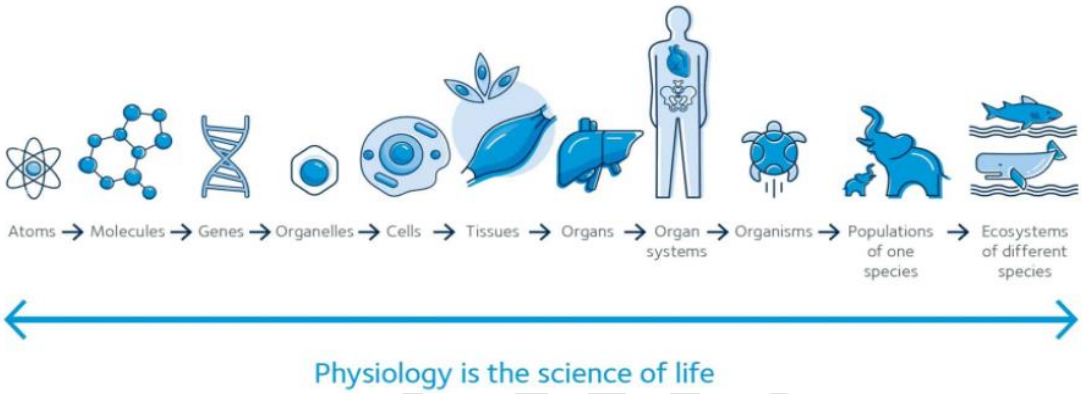
Physiology

Physiology :- Physiology is the study of how the human body works. It describes the chemistry and physics behind basic body functions, from how molecules behave in cells to how systems of organs work together. It helps us understand what happens in a healthy body in everyday life and what goes wrong when someone gets sick.



What Physiology Tells Us About the Body

Doctors use physiology to learn more about many different organ systems, including:

- The cardiovascular system -- your heart and blood vessels
- The digestive system -- the stomach, intestines, and other organs that digest food
- The endocrine system -- glands that make hormones, the chemicals that control many body functions
- The immune system -- your body's defense against germs and disease
- The muscular system -- the muscles you use to move your body
- The nervous system -- your brain, spinal cord, and nerves
- The renal system -- your kidneys and other organs that control the fluid in your body
- The reproductive system -- sex organs for men and women
- The respiratory system -- your lungs and airways

- The skeletal system -- bones, joints, cartilage, and connective tissue

Cell physiology

Cell Structure and Function:

What is a Cell?

Cells are the microscopic fundamental units of all living things. Every living thing has cells: bacteria, protozoans, fungi, plants, and animals are the main groups (Kingdoms) of living things. Some organisms are made up of just one cell (e.g. bacteria and protozoans) **unicellular(prokaryote)** , but animals, including human beings, are **multicellular (Eukaryote).**

Type of Specialized Cells of the Human Body:

• **Nerve Cells**: Also called Neurons, these cells are in the nervous system and function to process and transmit information (it is hypothesized).

• **Epithelial cells**: Functions of epithelial cells include secretion, absorption, protection, transcellular transport, sensation detection, and selective permeability. Epithelium lines both the outside (skin) . • **Exocrine cells**: These cells secrete products through ducts, such as mucus, sweat, or digestive enzymes.

• **Endocrine cells**: These cells are similar to exocrine cells, but secrete their products directly into the bloodstream instead of through a duct. Endocrine cells are found throughout the body but are concentrated in hormone-secreting glands such as the pituitary.

Blood Cells: The most common types of blood cells are:

• **red blood cells (erythrocytes)**.

• **white blood cells (leukocytes)**.

Cell Size

Cells are the smallest living units within our body, but play a big role in making our body function properly. Many cells never have a large increase in size after they are first formed from a parental cell. Typical stem cells reproduce, double in size, then reproduce again.

