of solutes are said to be **isotonic** (equal tension). When cells and their extracellular environments are isotonic, the concentration of water molecules is the same outside and inside the cells, and the cells maintain their normal shape (and function).

 Osmosis occurs when there is an imbalance of solutes outside of a cell versus inside the cell. A solution that has a higher concentration of solutes than another solution is said to be **hypertonic**, and water molecules tend to diffuse into a hypertonic solution

Cells in a hypertonic solution will shrivel as water leaves the cell via osmosis. In contrast, a solution that has a lower concentration of solutes than another solution is said to be **hypotonic**, and water molecules tend to diffuse out of a hypotonic solution. Cells in a hypotonic solution will take on too much water and swell, with the risk of eventually bursting.



**2-Active transport:**

Movement of molecules across cell membrane from the region lower concentration to areas of higher concentration (*upper hill movement*). This type is need expenditure energy, characterized of this transport is similar to the carrier transport, ex: Na-K-ATPase.

**3- Transport of very large molecules:**

 More than 7-10 A˚ and not have carriers.

Very large particles enter the cell by a specialized function of the cell membrane called *endocytosis.* The principal forms of endocytosis are *pinocytosis* and *phagocytosis.* **Pinocytosis** means drinking of minute particles that form vesicles of extracellular fluid and particulate constituents inside the cell cytoplasm. **Phagocytosis** means ingestion of large particles, such as bacteria or portions of degenerating tissue.

**Steps of endocytosis:**

1- The cell membrane receptors attach to the surface ligands of the particle.

2. The edges of the membrane around the points of attachment evaginate outward within a fraction of a second to surround the entire particle; then, progressively more and more membrane receptors attach to the particle ligands to form a closed phagocytic vesicle.

3. The vesicle pushed to the interior.

4. The vesicle separates from the cell membrane, leaving the vesicle in the cell interior.

*Note/ phagocytosis called cell\_ eating, pinocytosis called cell drinking.*

**Cell organelles:**

1- **Endoplasmic Reticulum** (E R)

a) Rough Endoplasmic Reticulum (RER): Involve with protein synthesis. So that found in large number in protein secreting cells (endocrine gland that secrete protein hormone).

b) Smooth Endoplasmic Reticulum (SRE): Involve in steroidogenesis and detoxification, found in (endocrine gland that secrete steroid hormone).

c) Sarcoplasmic Reticulum (SR): control the contraction and relaxation of muscle.

2- **Ribosome**: bound with RER to synthesis protein.

3- **Golgi apparatus**: glycosylation of protein.

4- **Lysosomes:** hydrolysis of damage and dead cell.

5- **Peroxisomes:** Peroxisomes are similar physically to lysosomes

6- **Mitochondria**: production energy to the cell.

7- **Nucleus**: consider of the control center function of the cell.