# cell biology & its methods of study

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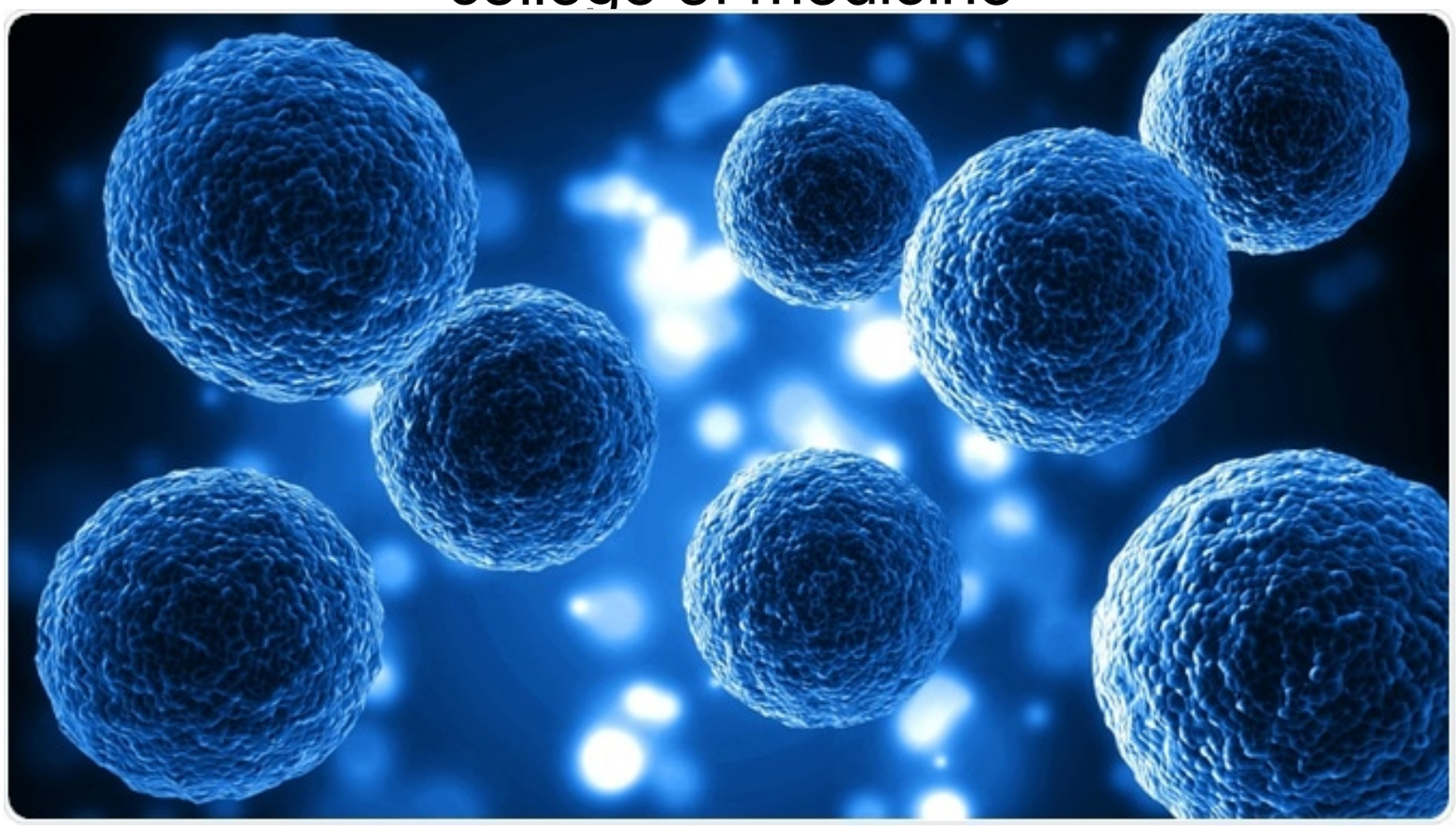
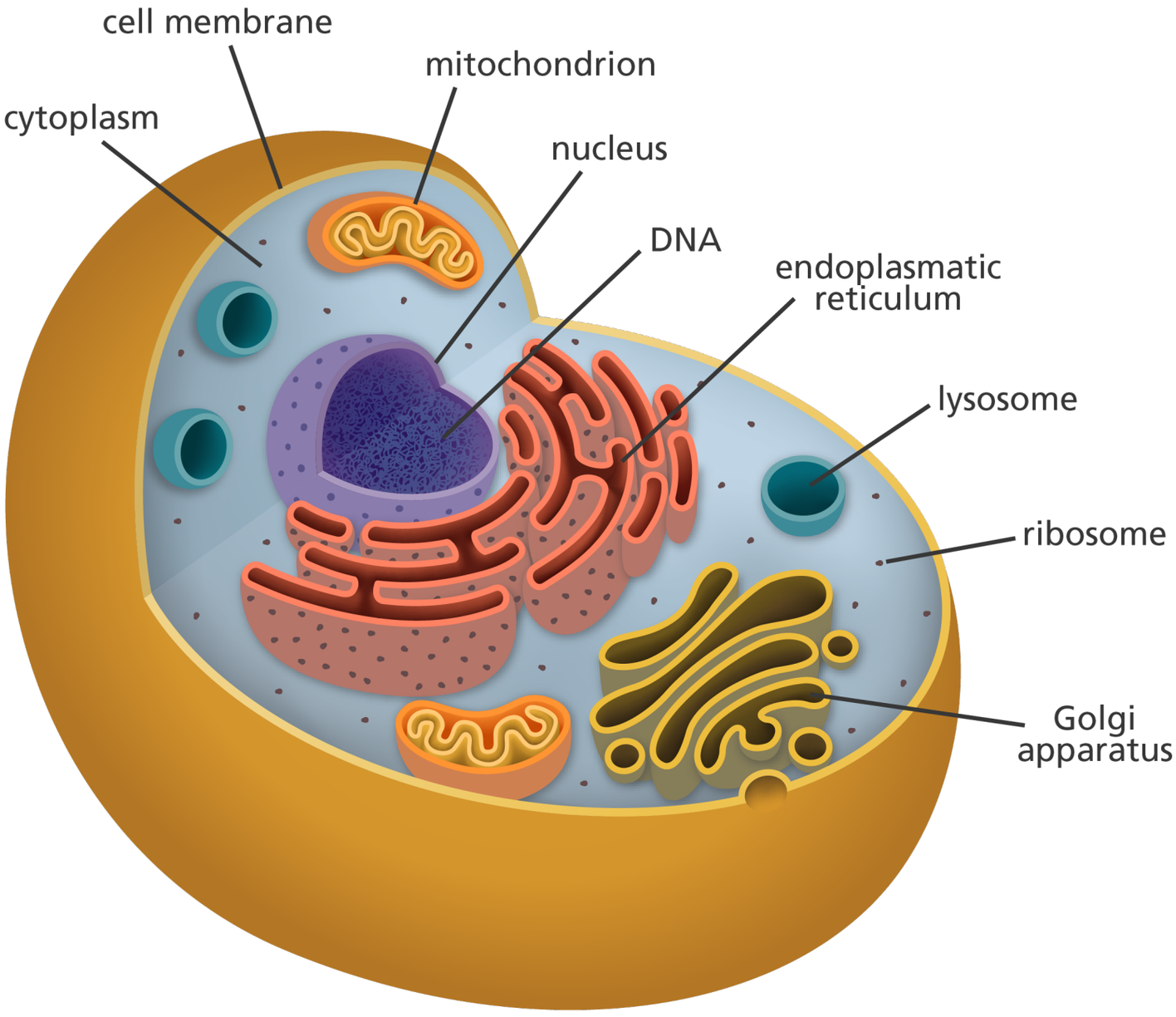