- **Eukaryotes and prokaryotes cells:**

Prokaryotes	Eukaryotes
Most prokaryotes are unicellular.	Most eukaryotes are multicellular.
The nucleus is poorly defined due to the absence of a nuclear membrane.	The nucleus is well defined and is surrounded by a nuclear membrane.
Nucleolus is absent.	Nucleolus is present.
Cell organelles such as plastids, mitochondria, golgi bodies, etc. are absent.	Cell organelles such as plastids, mitochondria, golgi bodies, etc. are present.
Bacteria and blue-green algae are prokaryotic cells.	Fungi, plant, and animal cells are eukaryotic cells.

Cellular components

Several different molecules interact to form organelles with our body. Each type of organelle has a specific function. Organelles perform the vital functions that keep our cells alive.

1- Cell Membranes

The boundary of the cell, sometimes called the plasma membrane, separates internal metabolic events from the external environment and controls the movement of materials into and out of the cell. This membrane is very selective about what it allows to pass through; this characteristic is referred to as "**selective permeability**." For example, it allows oxygen and nutrients to enter the cell while keeping toxins and waste products out. The plasma membrane is a **double phospholipid membrane, or a lipid bilayer,** with the **nonpolar hydrophobic tails pointing toward the inside of the membrane** and the **polar hydrophilic heads forming the inner and outer surfaces of the membrane.**

