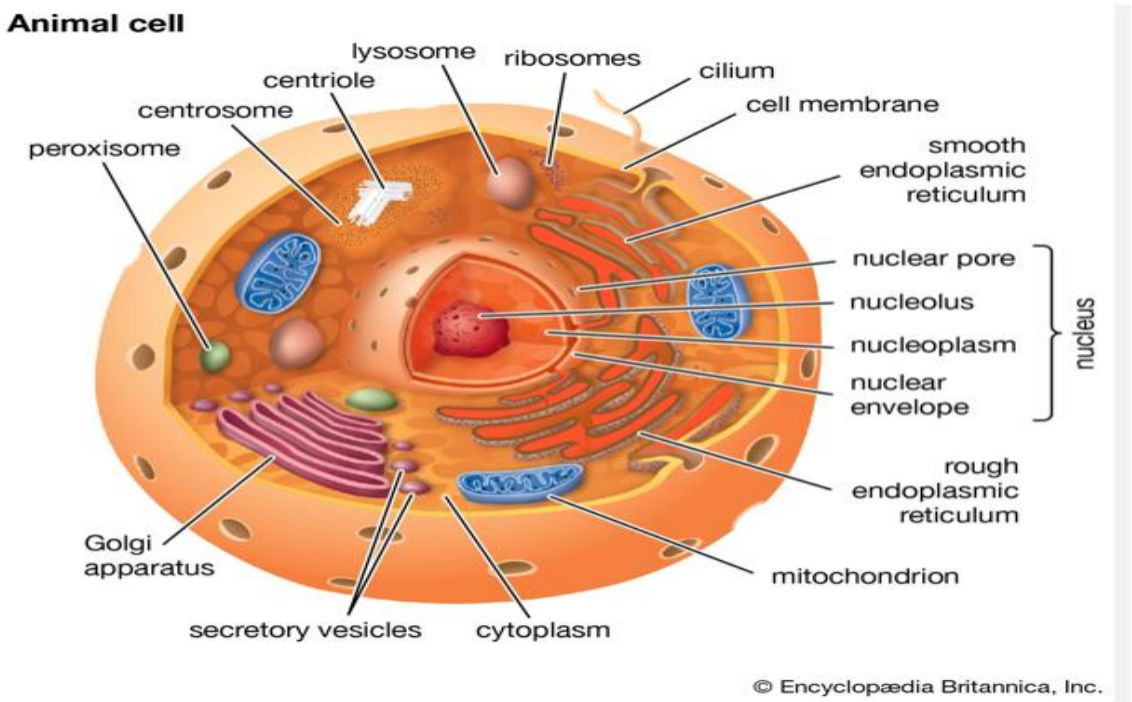
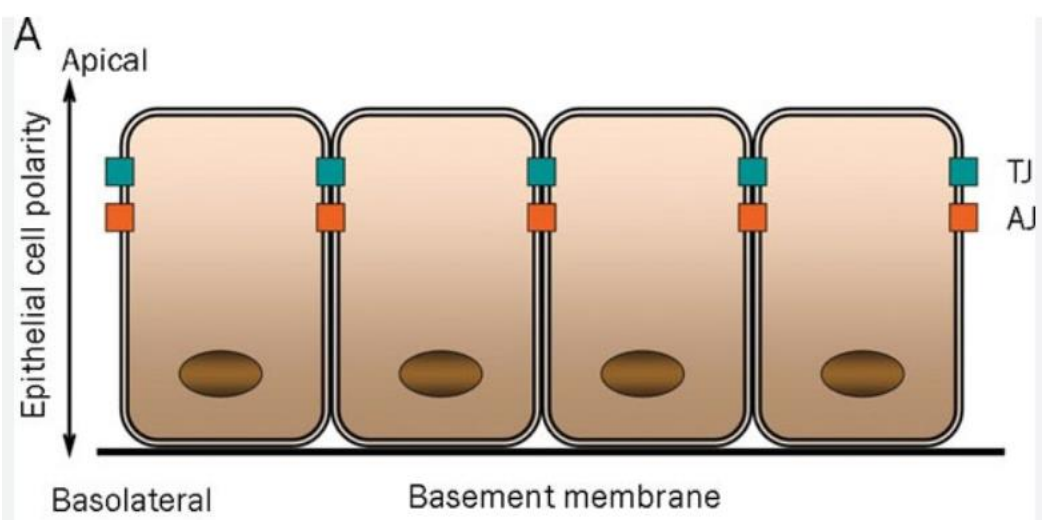
The cell