**The science of biology:** is the study of living things and how they interact with their surroundings.

**Cell Theory :**The cell is the basic unit of structure and function



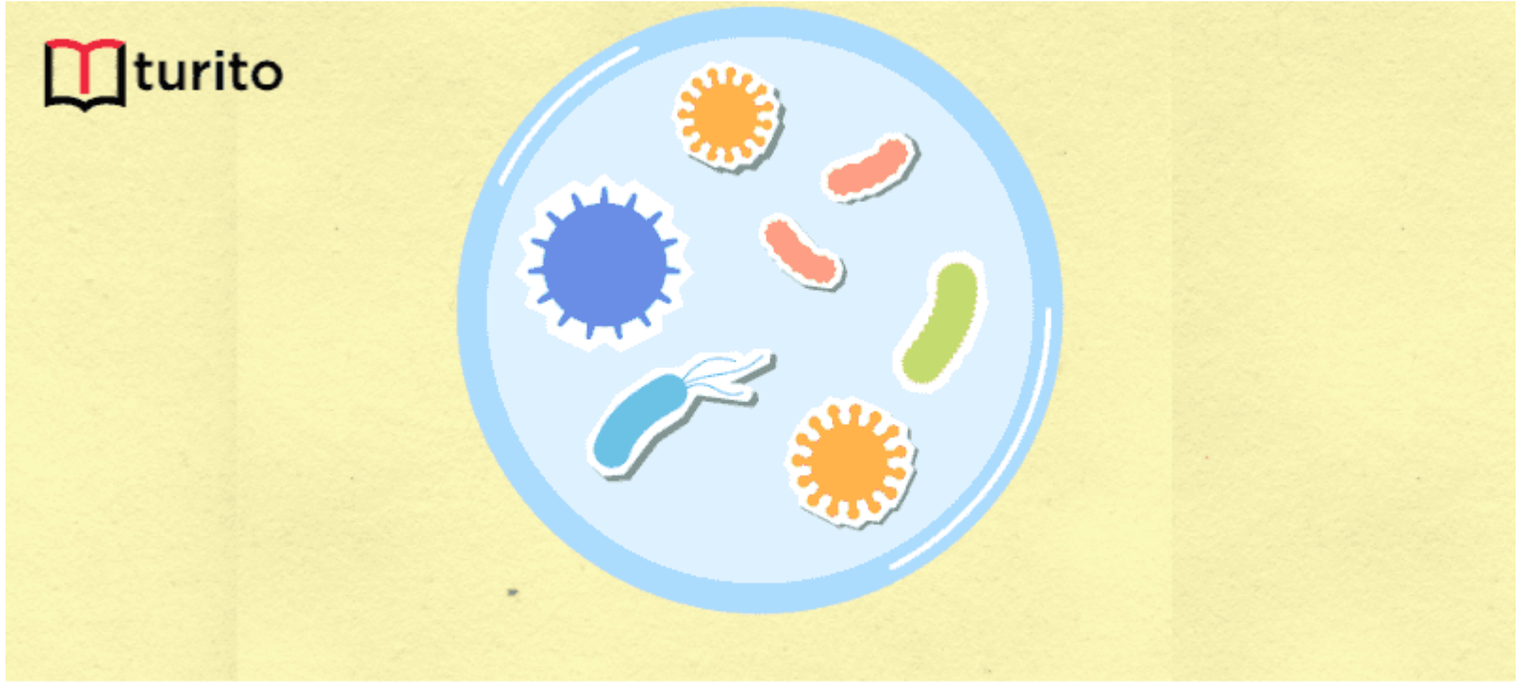
**Today the cell theory includes four more ideas :**

l - The cells are the building block of structures in living things

2- The cell is derived from other cells by division

3- The cell contains information for growth, development and functioning

4- The cell is the functioning unit of life; the chemical reactions of life take place within cells