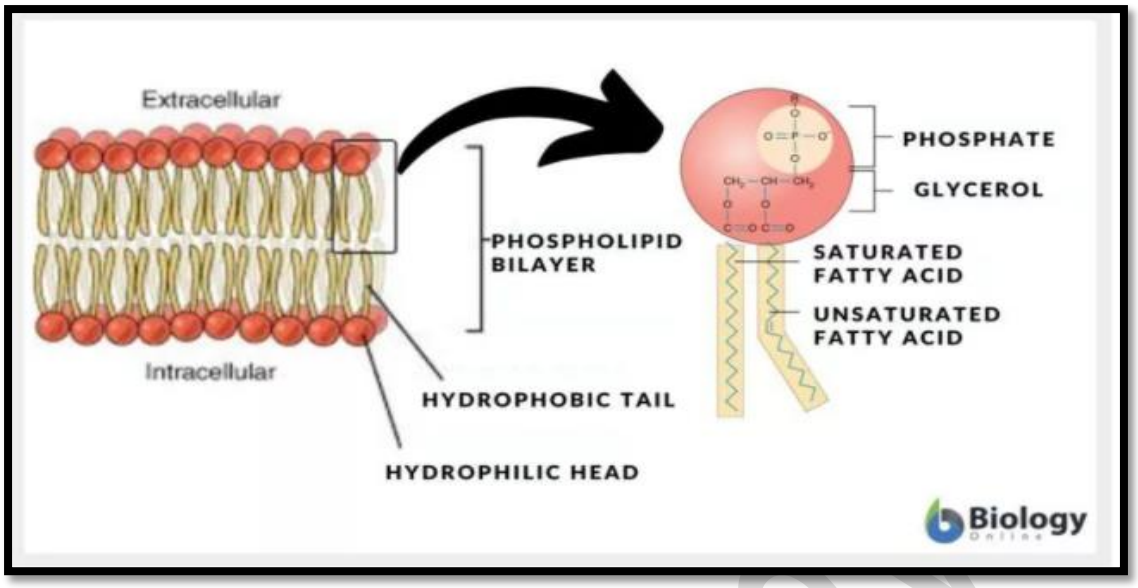


Figure 1. Cell membrane

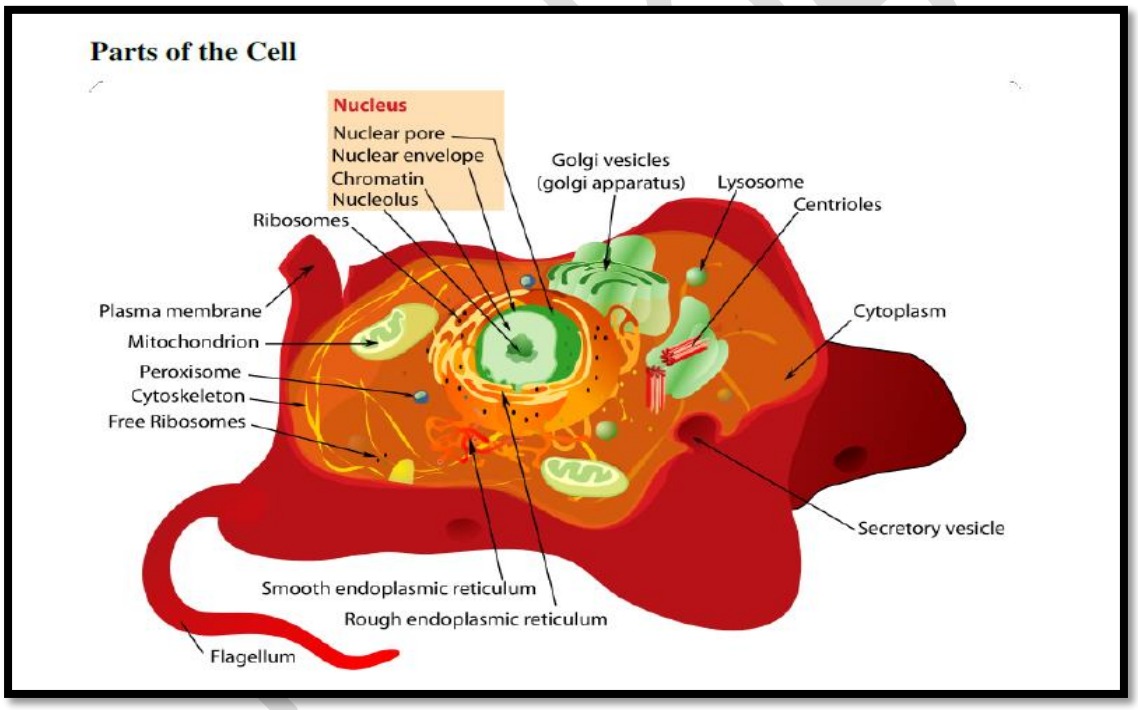


Figure 2. All component of living cell.

Function of cell membrane:

1- The cell membrane keeps the cytoplasm from leaking out.
2- Separates the interior of the cell from the outside environment.
3- The cell membrane consists of a lipid bilayer that is semipermeable
4- The cell membrane regulates the transport of materials entering and exiting the cell.

2- Cytoplasm

The gel-like material within the cell membrane is referred to as the cytoplasm. It is a fluid matrix, the cytosol, which consists of 80% to 90% water, salts, organic molecules and many enzymes that catalyze reactions, along with dissolved substances such as proteins and nutrients. The cytoplasm plays an important role in a cell, serving as a "molecular soup" in which organelles are suspended and held together by a fatty membrane.

Function:

1- The cytoplasm surrounds the nuclear envelope and the cytoplasmic organelles.

2-Maintain the shape and consistency of the cell and again.

3-It is also a storage space for chemical substances indispensable to life, which are involved in vital metabolic reactions, such as anaerobic glycolysis and protein synthesis.

3-Nucleus

Controls the cell; houses the genetic material (DNA). The nucleus is the **largest of the cells organelles**. Cells can have more than one nucleus or lack a nucleus all together. **Skeletal muscle** cells contain more than one nucleus whereas **red blood cells** do not contain a nucleus at all. The nucleus is bounded by the **nuclear envelope**.

1- The nucleus contains **the DNA**, as mentioned above, the hereditary information in the cell.
2- Normally the DNA is spread out within the nucleus as a threadlike matrix called **chromatin**.
3- The nucleus contain histones that serve to organize the lengthy DNA, coiling it into bundles called nucleosomes.
4- Also visible within the nucleus are one or more nucleoli, each consisting of DNA in the process of manufacturing the components of ribosomes. **Ribosomes are shipped to the cytoplasm where they assemble amino acids into proteins**.

5- The nucleus also serves as the site for the separation of the chromosomes during cell division.

