



BIOPHYSICS

LECTURE I

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WHAT IS BIOPHYSICS?



- Biophysics is a field of science that uses the ideas and tools of physics to understand how living things work
 - Cell movement
 - Signal transmission

CELLS



- **The cell:** is the smallest building unit of any organism
- Each organ is made up of many different types of cells that are held together by supportive structures between them.
- Each type of cell is specifically adapted to carry out one or a few specific functions.

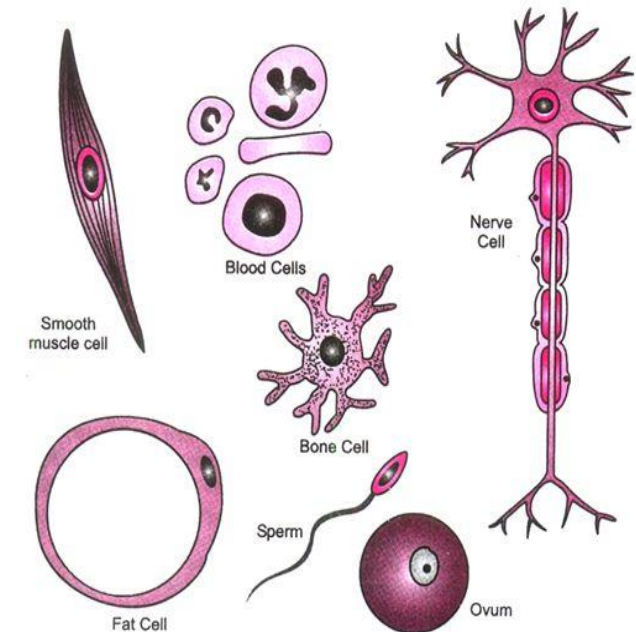
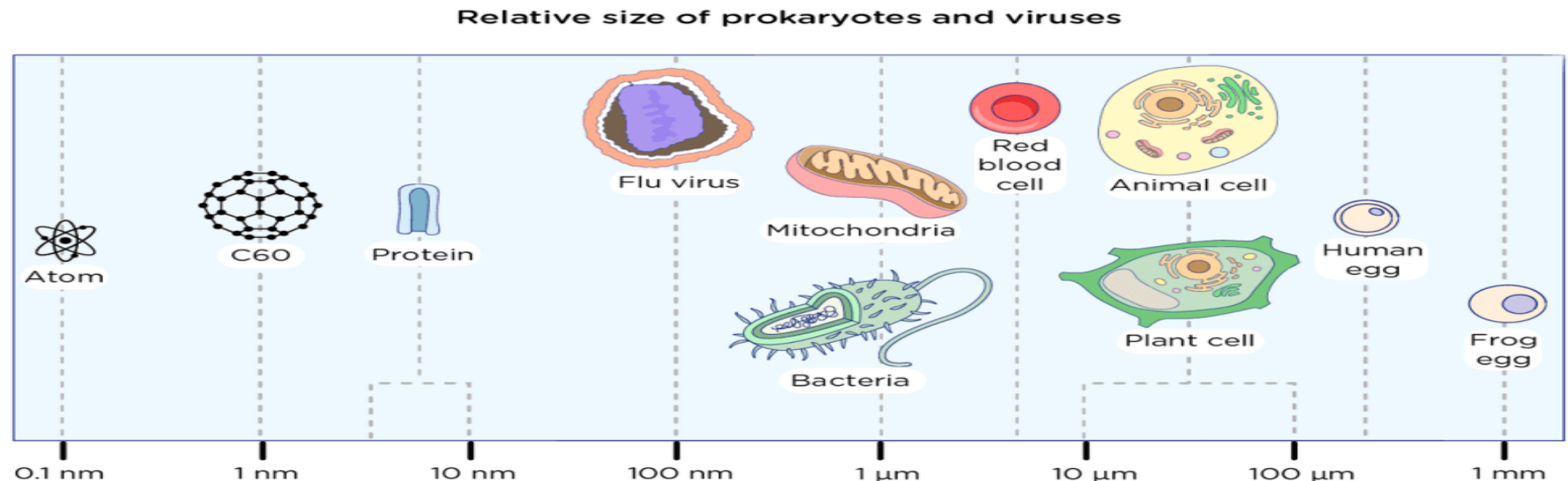


Figure : VARIOUS CELLS FROM THE HUMAN BODY

CELL THEORY



- All living organisms are composed of cells
- Cells are the smallest functional units of all living organisms
- All cells originate from pre-existing cells through the process of cell division



CHARACTERISTICS OF ALL CELLS



- A surrounding membrane
- Protoplasm: a thick fluid containing the cell's components
- Organelles: structures responsible for different cell functions
- Nucleus: the control center containing DNA

CELL TYPES

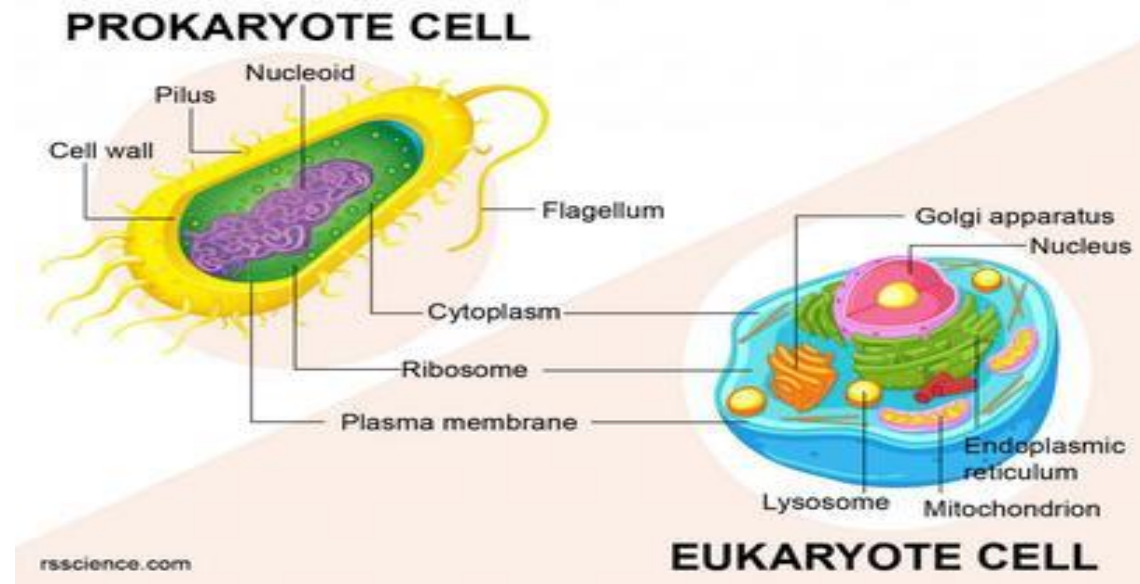


Prokaryotic

Simple cells without a nucleus,
e.g. : bacteria.