**Cell Theory**

# Eukaryotic and Prokaryotic cells

## Prokaryotes

**1- Organisms made up of cells that lack a cell nucleus or any membrane-encased organelles.**

**2- DNA is less structured in prokaryotes than in eukaryotes. In prokaryotes, DNA is a single loop. In Eukaryotes, DNA is organized into chromosomes.**

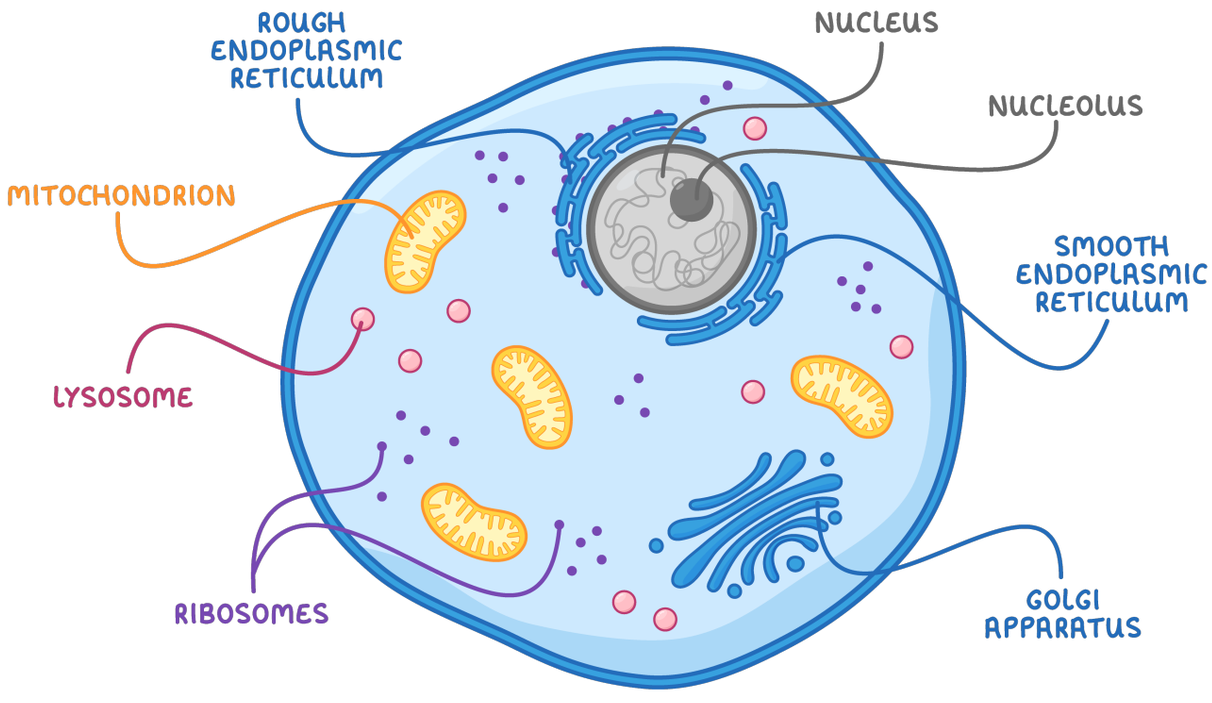
**3- Most prokaryotes are made up of just a single cell (unicellular )**

## Eukaryotes

1- Organisms made up of cells that possess a membrane-bound organelles

***2- Genetic material*** in eukaryotes is contained within a nucleus within the cell and DNA is organized into chromosomes.

3- Eukaryotic organisms may be multicellular or single-celled organisms. All animals are eukaryotes



**Differentiation**

**• The process by which a less specialized cell goes through development and maturation in order to become more distinct in terms of form and function**

• **Stem cells** change from unspecialized form to a differentiated one, more specialized

. Differentiation dramatically changes a cell's size, shape, membrane potential, metabolic

activity, and responsiveness to signals. These changes are largely due to highly controlled

modifications in gene expression but never involves a change in the DNA sequence itself

**Cell differentiation is primarily influenced by:**

**1. Structure of the gene**

**2. Environmental factors -** temperature-change, oxygen supply and many other

environmental factors

**Examples of Situations require Cell differentiation**

**Regular turnover of cells**

**Immature cells growing into an adult**

**Repair of damaged tissues**

Thus, living organisms formed from cells are highly complex and organized and perform **a**

**variety of function**

| Function | Specialized Cell(s) |
|---|---|
| Movement | Muscle and other contractile cells |
| Form adhesive and tight junctions between cells | Epithelial cells |
| Synthesize and secrete components of the extracellular matrix | Fibroblasts, cells of bone and cartilage |
| Convert physical and chemical stimuli into action potentials | Neurons and sensory cells |
| Synthesis and secretion of enzymes | Cells of digestive glands |
| Synthesis and secretion of mucous substances | Mucous-gland cells |
| Synthesis and secretion of steroids | Some adrenal gland, testis, and ovary cells |
| Ion transport | Cells of the kidney and salivary gland ducts |
| Intracellular digestion | Macrophages and some white blood cells |
| Lipid storage | Fat cells |
| Metabolite absorption | Cells lining the intestine |