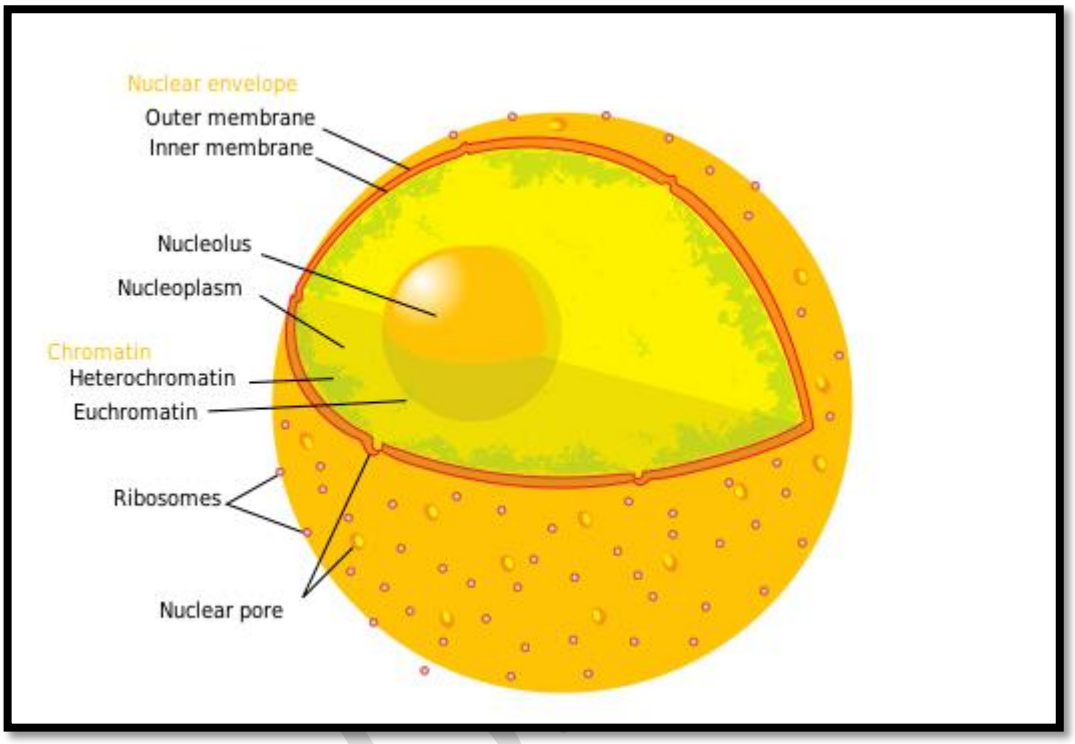


Figure 3. Diagram human cell nucleus.