Cell polarity

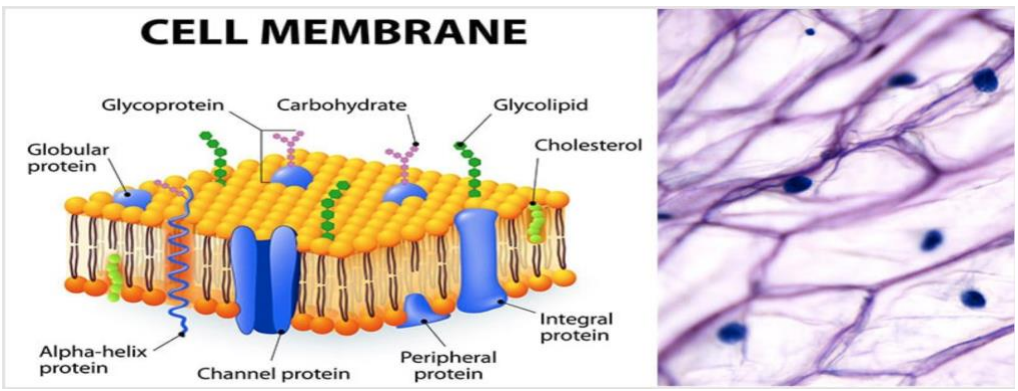
Many cells show polarity, meaning different areas of the cell have different structures. The most-studied polarity is in epithelial cells, they have

- Apical domain
- Basal (basolateral) domain



1. The Plasma Membrane

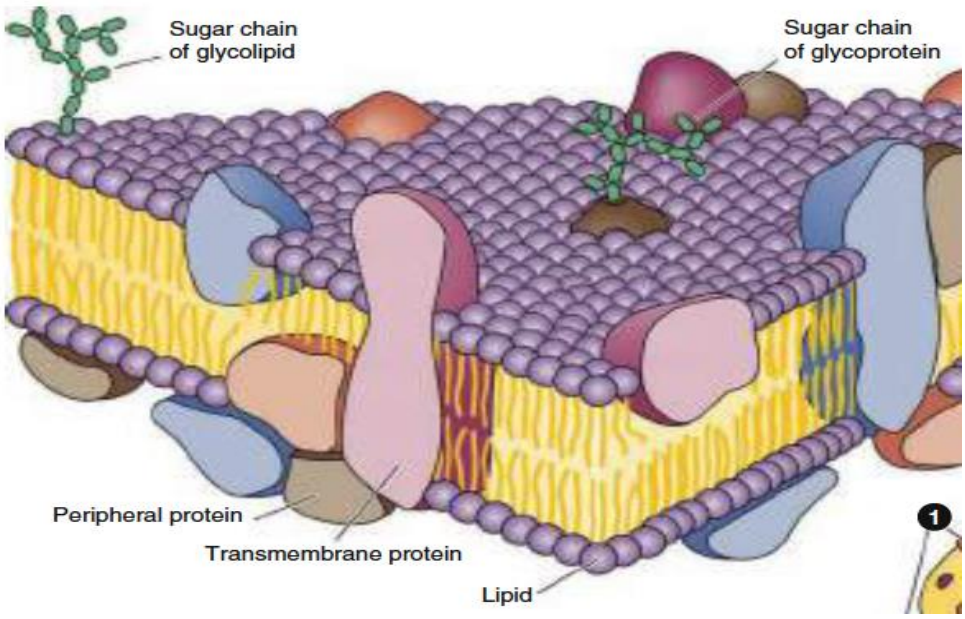
- The membrane that envelops every eukaryotic cell.It functions as a selective barrier; regulating the passage of materials in and out of the cell.