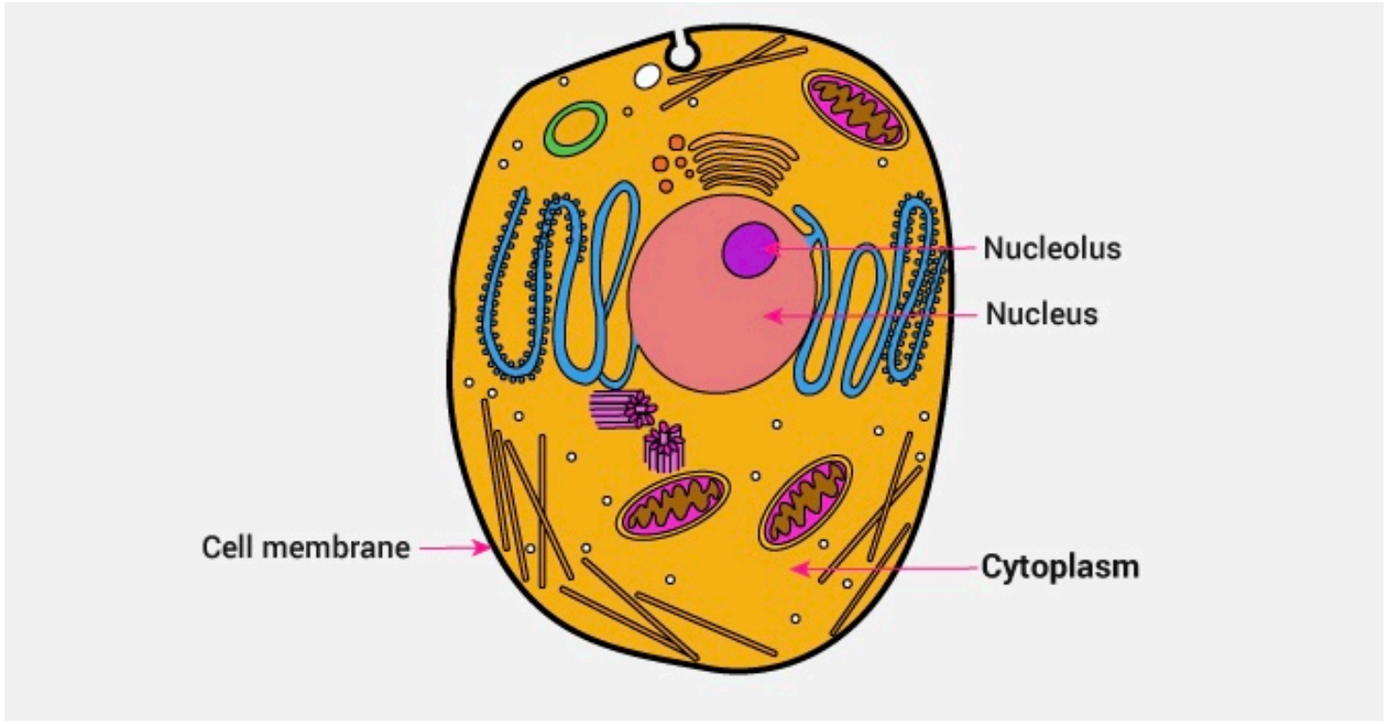
**Cellular Structure**

In Biological systems: water, amino acids, carbohydrates (sugar), fatty acids, and ions account for 75–80 % of the matter in cells

20-25 % macromolecules, or polymers (biopolymers), include:

- peptides/proteins (formed from amino acids)
- polysaccharides (formed from sugars)
- DNA (formed from nucleotide bases and dioxyribose sugar)
- RNA (formed from nucleotide bases and ribose sugar)
- phospholipids (formed from fatty acids)