Eukaryotic

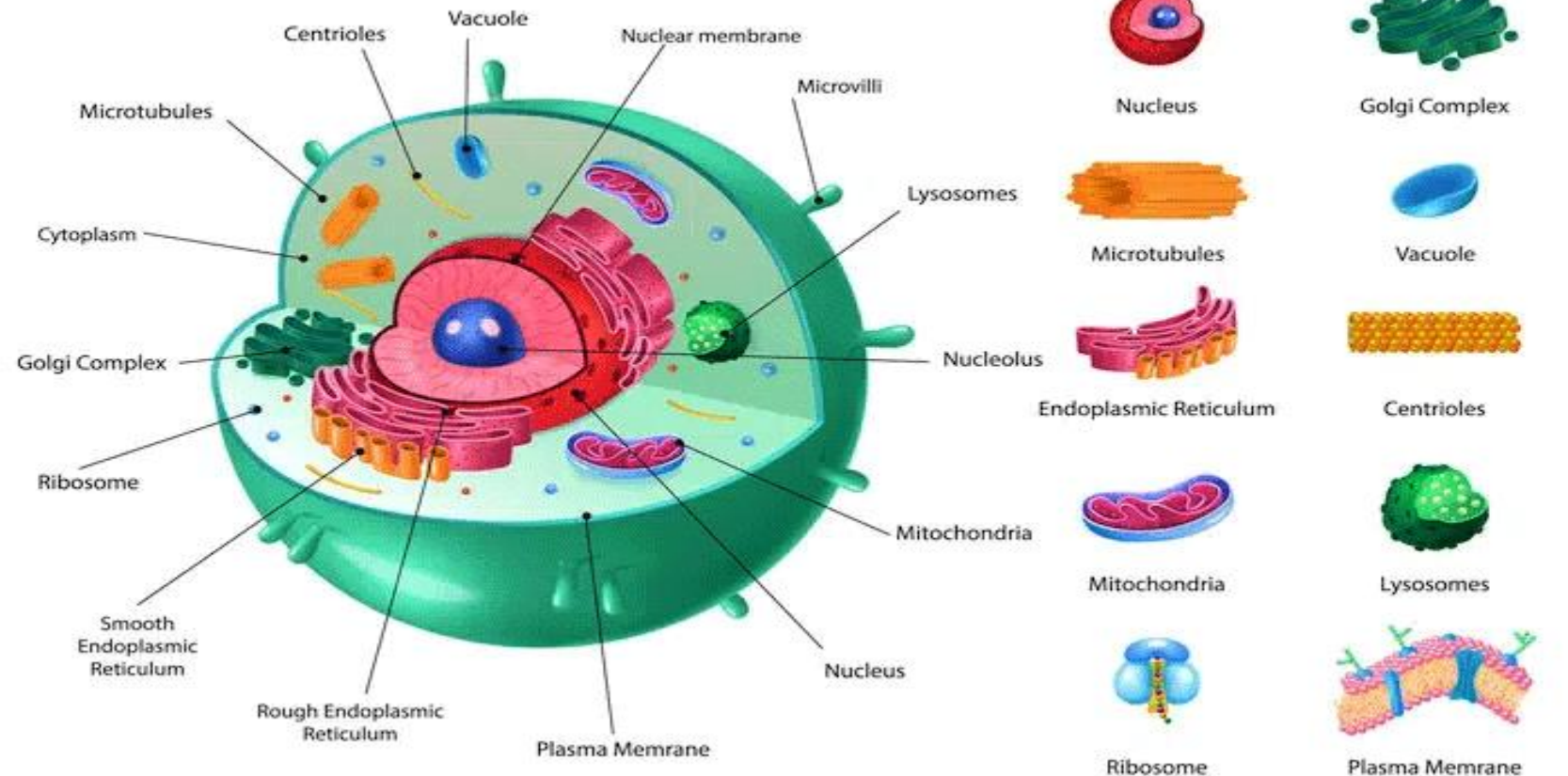
More complex cells with a nucleus,
e.g. : plants, animals and fungi.



ANIMAL CELL



ANIMAL CELL DIAGRAM

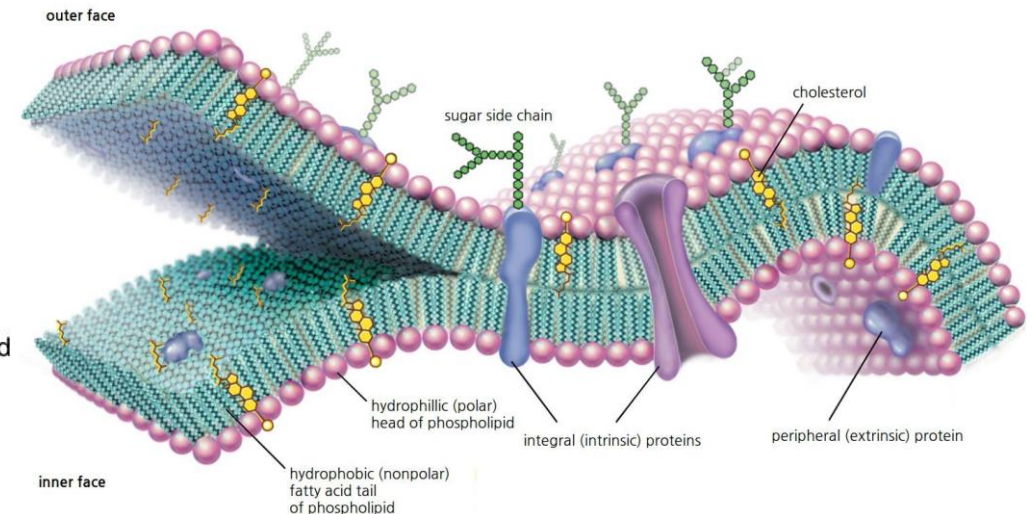
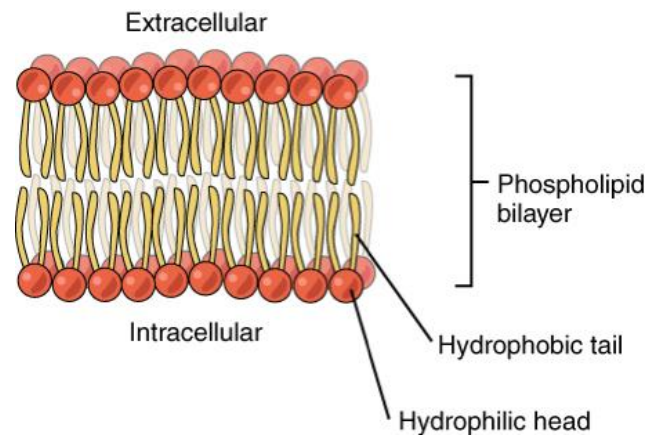
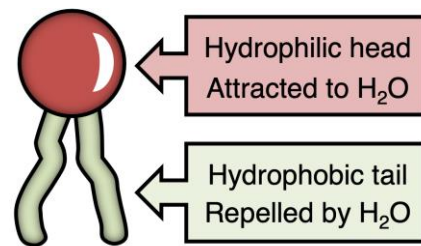


PLASMA MEMBRANE



- Made up of double layer of phospholipids and proteins
- the plasma membrane regulates the exchange of substances
- interacting with the cell's external environment.

Phospholipids: molecules with hydrophilic heads and hydrophobic tails that interact with water.



MEMBRANE PROTEINS

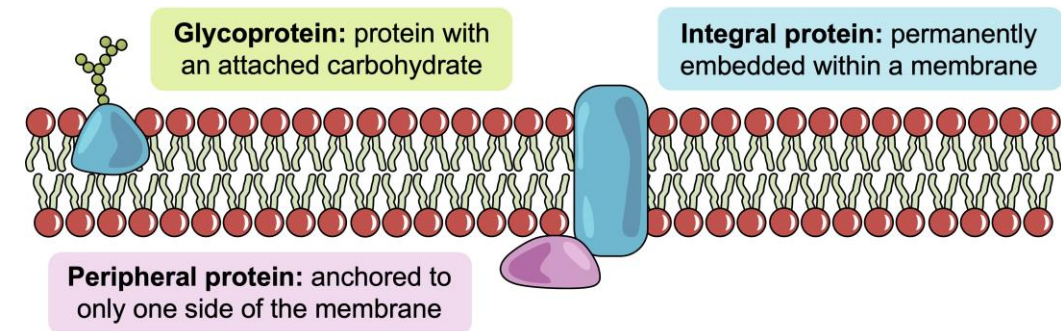
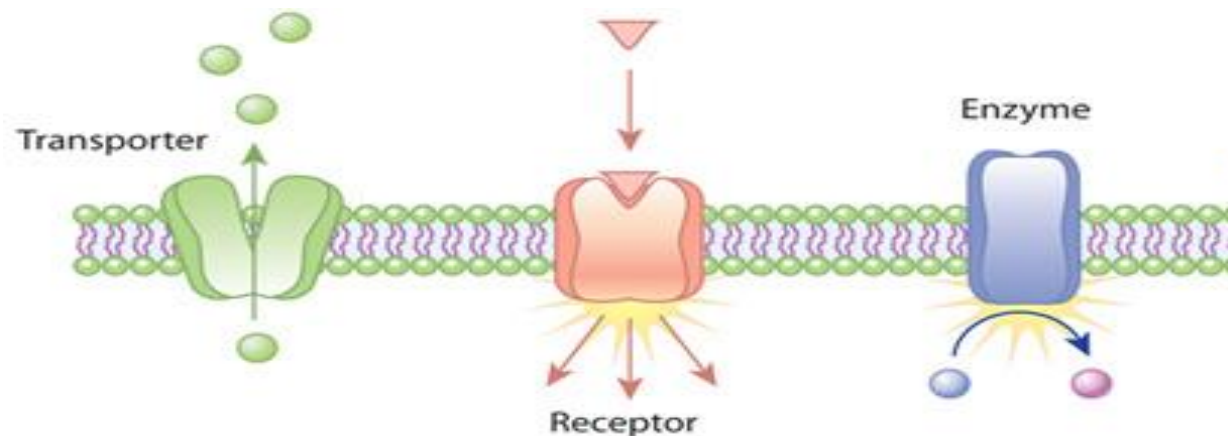