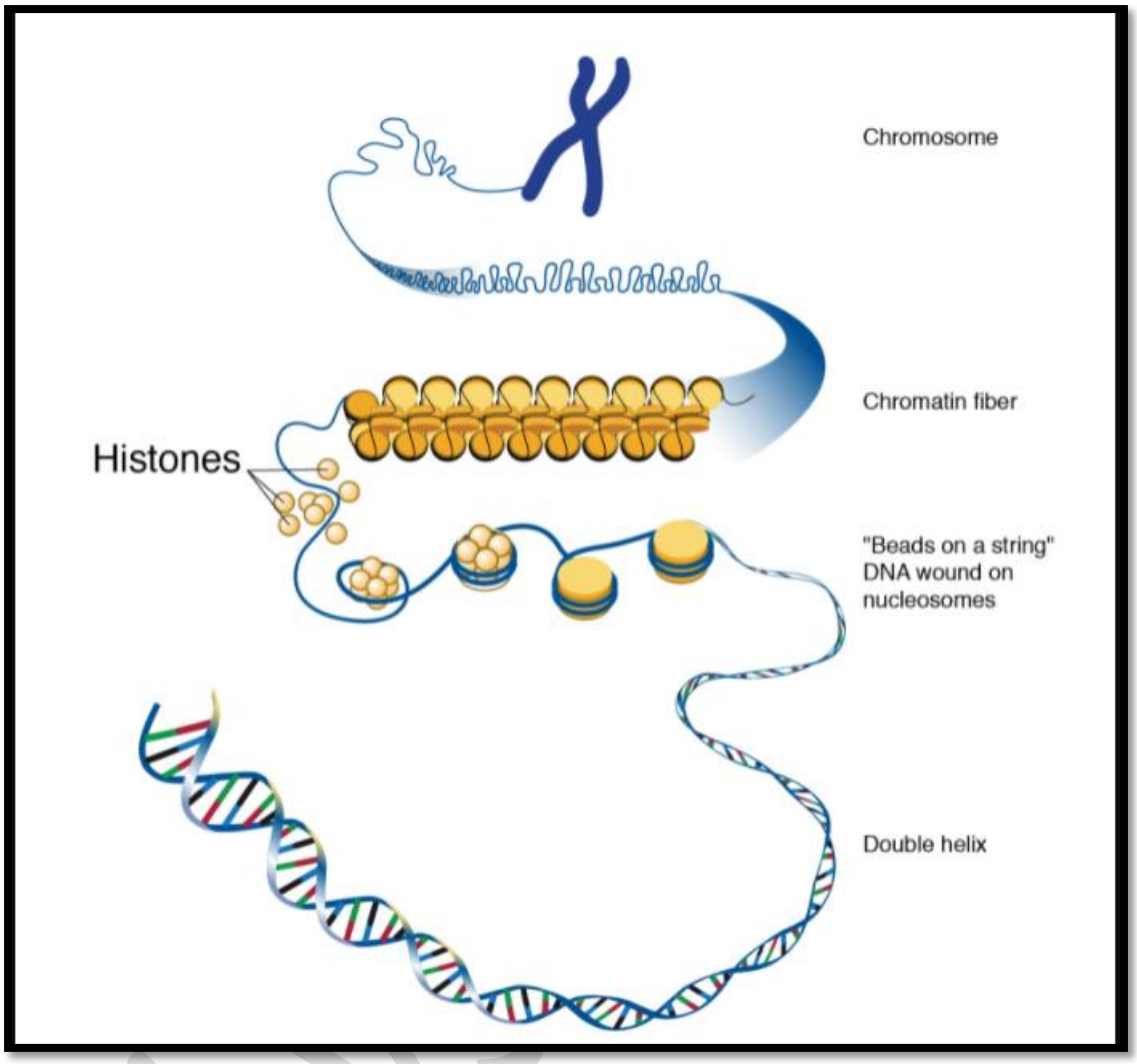


Figure 4. component of chromatin

A histone is a protein that provides structural support to a chromosome. In order for very long DNA molecules to fit into the cell nucleus, they wrap around complexes of histone proteins, giving the chromosome a more compact shape.

Chromatin is the material that makes up a chromosome that consists of DNA and protein. The major proteins in chromatin are proteins called histones.

Histones= Five unite of protein
Chromatin= protein (histones) + DNA

4-Ribosomes

Ribosomes play an active role in the complex process of **protein synthesis**, where they serve as the structures that facilitate the joining of amino acids.

5-Mitochondria

Mitochondria are tiny **sac-like** structures found near the nucleus Mitochondria are the organelles that function as the cell "**powerhouse‹"** generating ATP, the universal form of energy used by all cells. It converts food nutrients such as glucose, to a fuel (ATP) that the cells of the body can use. Little shelves called **cristae** are formed from folds in the inner membrane. Cells that are metabolically active such as **muscle‹ liver and kidney cells** have high energy requirements and therefore have more mitochondria.