# Cytoplasmic organelles



# Plasma membrane

## Structure

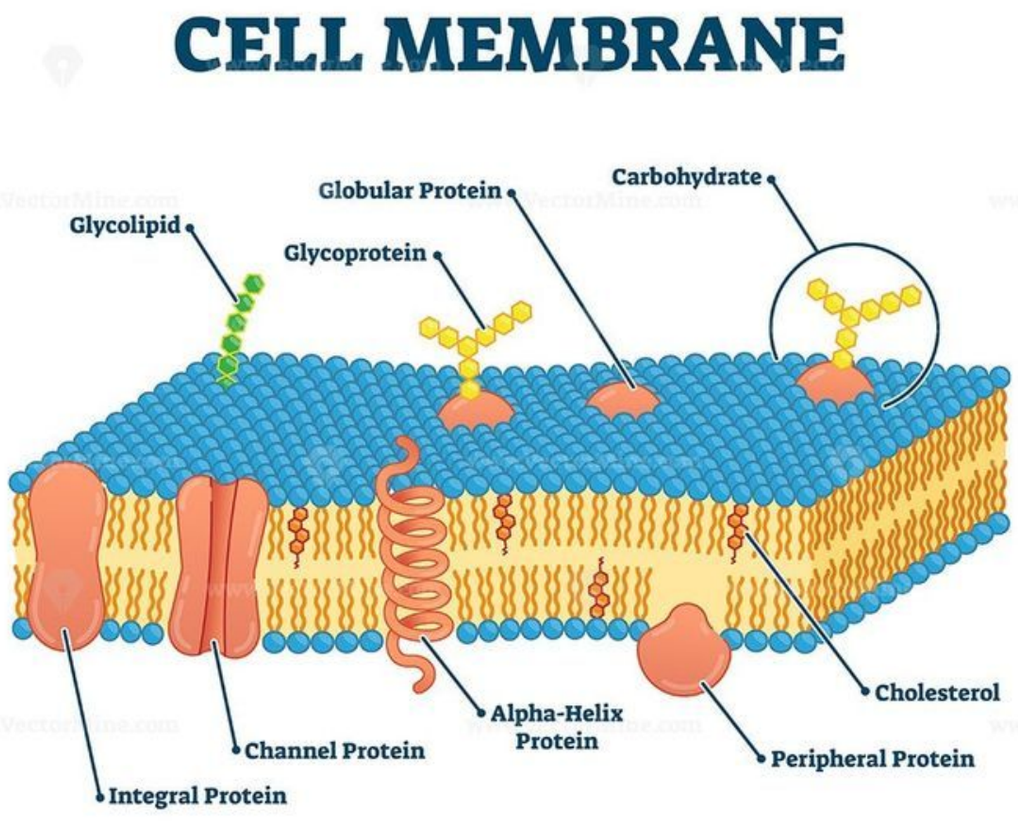
**phospholipids, cholesterol, proteins, and oligosaccharide chains covalently linked to phospholipid and protein molecules.**

**7.5 nm thick**

**consists of two layers, known as the lipid bilayer that contain associated integral and peripheral proteins.**

**The inner layer of the plasma membrane faces the cytoplasm, and the outer layer faces the extracellular environment.**

- **Phospholipid molecules spontaneously orient to form a bilayer in which the hydrophobic tails are pointed inwards. The hydrophilic, ionic head groups are in the exterior and are thus in contact with the surrounding aqueous environment.**



# Cytoplasm

## Structure:

**Cytoplasm represents everything enclosed by the plasma membrane, with the exclusion of the nucleus.**

- **It consists of a viscous fluid medium that includes salts, sugars, lipids, vitamins, nucleotides, amino acids, RNA, and proteins which contain the protein filaments, actin microfilaments, microtubules, and intermediate filaments.**
- **These filaments function in animal and plant cells to provide structural stability and contribute to cell movement.**

**Function:**

**1.Energy production through metabolic reactions,**
**2.Biosynthetic processes, and photosynthesis in plants.**
**3.Storage place of energy within the cell.**

**Cytosol: is the fluid of the cytoplasm, refers only to the protein-rich fluid environment, excluding the organelles.**

# Cytoskeleton

Structure:

Complex array of protein fibers found in three forms:

(1) **Microtubules**: hollow structure, with an outer diameter of 25 nm and a wall 5 nm thick, give the rigidity to help maintain cell shape.

(2) **Microfilaments**: composed of actin, allow cellular motility and most contractile activity in cells

(3) **Intermediate filaments:** intermediate in size between the other two and with a diameter averaging 10 nm. The intermediate filaments are much more stable than microtubules and actin filaments, composed of different protein subunits in different cell

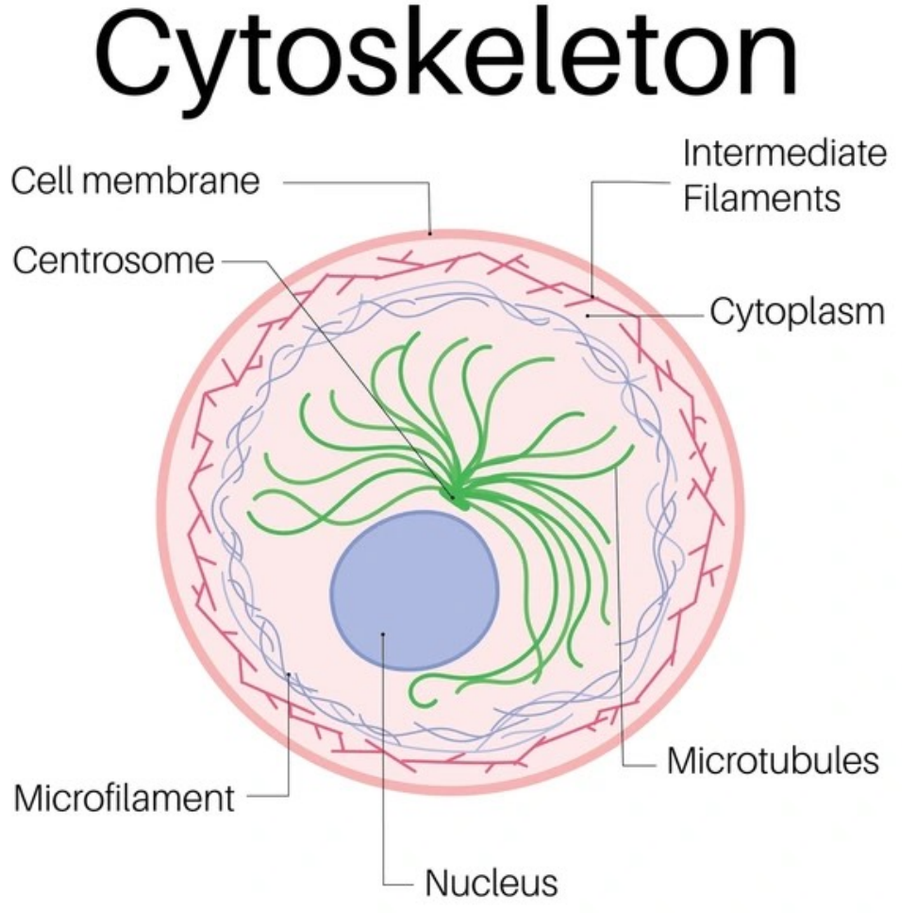
**Functions of Cytoskeleton :**

**1. Structural:**

- **Provides structural support to cell**
- **Stabilizes junctions between cells**