Channels or Transporters:

- These proteins act like doors in the cell membrane, allowing specific molecules to enter or exit the cell.

Receptors:

- Receptors are proteins that receive signals from outside the cell
- When a molecule (like a hormone) binds to a receptor, it triggers a response inside the cell.



MEMBRANE PROTEINS

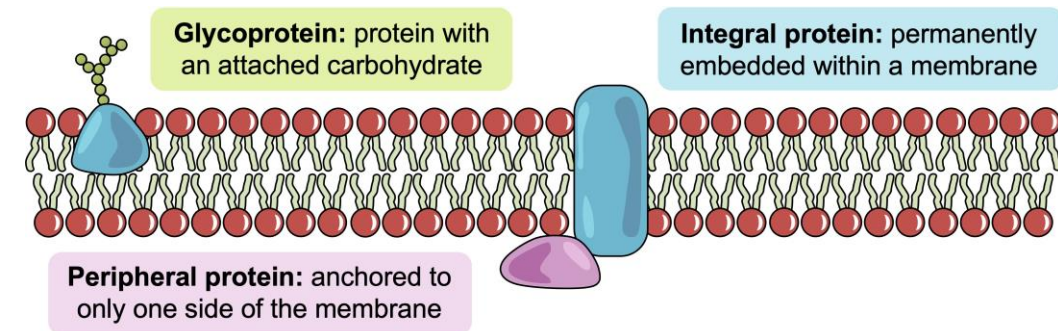
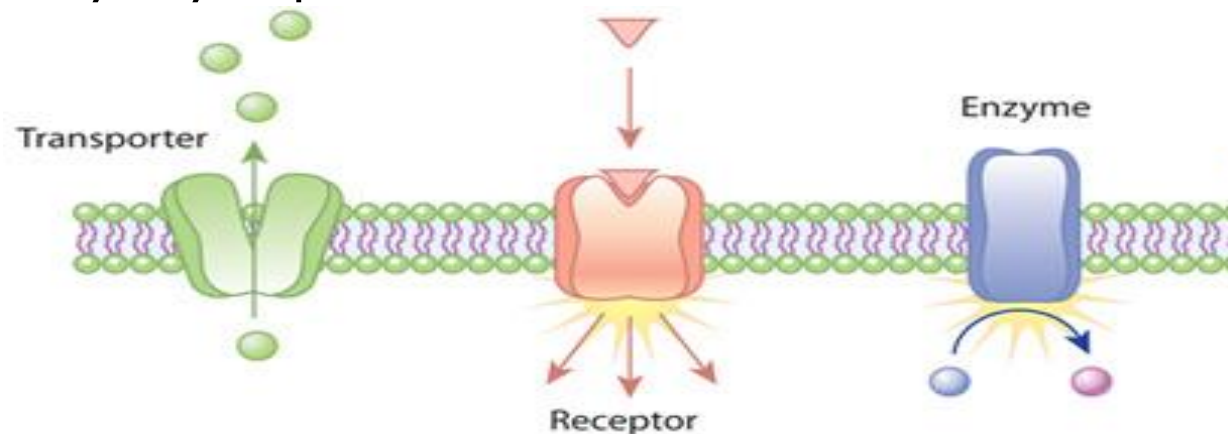


Glycoproteins:

- These proteins have a carbohydrate attached to them.
- They help cells recognize each other and are important for the immune system to identify which cells belong to the body.

Enzymes:

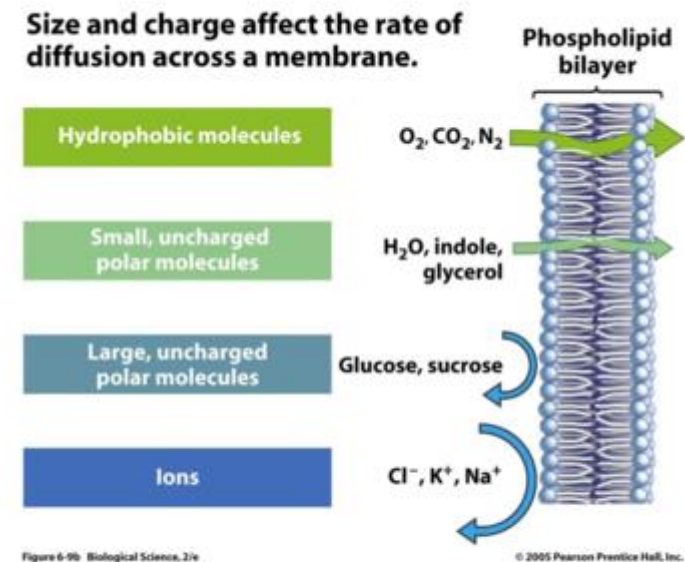
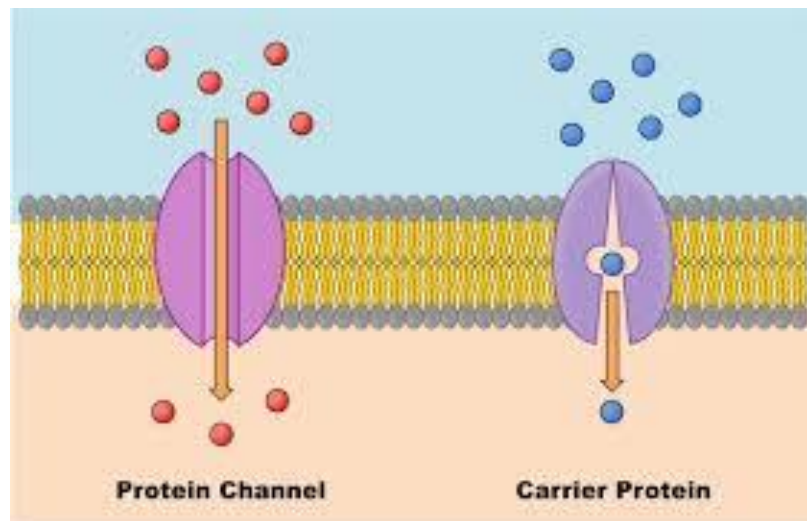
- Enzyme proteins in the membrane help speed up chemical reactions.
- They may help break down substances or build new molecules right at the cell surface.



MOVEMENT ACROSS THE PLASMA MEMBRANE



- Some small molecules can move freely across the membrane
 - **Example:** water, carbon dioxide and oxygen
- Larger molecules or ions need carrier proteins to move across the membrane.