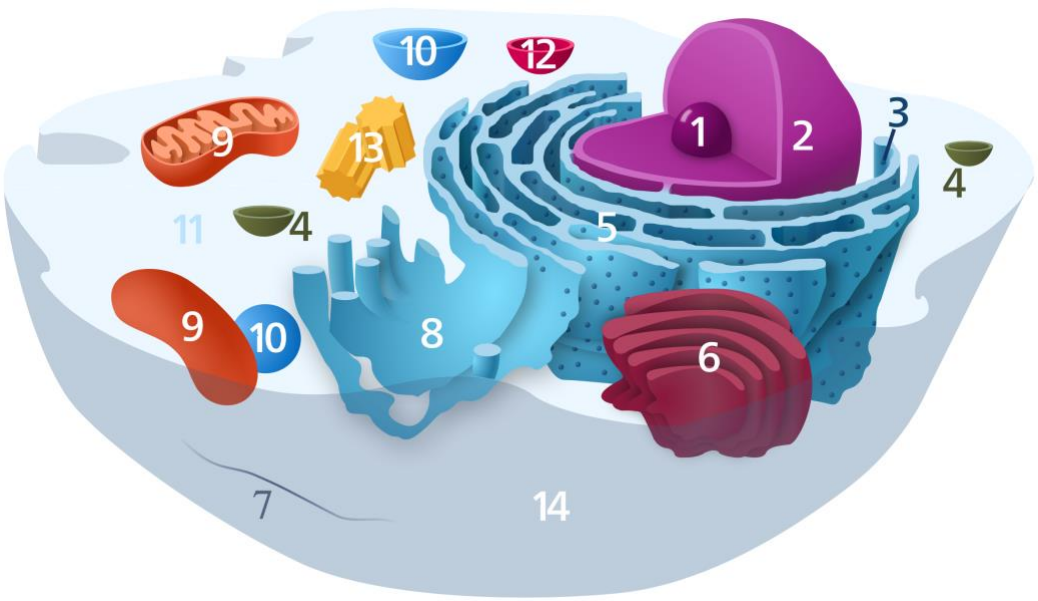
- Membranes range from 7.5 to 10 nm in thickness and are visible only in the electron microscope.

<u>Components of plasma membrane</u>

- Phospholipids
- Cholesterol
- Proteins
  1. Integral: incorporated directly within the lipid bilayer
  2. Peripheral: bound to one of the two membrane surfaces, particularly on the cytoplasmic side
- Oligosaccharide (carbohydrate) chains linked to many of the phospholipid (to form glycolipids) and protein (to form glycoproteins) molecules.



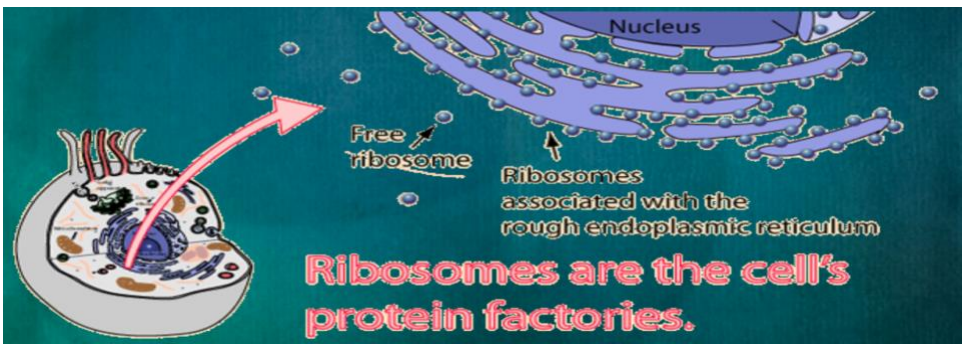
The Cytoplasm



- Inside the cell membrane, the fluid cytoplasm (or **cytosol**) bathes metabolically active structures called **organelles**, which may be membranous(such as mitochondria) or nonmembranousprotein complexes (such as ribosomes).