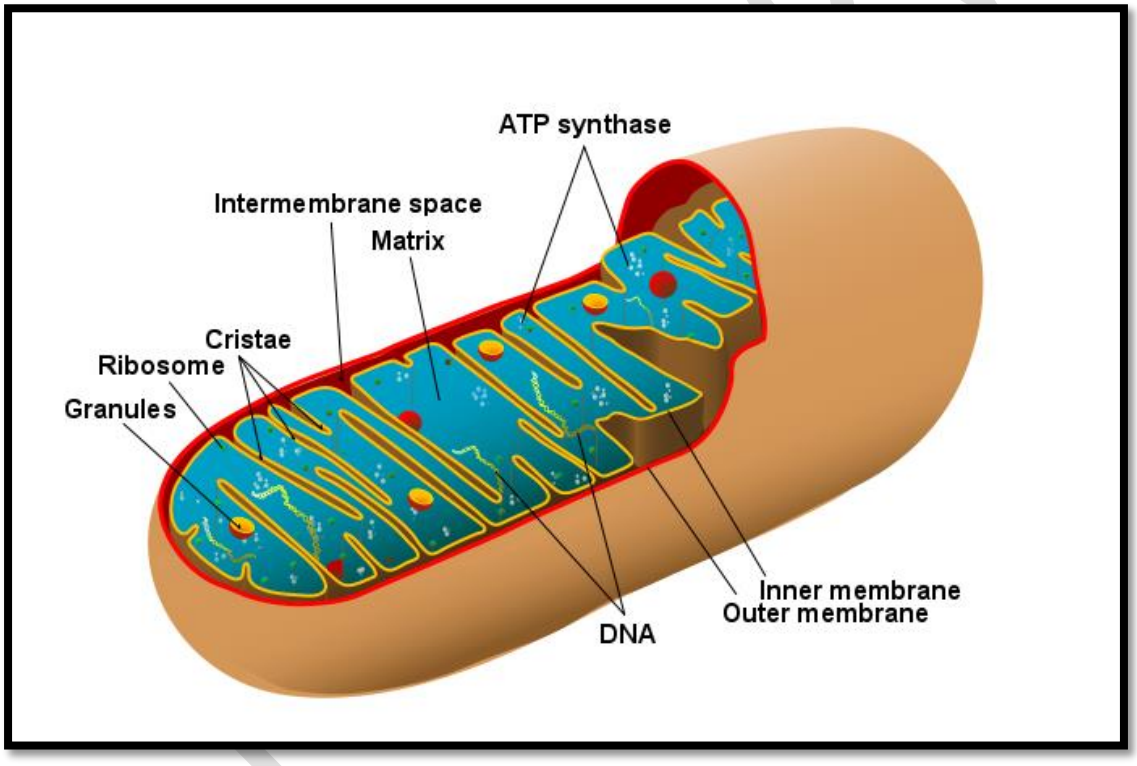


Figure 5. Structure of Mitochondria.

6-Endoplasmic Reticulum

Endoplasmic means "within the plasm" and reticulum means "network".

A complex three dimensional internal membrane system of flattened sheets, sacs and tubes, that play an important role in making proteins and

shuttling cellular products; also involved in metabolisms of fats, and the production of various materials.

Its consist of tow types:

A- **Rough endoplasmic reticulum** has characteristic bumpy appearance due to the multitude of ribosomes coating it. It is the site where proteins in the cytoplasm are synthesized.

B- **Smooth endoplasmic reticulum** provides a variety of functions, including lipid synthesis and degradation, and calcium ion storage. In liver cells, the smooth ER is involved in the breakdown of toxins, drugs, and toxic byproducts from cellular reactions.

7- Golgi Apparatus

"Packages" cellular products in sacs called vesicles so that the products can cross the cell membrane and exit the cell.

The **Golgi apparatus** is the central delivery system for the cell. It is a group of flattened sacs arranged much like a stack of bowls.

1- **They function to modify and package proteins and lipids into vesicles**.
2- **The Golgi apparatus also transports lipids and creates lysosomes and organelles involved in digestion.**

8- Vacuoles

Spaces in the cytoplasm that sometimes serve to carry materials to the cell membrane for discharge to the outside of the cell.

Vacuoles are formed during endocytosis when portions of the cell membrane are pinched off.

9- Lysosomes

Lysosomes are sac-like compartments that contain a number of degradative enzymes. They are built in the Golgi apparatus.