CYTOPLASM



- **A Viscous Fluid** Contains organelles, cytosol, and interconnected filaments.
- **Components:**
 - **Cytosol:** The fluid portion in which organelles are suspended.
 - **Organelles:** Structures that perform specific functions for the cell
 - **Filaments:** Provide structural support and help maintain cell shape.
- **Function:**
 - Facilitates cellular processes.
 - Provides a medium for organelles and biochemical reactions.

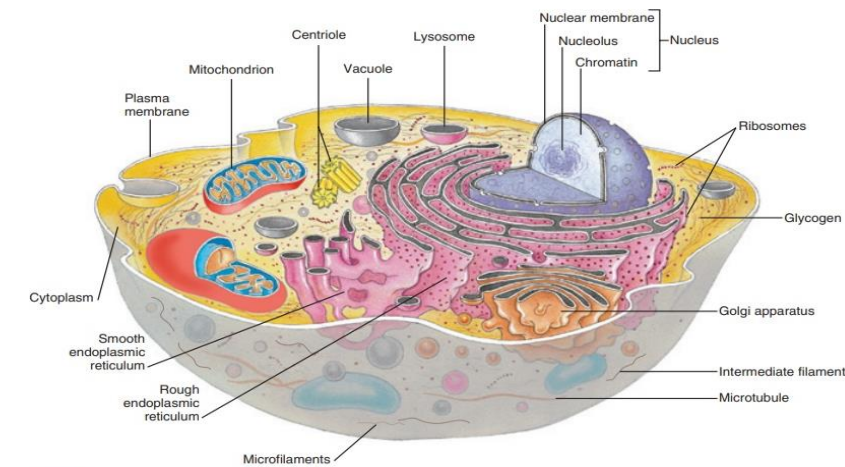
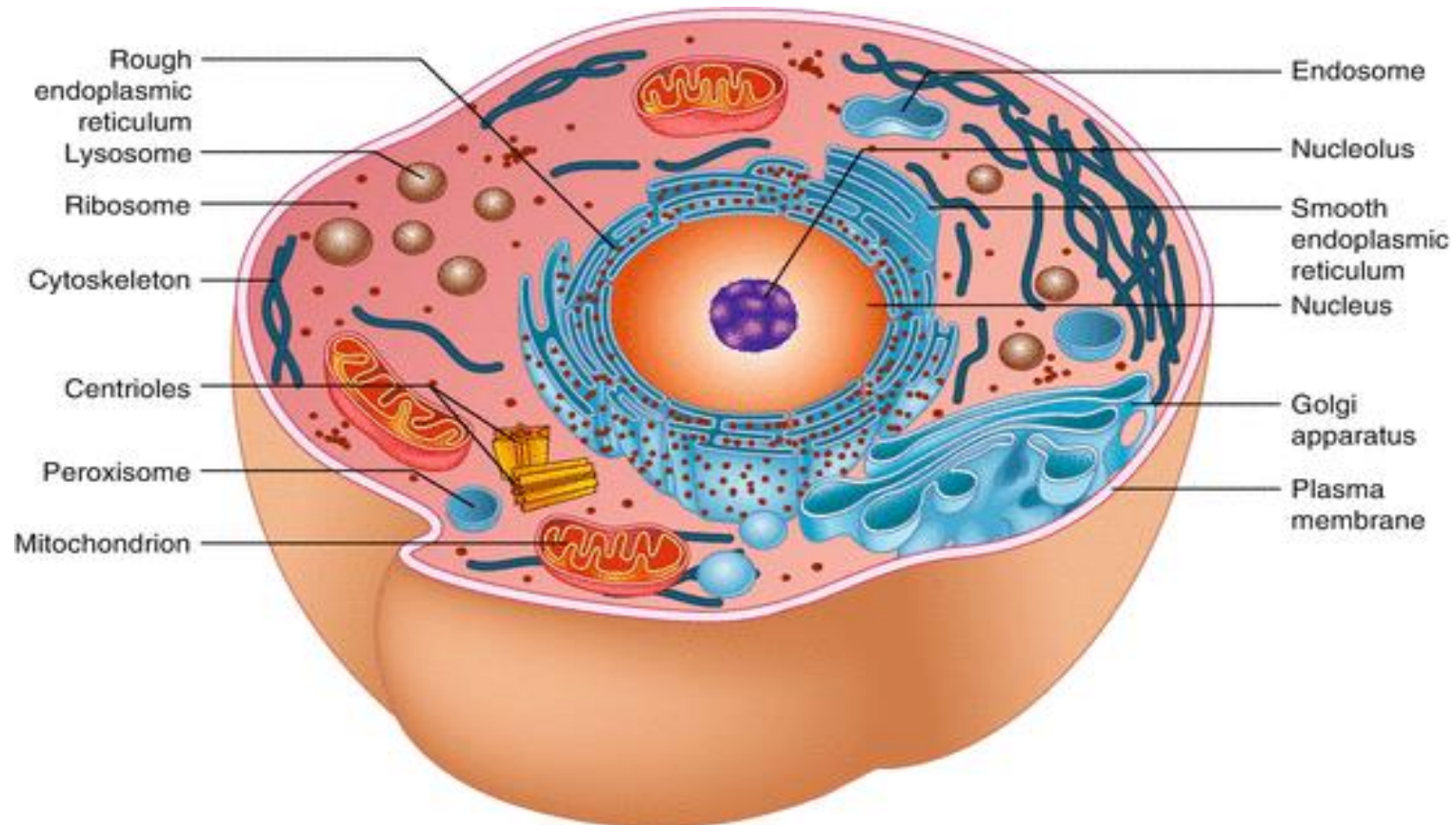


FIGURE 3-1 The cell.