**2. Movement:**

- **Assists with cytosol streaming and cell motility;**
- **helps moving organelles and materials throughout cell;**
- **helps moving chromosomes during cell division.**



# Nucleus

**Structure:** The nucleus, the largest organelle of the cell, includes the **nuclear envelope, nucleolus, nucleoplasm,** and **chromatin** and contains the genetic material encoded in the (DNA) of chromosomes.

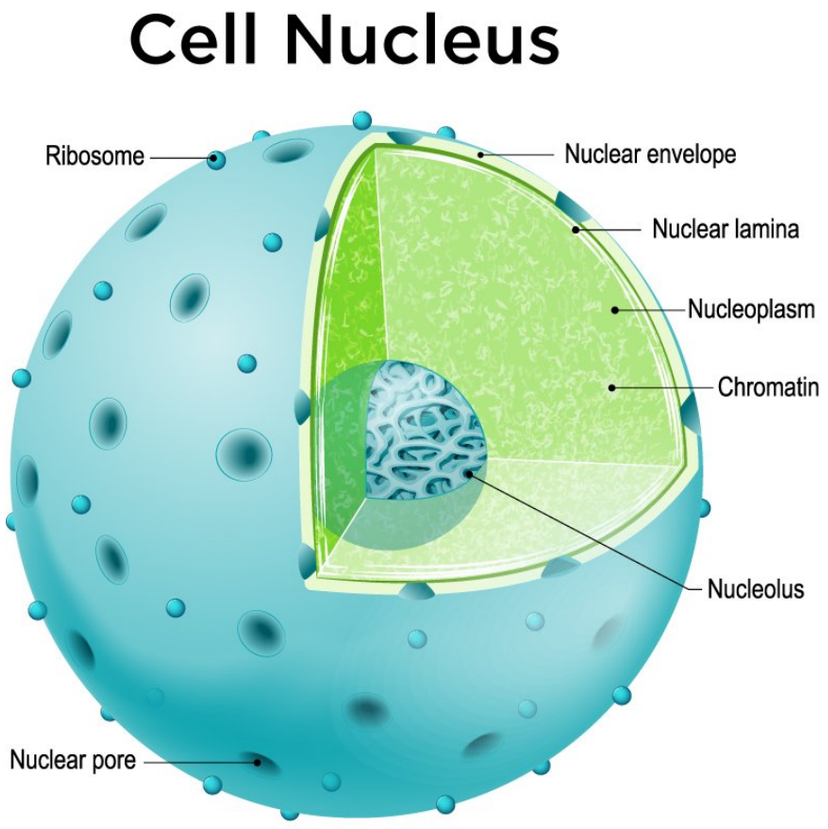
**1. The nuclear envelope:** surrounds the nuclear material and consists of two parallel membranes separated by a narrow perinuclear space. These membranes fuse at intervals, forming openings called **nuclear pores** in the nuclear envelope.

**2. Nucleolus:** spherical, highly basophilic, actively making proteins. The intense basophilia of nucleoli is due the presence of heterochromatin and the presence of densely concentrated ribosomal RNA (rRNA) that is transcribed, processed, and complexed into ribosomal subunits in nucleoli.

**3.Nucleoplasm:** is the protoplasm within the nuclear envelope. It consists of a matrix and various types of particles.

**4.Chromatin:** consists of double-stranded DNA complexed with histones and acidic proteins. It resides within the nucleus as heterochromatin and euchromatin. The euchromatin/heterochromatin ratio is higher in malignant cells than in normal cells??.

• Chromatin is responsible for RNA synthesis.