They break down harmful cell products and waste materials, cellular debris, and foreign invaders such as bacteria, and then force them out of the cell.

Extracellular structures

1-Extracellular matrix

Human cells, like other animal cells, do not have a rigid cell wall. Human cells do have an important and variable structure outside of their cell membrane called the extracellular matrix. Sometimes this matrix can be extensive and solid (examples = calcified bone matrix, cartilage matrix), while other times it consists of a layer of extracellular proteins and carbohydrates. **This matrix is responsible for cells binding to each other and is incredibly important in how cells physically and physiologically interact with each other.**

2-Flagella and cilia

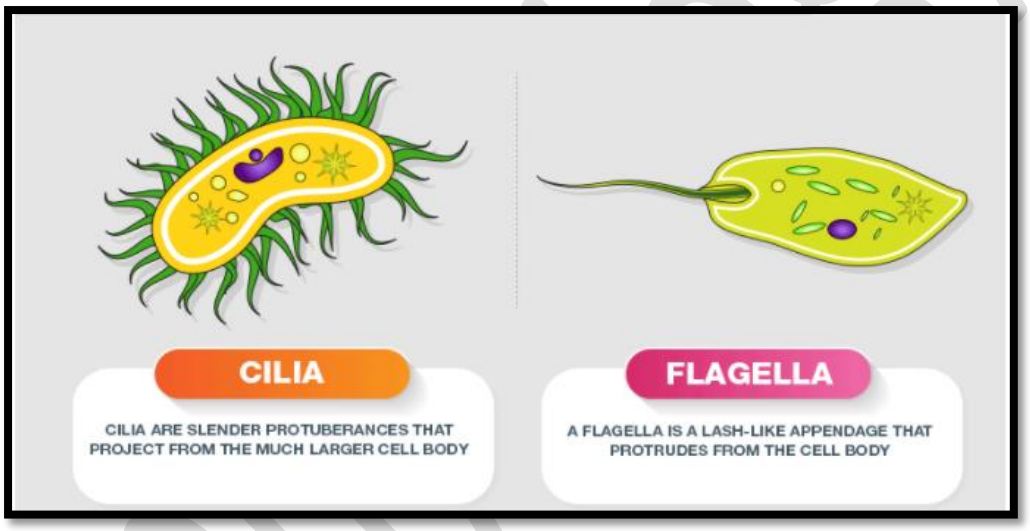


Figure 6. Flagella and cilia

Cilia vs Flagella

The difference between cilia and flagella are summarized below.

Difference Between Cilia And Flagella	
Cilia	**Flagella**
The number of cilia is comparatively more (typically ranges in the thousands)	The number of flagella is comparatively less (usually ranges from 1 to 8)
Cilia is usually shorter in length	Flagella is comparatively longer in length
Beating pattern of cilia is very complicated – Can move in a wide range of motions	Beating pattern of Flagella involves circular, wave-like or propeller-like motion
Found in Eukaryotic cells	Found in prokaryotic cells and eukaryotic cells
Cilia are of two types: Non-motile cilia and Motile cilia	Flagella are of three types: Bacterial flagella, Archaeal flagella and Eukaryotic flagella

3-Cell Junctions

The plasma membranes of adjacent cells are usually separated by extracellular fluids that allow transport of nutrients and wastes to and from the bloodstream. In certain tissues, however, the membranes of adjacent cells may join and form a junction. **Three kinds of cell junctions are recognized:**

• **Desmosomes** are protein attachments between adjacent cells. It is hold together tissues that undergo considerable stress, such as our skin or heart muscle.

• **Tight junctions** are tightly stitched seams between cells., preventing the movement of material between the cell. Tight junctions are characteristic of cells lining the digestive tract, where materials are required to pass through cells.

• **Gap junctions** are narrow tunnels that directly connect the cytoplasm of two neighbouring cells, consisting of proteins called connexons. These

proteins allow only the passage of ions and small molecules. Gap junctions allow communication between cells through the exchange of materials or the transmission of electrical impulses.