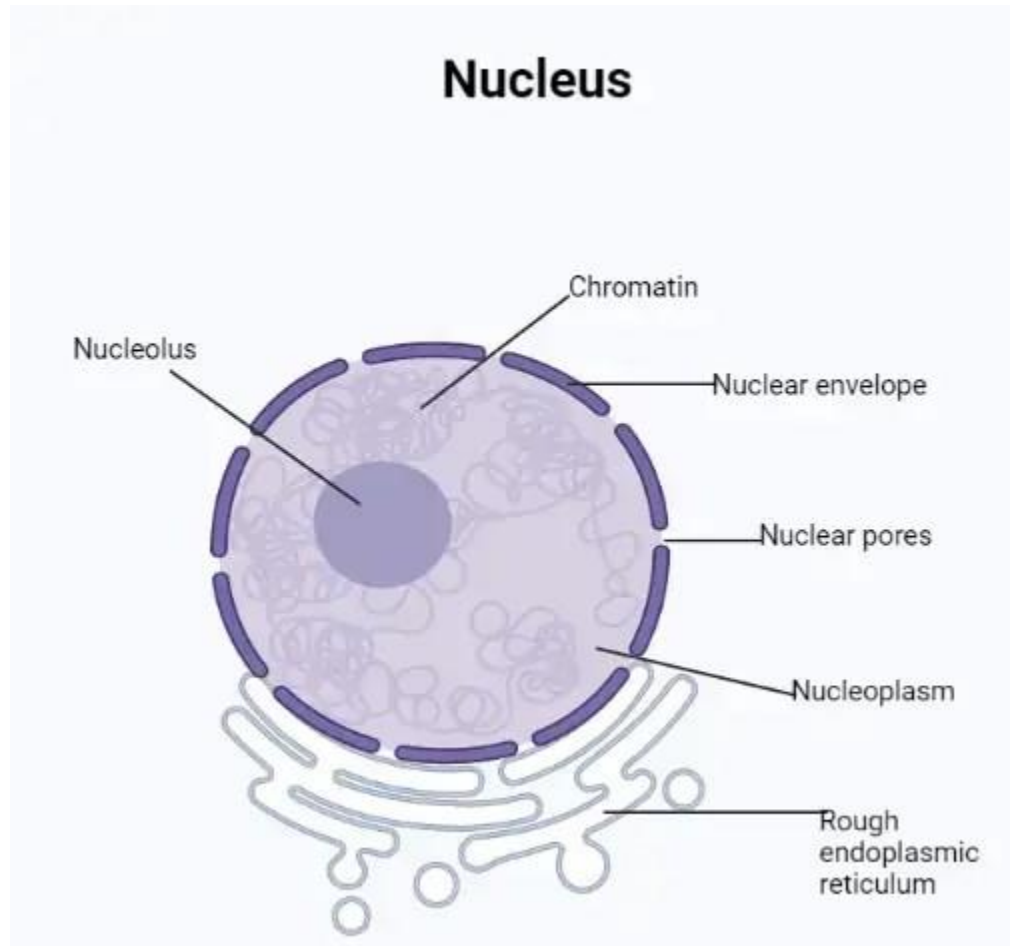
MEMBRANOUS ORGANELLES



- Functional components within cytoplasm Bounded by a membrane



NUCLEUS

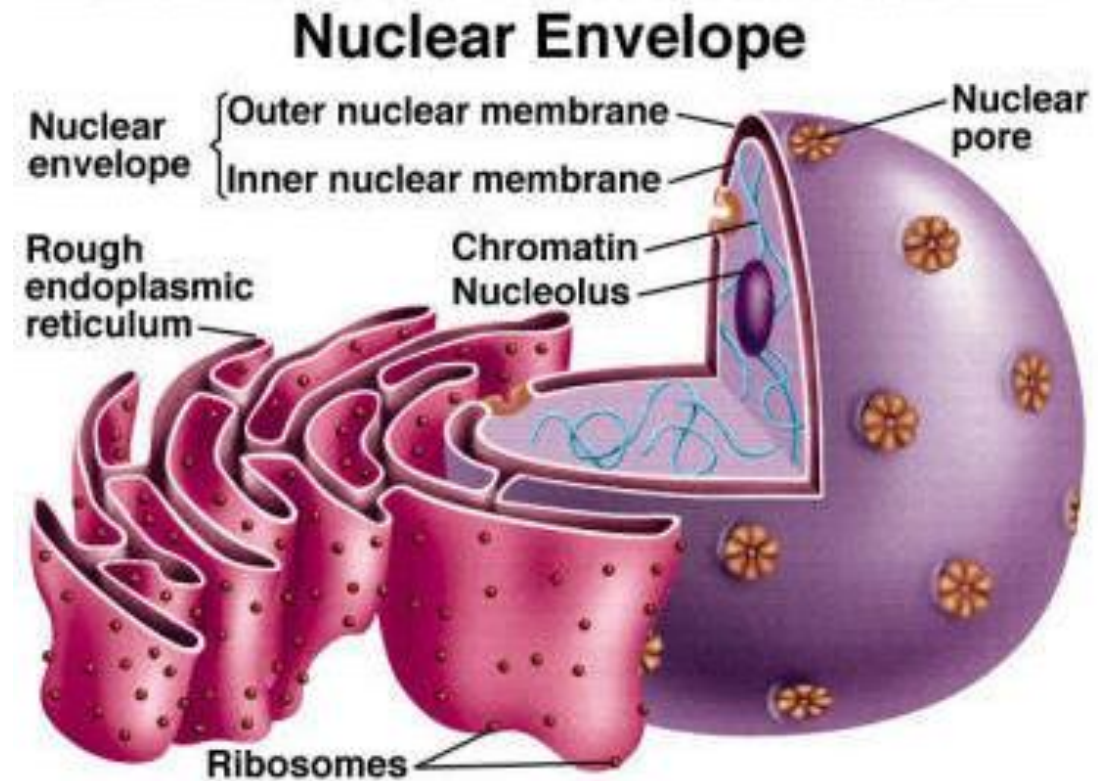


- The control center of the cell, containing DNA.
- Stores genetic information and controls cell activities. It is surrounded by a **nuclear envelope**, which is a double membrane with pores to regulate the exchange of materials with the cytoplasm.

NUCLEAR ENVELOPE



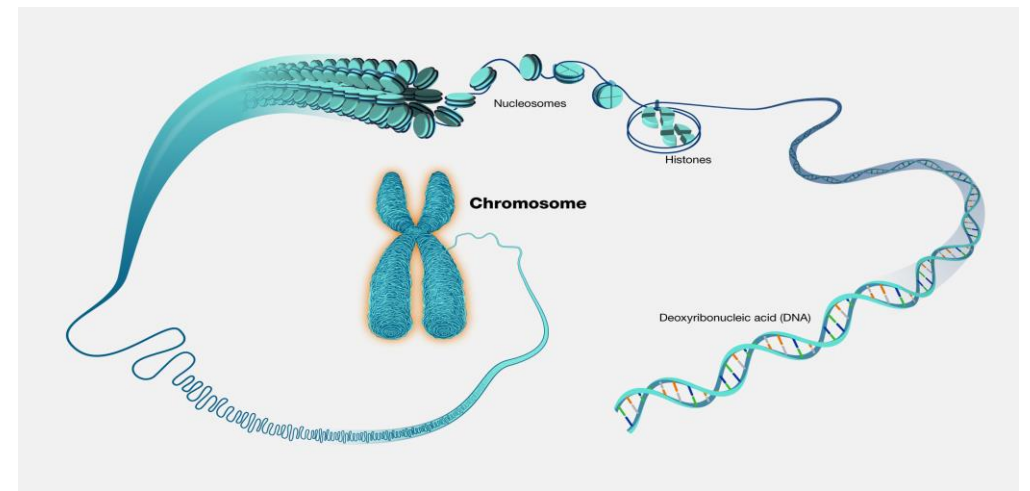
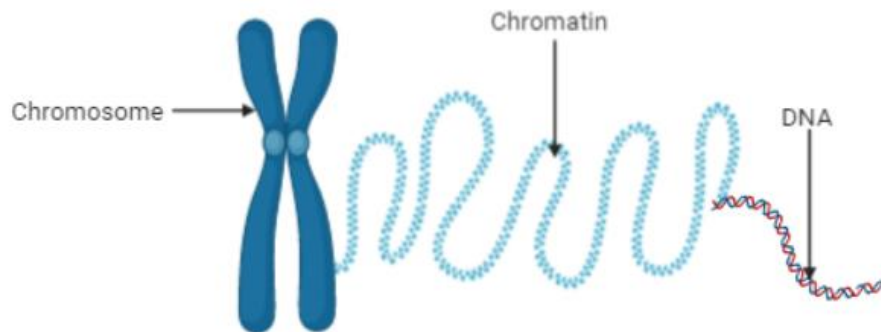
- A **double membrane (10-50 nm apart)** that surrounds the nucleus.
- Protects the DNA and regulates the movement of substances between the **nucleus** and the **cytoplasm** through **nuclear pores**



DNA



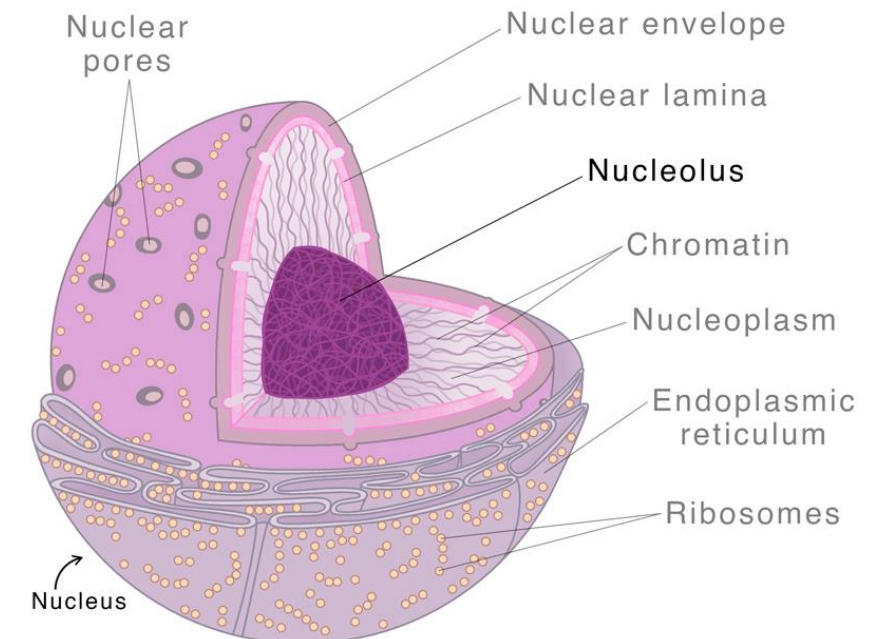
- **DNA (Deoxyribonucleic Acid):** is the molecule that carries the genetic information in all living organisms.
- **Chromatin:** the uncoiled form of DNA found in the nucleus during normal cell activities
- **Chromosomes:**
 - Chromosomes are made of **DNA** wrapped around proteins. They contain all the genetic information required for the cell's functions.