# Mitochondria

**Structure:**

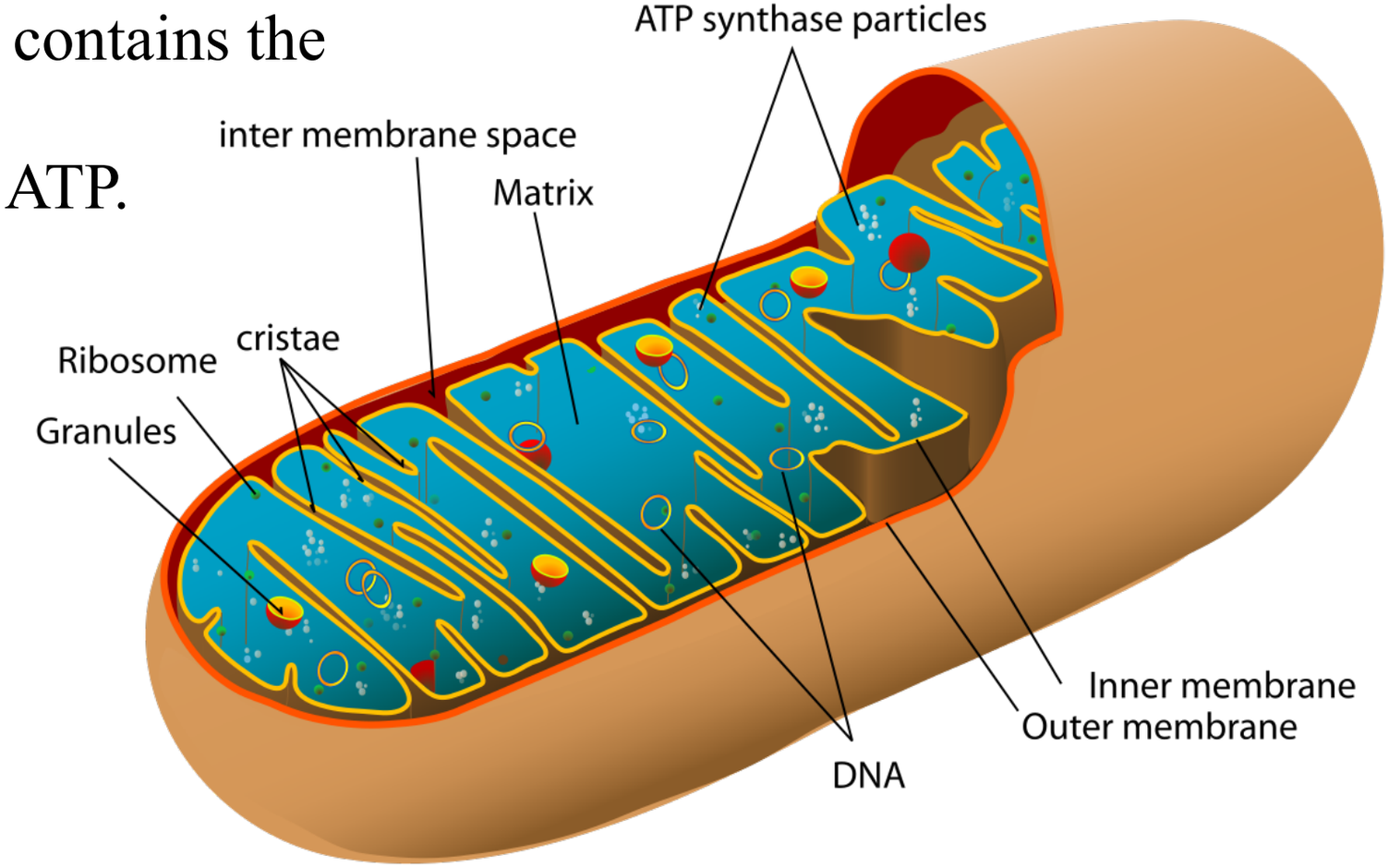
• rod-shaped organelles that are 0.2 um wide and up to 7 um long.

• They occupy about 20% of the cytoplasmic volume.

• They possess an outer membrane, which surrounds the organelle, and an inner membrane, which folded to form **cristae** which provide a large surface area for attachment of enzymes involved in respiration.

• The matrix space enclosed by the inner membrane is rich in enzymes and contains the mitochondrial DNA

**Function**: mitochondria generate ATP.



# Endoplasmic Reticulum:

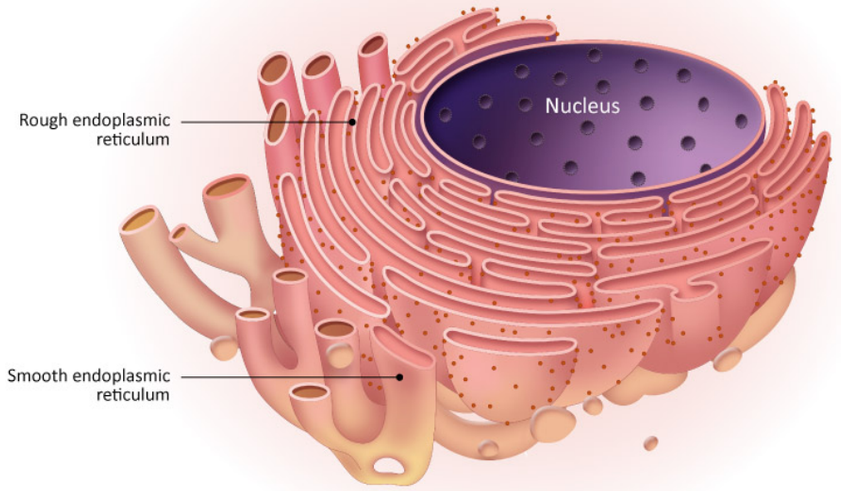
**Structure:**

• flattened sheets of membranes that extend throughout the cytoplasm of eukaryotic cells and enclose a large intracellular space called lumen.

• There is a continuum of the lumen between membranes of the nuclear envelope.

• The rough endoplasmic reticulum (rough ER): is close to the nucleus, and is the site of attachment of the ribosomes.

• Ribosomes are small and dense structures, 20 nm in diameter, that are present in great numbers in the cell, mostly attached to the surface of rough ER, but can float free in the cytoplasm.




**• They are manufactured in the nucleolus of the nucleus on a DNA template and are then transported to the cytoplasm. Ribosomes are the sites of protein synthesis.**

**• The rough ER transitions into a smooth endoplasmic reticulum (smooth ER), which is generally more tubular and lacks attached ribosomes.**

**Function:**

• Rough ER responsible for protein synthesis.