- Most organelles are positioned in the cytoplasm by movements along the polymers of the **cytoskeleton**, which also determines a cell's shape and motility.

1. Ribosomes



- are macromolecular machines, about 20 .30 nm in size, which assemble polypeptides (proteins) from amino acids in a sequence specified by mRNA.

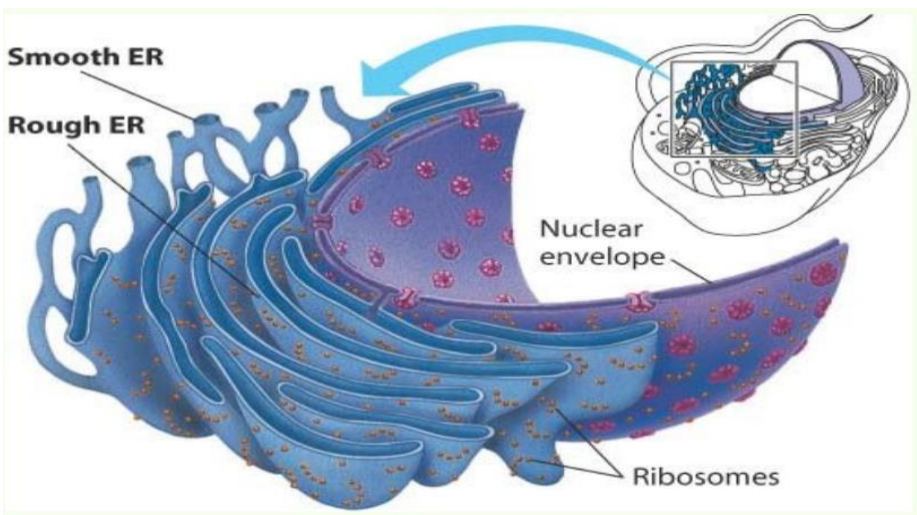
- They can be free in the cytosol or bound to the rough endoplasmic reticulum

- During protein synthesis many ribosomes typically bind the same strand of mRNA to form larger complexes called **polyribosomes**, or **polysomes**

- Free ribosomes synthesize cytosolic and cytoskeletal proteins and proteins for import into the nucleus, mitochondria, and peroxisomes.

- Bound ribosomes synthesize proteins that are to be incorporated into membranes, stored in lysosomes, or eventually secreted from the cell. The proteins produced by these ribosomes are segregated during translation **into** the interior of the ER's membrane cisternae.

2. Endoplasmic Reticulum (ER)



- Is an anastomosing network of intercommunicating channels or **cisternae** formed by a continuous membrane network.

- Types :

1. Rough endoplasmic reticulum (rER)

2. Smooth endoplasmic reticulum (sER)

- Functions of ER

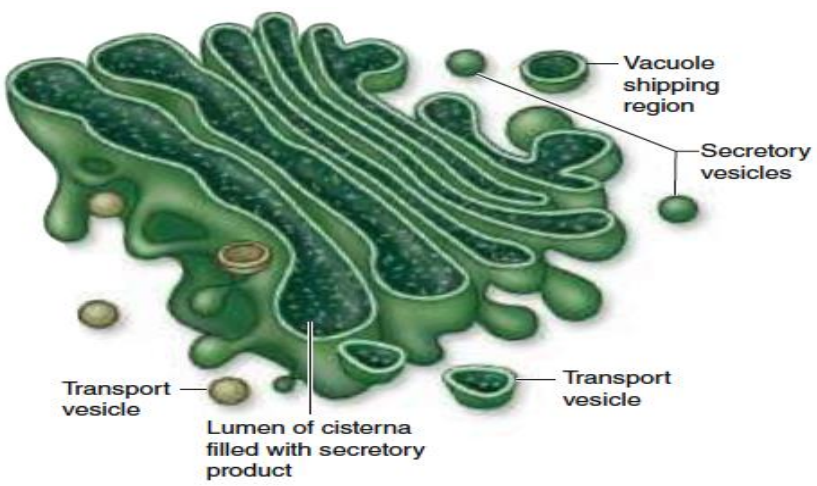
1. **Synthesis:** Provides a place for chemical reactions
2. sER is the site of lipid synthesis and carbohydrate metabolism