NUCLEOLUS



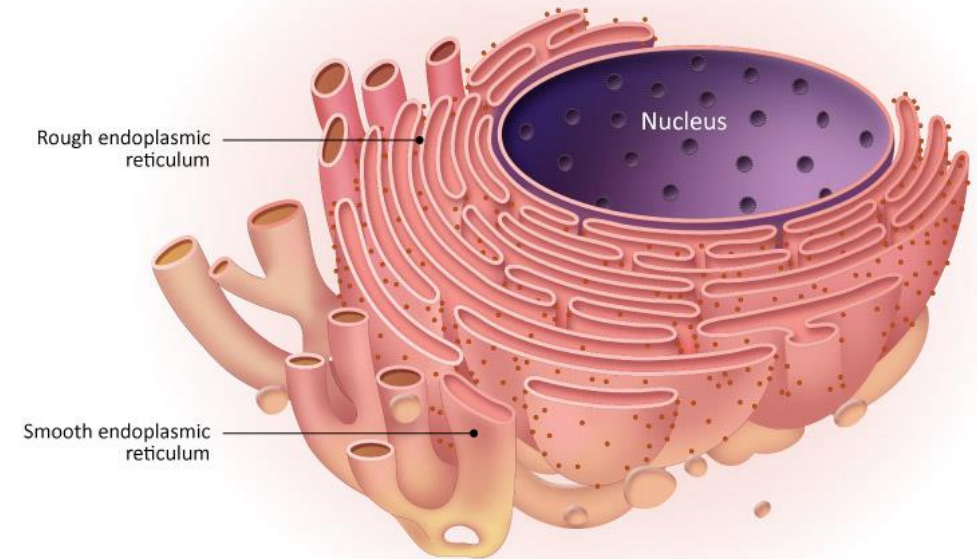
- **Most Cells Have 2 or More:** Many cells contain more than one nucleolus
- **Directs Synthesis of RNA:** The nucleolus is responsible for producing **ribosomal RNA (rRNA)**, which is an essential part of ribosome formation.
- **Forms Ribosomes:** The ribosomes which are involved in protein synthesis, are partially assembled in the nucleolus before being sent out to the cytoplasm where they complete assembly and become functional.



ENDOPLASMIC RETICULUM (ER)



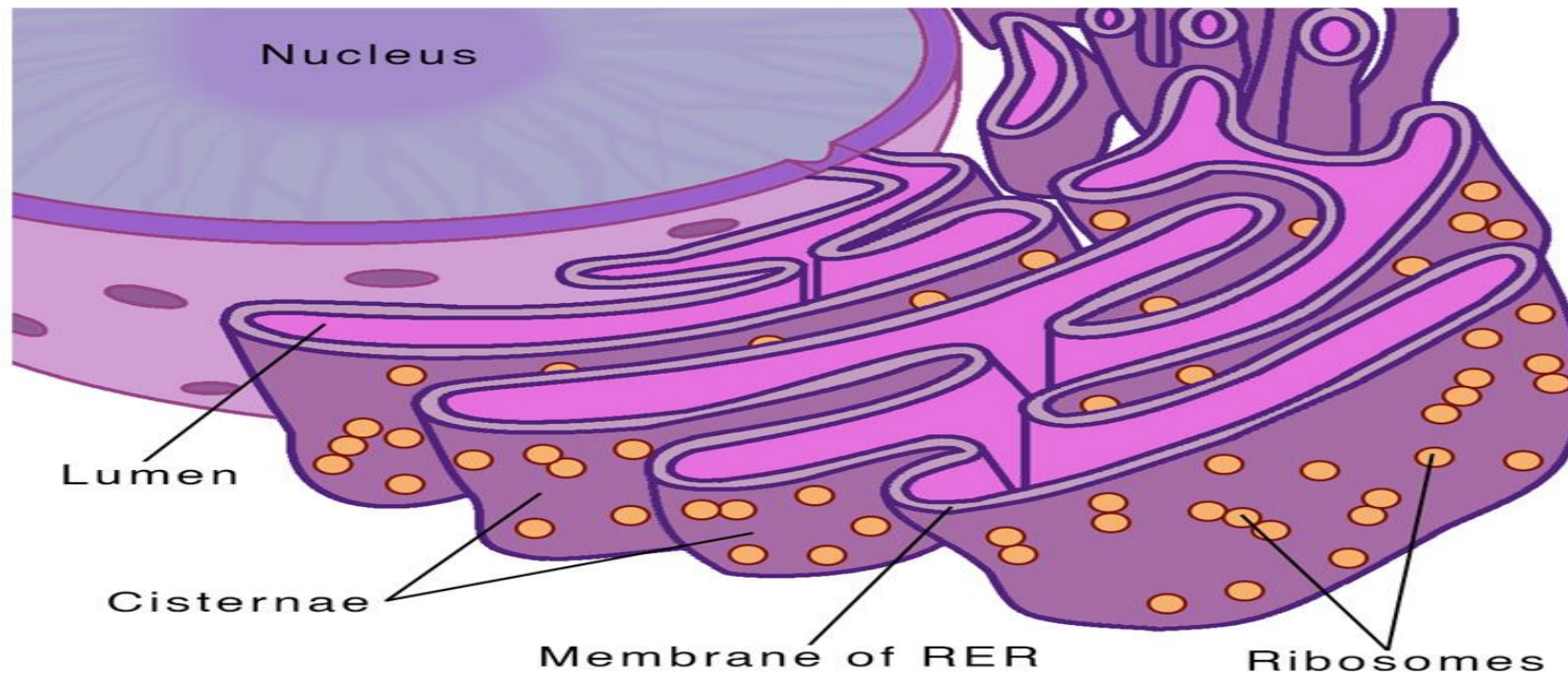
- **Helps Move Substances Within Cells:** The ER acts like a transportation system inside the cell, helping move substances such as proteins and lipids.
- **Network of Interconnected Membranes:** It consists of a series of folded membranes that create channels within the cell, allowing it to efficiently transport materials
- **Types of ER:**
 - Rough Endoplasmic reticulum
 - Smooth Endoplasmic reticulum
- **Ribosomes:** The main job of ribosomes is to produce **proteins** through a process called **protein synthesis**.