• Smooth ER is the primary site of synthesis of lipids and sugars

• contains degradative enzymes, which detoxify many organic molecules

## Golgi apparatus:

**Structure.**

• consists of several membrane-bounded **cisternae (saccules)** arranged in a **stack**

• positioned and held in place by microtubules.

• Cisternae are disk-shaped and slightly curved, with flat centers

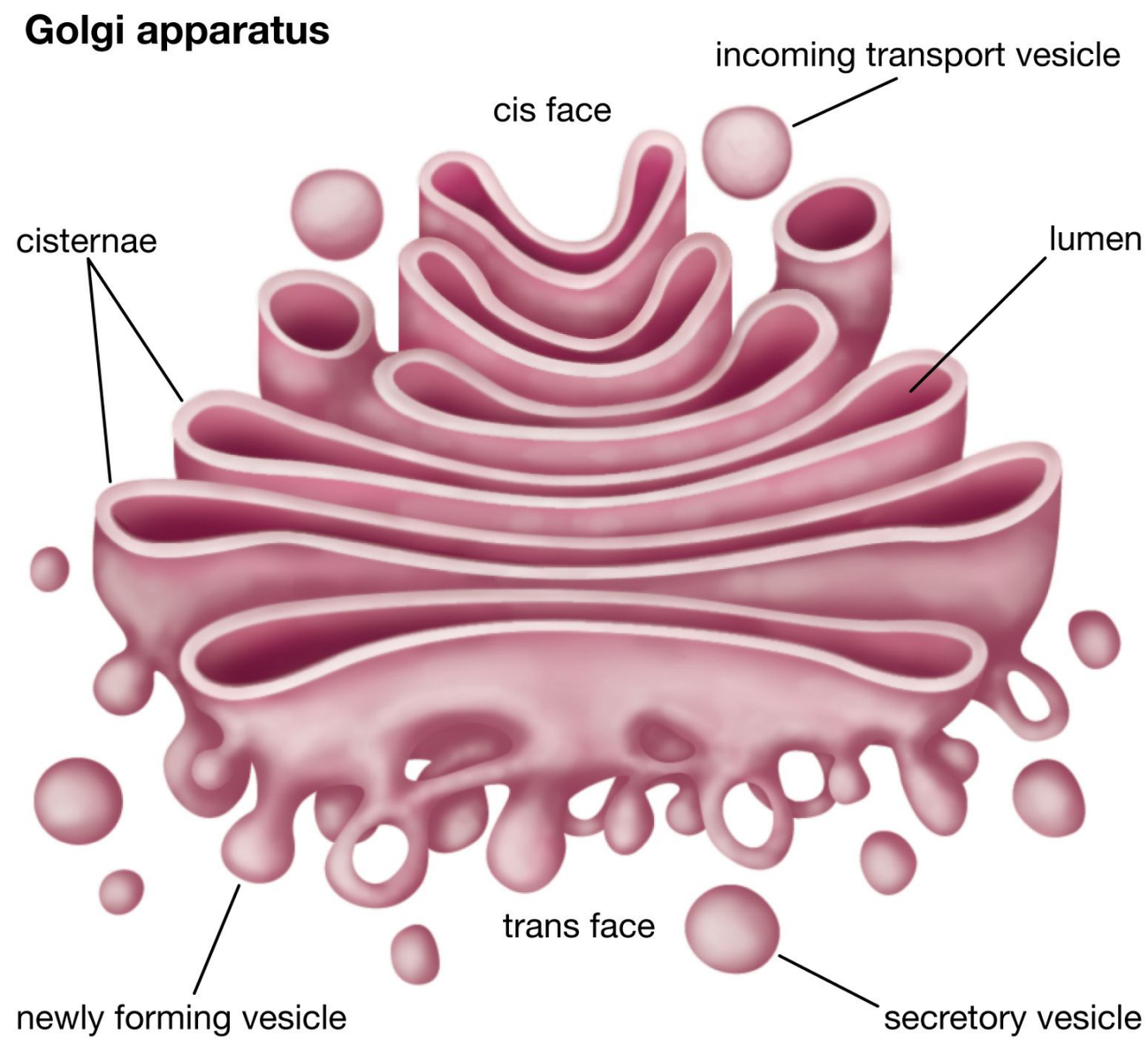
**Function**:

• modifying, sorting, and packaging of proteins for secretion

or

• delivery to other organelles or

• for secretion outside of the cell.



**Lysosomes:** These are vesicles of hydrolytic enzymes and are single-membrane bound. They have an acidic interior and contain about 40 hydrolytic enzymes involved in intracellular digestions.

**Peroxisomes:** These are membrane-bound vesicles containing oxidative enzymes that generate and destroy hydrogen peroxide.

• Peroxisomes participate in many different metabolic activities, including the oxidation of fatty acids, the breakdown of purines, and the biosynthesis of cholesterol.

# Common Methods of Study in Cell Biology:

- **Microscopy Techniques: Light microscopy, electron microscopy (EM), confocal microscopy, and fluorescence microscopy.**
- **Cell Culture: Growing cells outside their natural environment in controlled conditions.**
- **Flow Cytometry: Used to analyze the physical and chemical characteristics of cells.**
- **Western Blotting: Technique to detect specific proteins within a sample.**
- **PCR (Polymerase Chain Reaction): Amplifying DNA sequences for genetic studies.**
- **Immunohistochemistry: Used to detect specific antigens in tissue sections.**
- **CRISPR-Cas9: Gene-editing technology for manipulating the genome.**
- **Cell Fractionation: Separating cell components for analysis.**


Thank
you!