3. rER synthesizes proteins for secretion, incorporation into the plasma, membrane, and as enzymes within lysosomes
4. **Transport:** Moves molecules through cisternal space from one part of the cell to another, sequestered away from the cytoplasm

5. **Storage:** Stores newly synthesized molecules, sER stores Ca^{2+}

6. **Detoxification:** sER detoxifies both drugs and alcohol

3. Golgi Apparatus



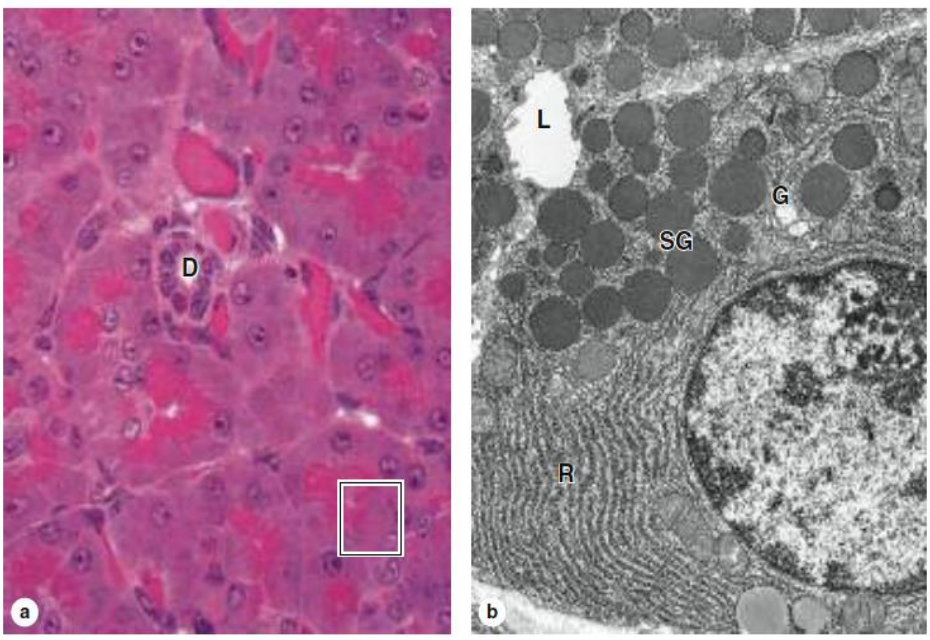
- Completes posttranslational modifications of proteins produced in the rER and then packages and addresses these proteins to their proper destinations.

- Material moves from the rER cisternae to the Golgi apparatus in small, membrane-enclosed carriers called **transport vesicles**