ROUGH ENDOPLASMIC RETICULUM



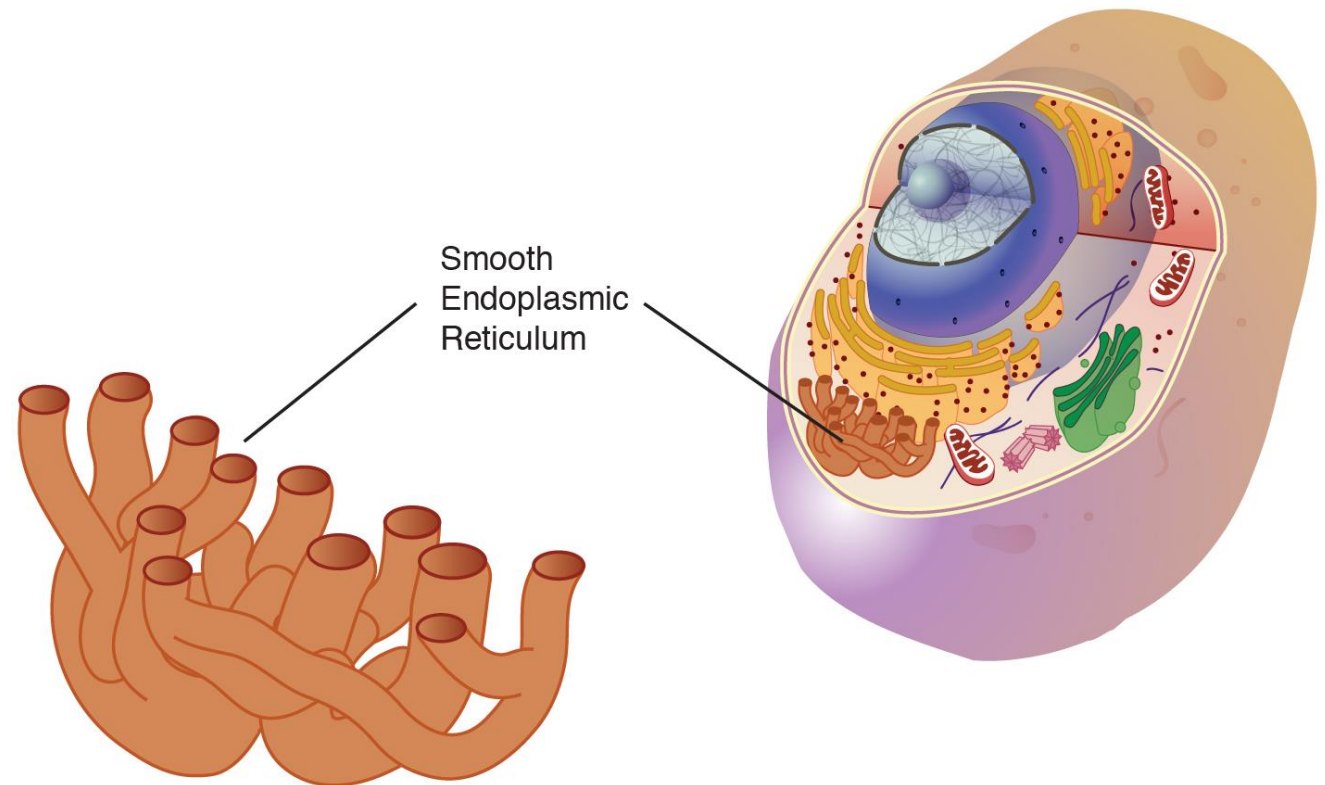
- Has ribosomes on its surface, giving it a "rough" look.
(note: not all ribosomes attached to RER)
- Involved in **protein synthesis**.



SMOOTH ENDOPLASMIC RETICULUM



- Lacks ribosomes, giving it a "smooth" appearance.
- Involved in the **synthesis of lipids**, metabolism of carbohydrates, and detoxification.

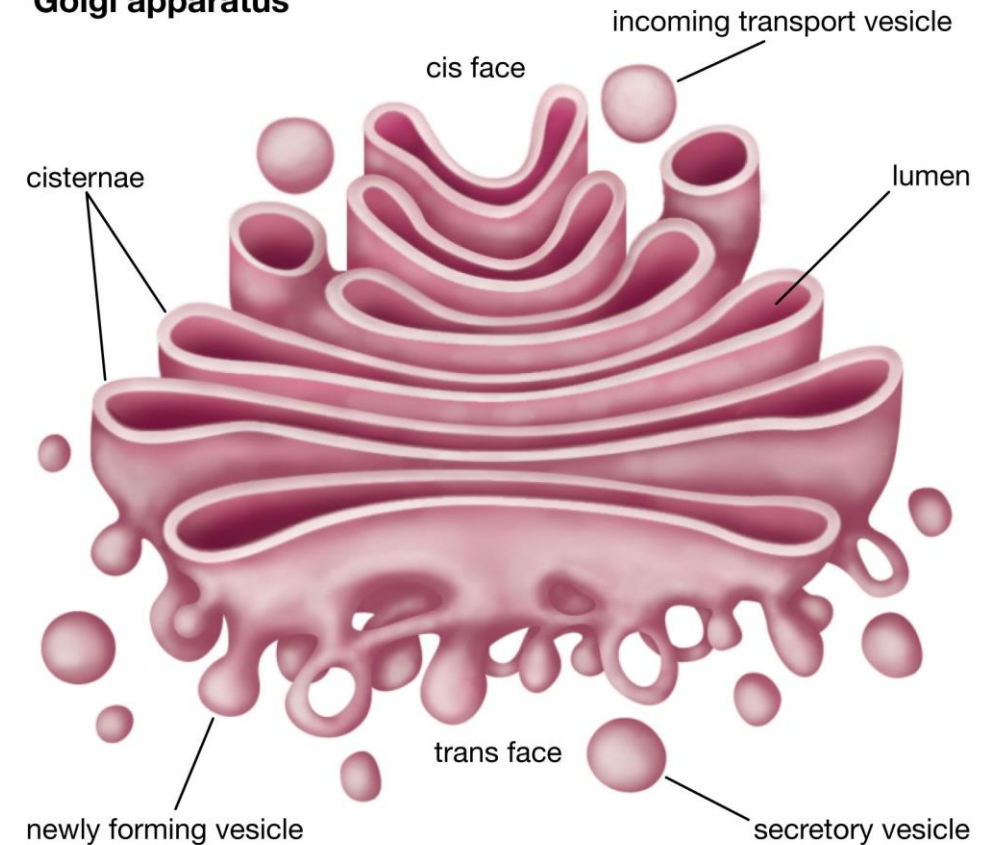


GOLGI APPARATUS



- A stack of membrane-bound sacs
- **Sorts, packages and delivers** proteins and lipids for transport to their final destinations, either inside or outside the cell.

Golgi apparatus

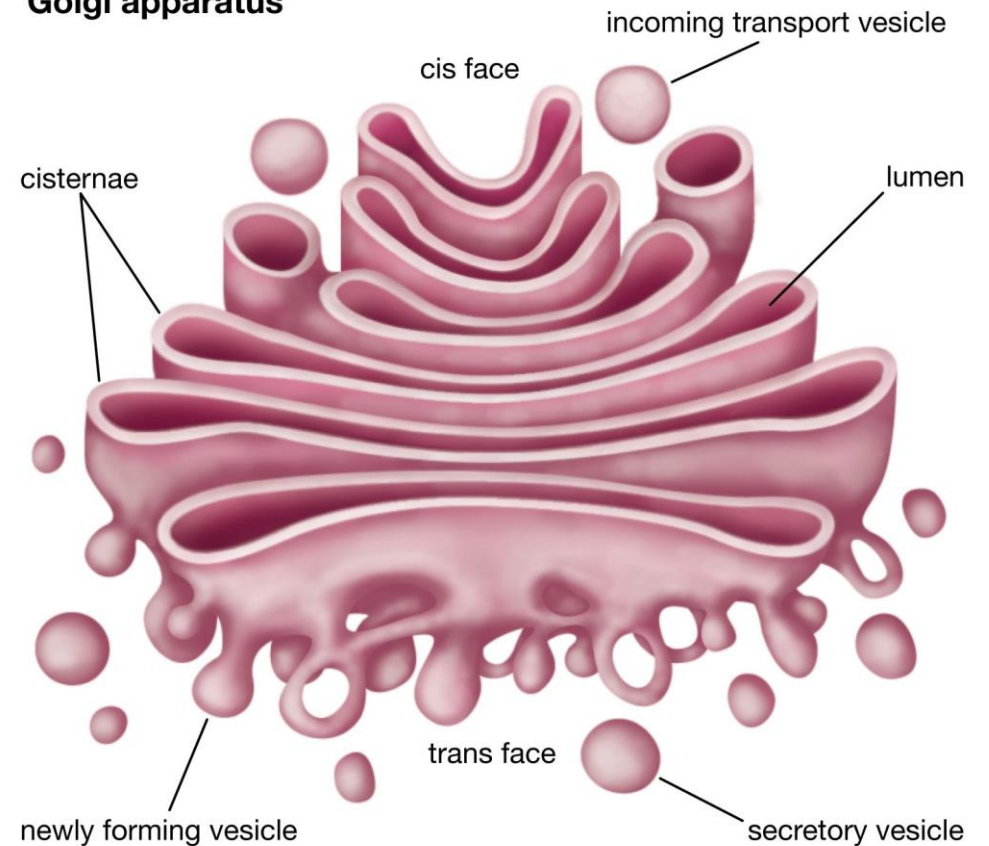


GOLGI APPARATUS PACKAGING STEPS



1. Molecules are transported to the Golgi apparatus inside vesicles.
2. Vesicles fuse with the Golgi membrane.
3. The Golgi apparatus modifies the molecules as needed.
4. Modified molecules are packaged into new vesicles.
5. These vesicles bud off from the Golgi apparatus.
6. Vesicles can then merge with the plasma membrane to release their contents outside the cell.