- Has two sides (ends):
- Receiving end (cis): receives transport vesicles

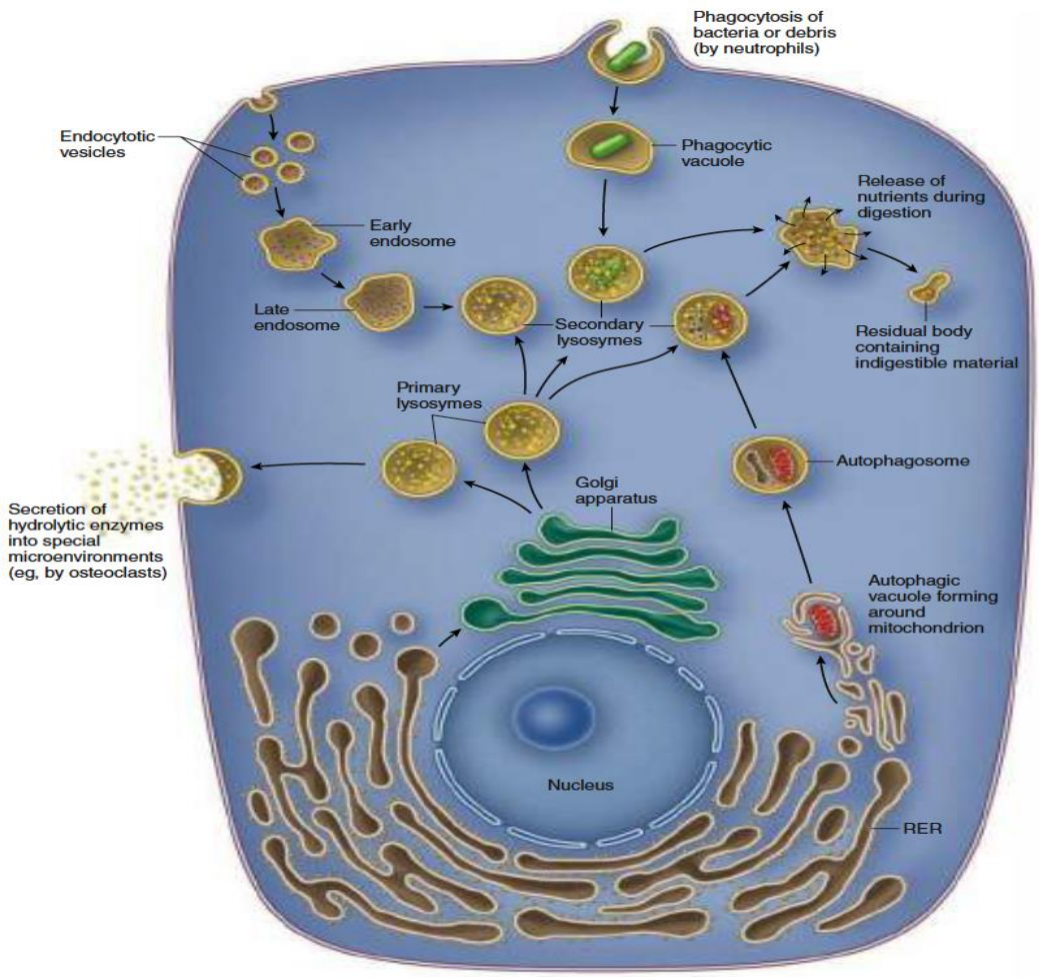
- Shipping end (tran): ships secretory vesicles

4. Secretory Granules



- The granules are surrounded by membrane and contain a concentrated form of the secretory product

5. Lysosomes

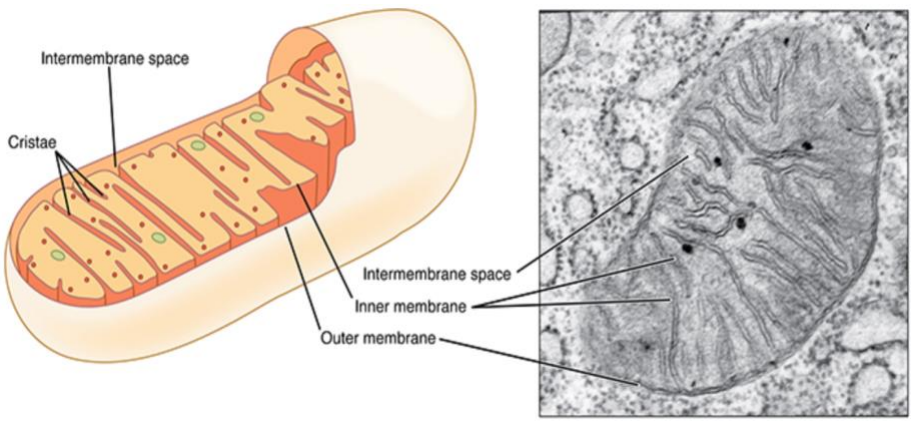


- Are sites of intracellular digestion and turnover of cellular components.

- Lysosomes are not well shown on H&E-stained cells but can be visualized by light microscopy after staining with toluidine blue.

- Synthesis of lysosomal enzymes occurs in the rER, with packaging in the Golgi apparatus. Endocytosis produces vesicles that fuse with **endosomes** before merging with **lysosomes**.
- Phagocytic vacuoles (or phagosomes) fuse with primary lysosomes to become **secondary lysosomes** (or heterolysosomes), in which ingested material is degraded.