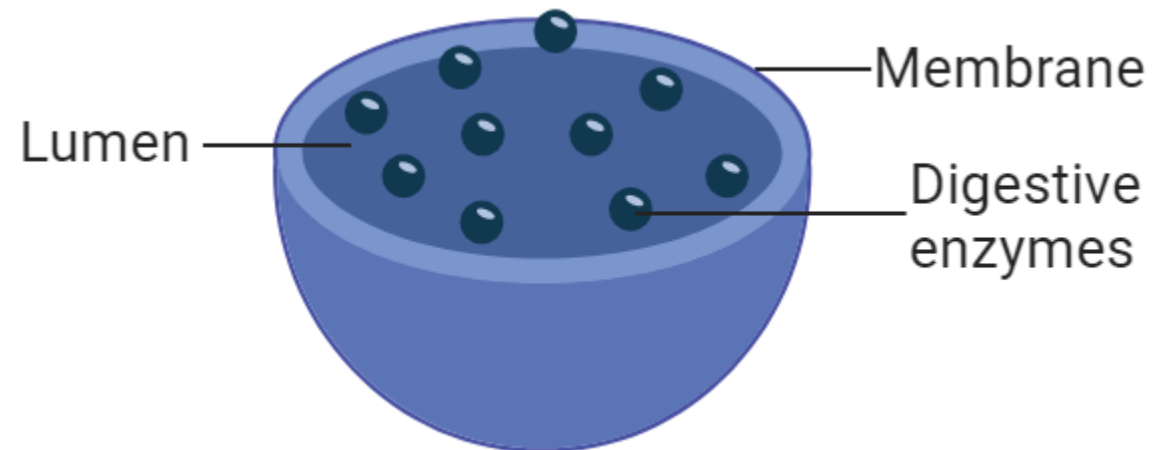
Golgi apparatus



LYSOSOMES



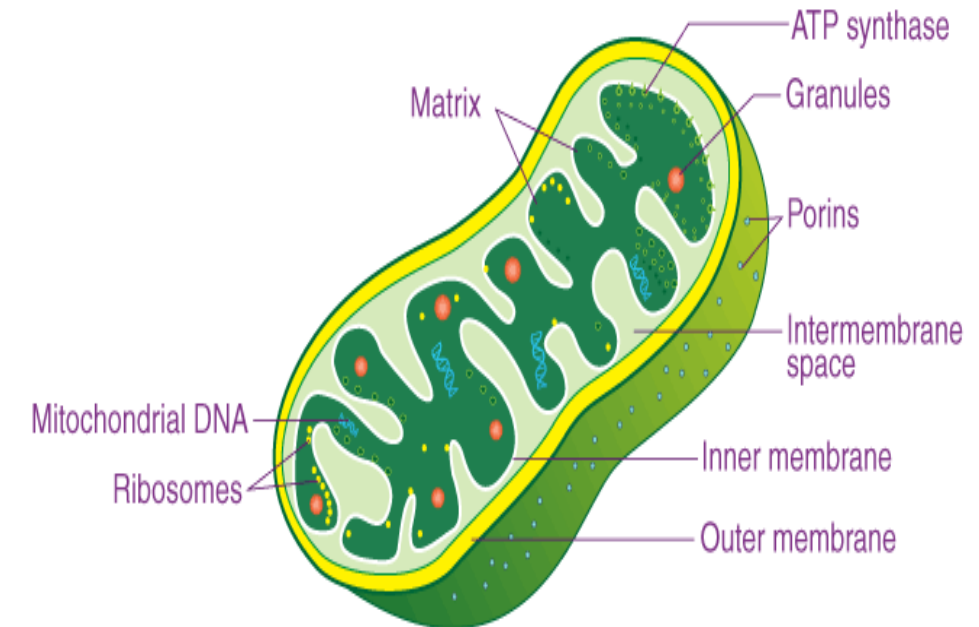
- **Lysosomes:** are small, membrane-bound organelles filled with **digestive enzymes**.
 - help to **recycle old and damaged parts** of the cell.
 - They digest old, non-functional cell organelles and break them into smaller molecules.
 - Lysosomes play an important role in the cell's defense system by breaking down and digesting foreign invaders, such as bacteria or viruses.



MITOCHONDRIA



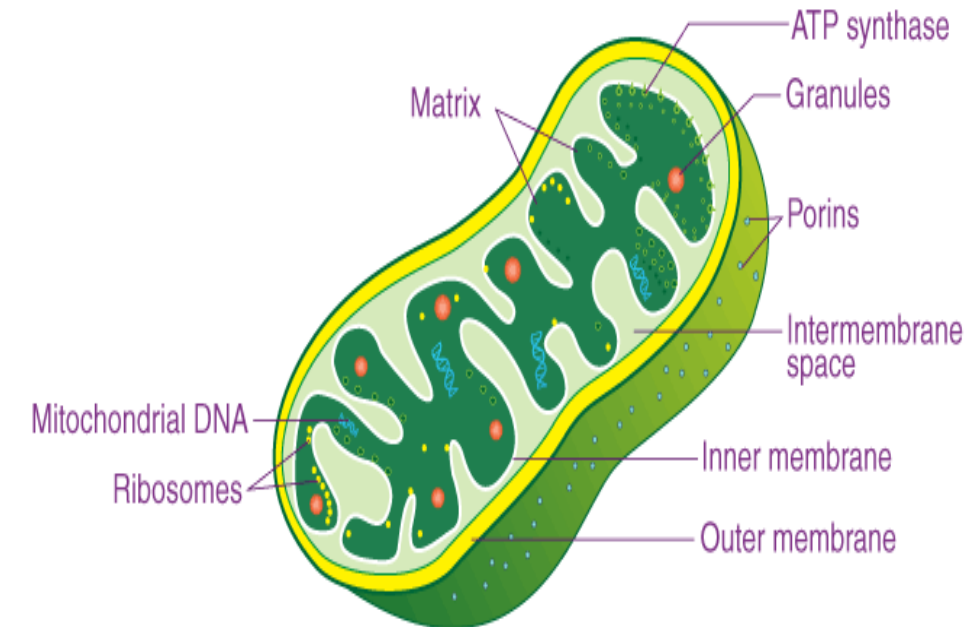
- Often called the "powerhouse" of the cell.
- Produce most of the cell's **Adenosine Triphosphate (ATP)** which is used as a main source of energy.
- Contain their own **DNA**, allowing some independent functions.
- Enclosed by a **double membrane** an outer membrane and a highly folded inner membrane (cristae).
- Besides energy production, they play roles in **cell signaling, cell growth, and regulation of the cell cycle**.



MITOCHONDRIA FUNCTION



- **Break down fuel molecules:** through a process called **cellular respiration**.
 - Process fuels like **glucose** and **fatty acids**.
- **Release energy** in the form of **ATP**



Thank you