6. Mitochondria



- Are membrane-enclosed organelles with arrays of enzymes specialized for aerobic respiration and production of **adenosine triphosphate (ATP)**, which supplies energy for most cellular activities.

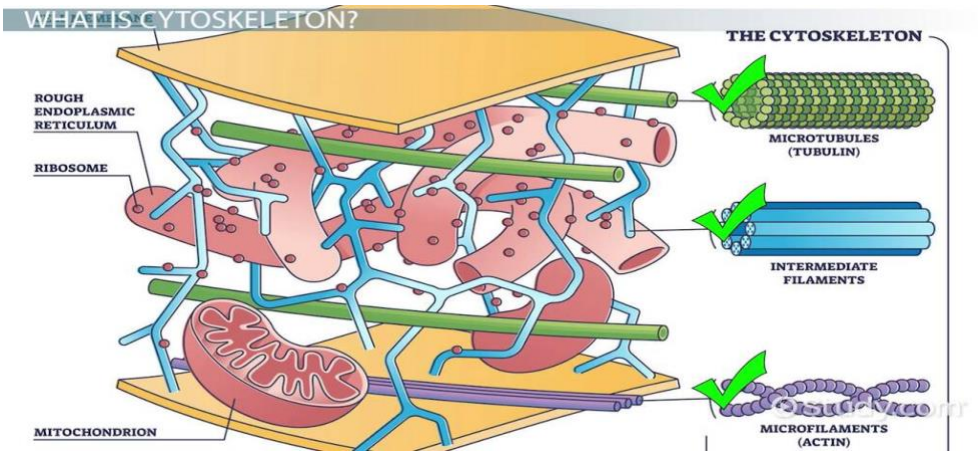
- The number of mitochondria is related to the cell's energy needs: cells with a high-energy metabolism (eg, cardiac muscle, cells of some kidney tubules) have abundant mitochondria, whereas cells with a low-energy metabolism have few mitochondria.

- Under the transmission electron microscope each mitochondrion is seen to have two separated and very different membranes that together create two compartments: the innermost **matrix** and a narrow **intermembranespace**

- The **outer membrane** contains many transmembraneproteins called **porins**that form channels through which small molecules such as pyruvate and other metabolites pass from the cytoplasm to the intermembranespace.

- The **inner membrane** has many long folds called **cristae**, which project into the matrix and greatly increase the membrane's surface area

7. The cytoskeleton



- Is a complex array of:

  1. microtubules.
  2. microfilaments (also called actin filaments)
  3. intermediate filaments.

- These protein polymers determine the shapes of cells, play an important role in the movements of organelles and cytoplasmic vesicles, and also allow the movement of entire cells.

8. The Nucleus

- Contains the code for all of a cell's enzymes and other proteins. It also contains the molecular machinery to replicate the DNA and to synthesize and process all types of RNA.

- The nucleus usually appears as a large rounded or oval structure, often near the cell's center.

- It consists of a **nuclear envelope** containing **chromatin**, with one or more specialized regions of chromatin called **nucleoli**.

8.1. <u>Chromatin</u>

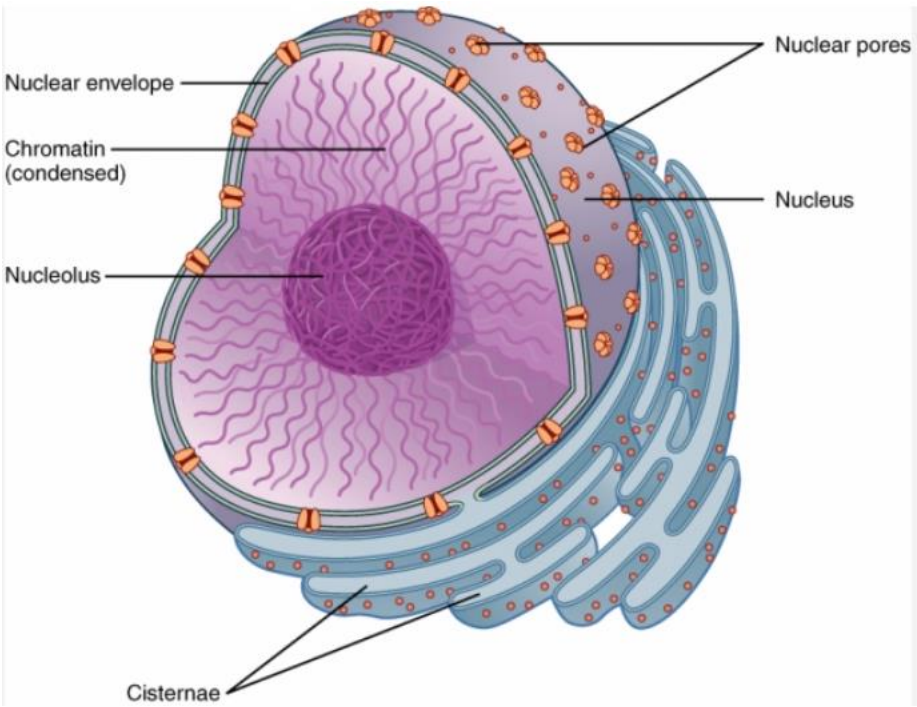
- The mass of DNA and its associated proteins

- Microscopically two categories of chromatin can be distinguished:

  1. **Euchromatin**is visible as finely dispersed granular material in the electron microscope and as lightly stained basophilic areas in the light microscope. It is associated with **active** cells

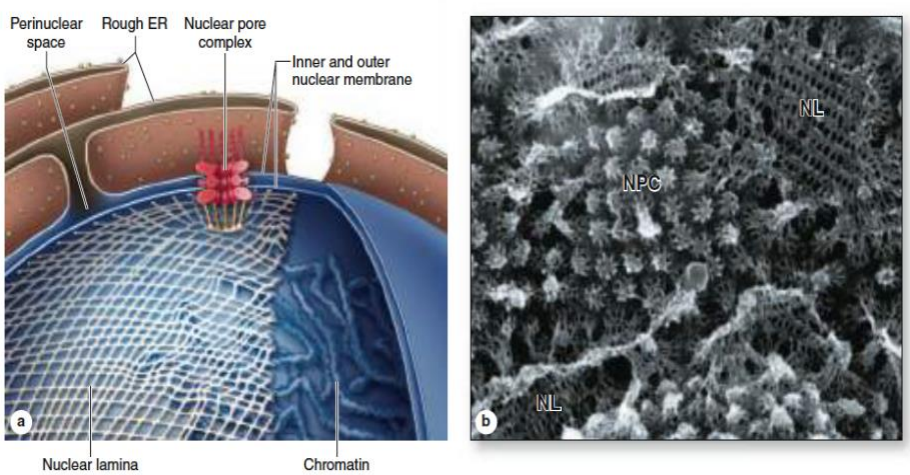
2. **Heterochromatin** appears as coarse, electron-dense material in the electron microscope and as intensely basophilic clumps in the light microscope. It is associated with **inactive** cells

8.2. Nucleolus



- The **nucleolus** is a spherical, highly basophilic subdomain of nuclei in cells actively engaged in protein synthesis
- It is the location of ribosomal subunit assembly and transcription of ribosomal RNA (**rRNA**)

8.3. The Nuclear Envelope



- The **nuclear envelope is** a double set of membranes with a narrow perinuclear space, which separates the cytoplasm from nucleoplasm

- The outer membrane binds ribosomes and is continuous with the rER.

- It is penetrated by **nuclear pore complexes**,

- It is supported internally by a meshwork, the nuclear lamina, composed of intermediate filament subunits called **lamins**.

8.4. Nuclear pore complexes

- **Nuclear pore complexes (nuclear pores)** contain more than 30 core proteins (nucleoporins), span both membranes of the nuclear envelope, and regulate the bidirectional transfer of macromolecular complexes between the nucleus and cytoplasm