**Cytoplasmic organelles**

**Plasma membrane**

**Structure.** The plasma membrane is made of phospholipids, cholesterol, proteins, and oligosaccharide chains covalently linked to phospholipid and protein molecules. It is approximately 7.5 nm thick and 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.

**Function**

1. Physical barrier: Establishes a flexible boundary, protects cellular contents, and supports cell structure. Phospholipid bilayer separates substances inside and outside the cell
2. Selective permeability: Regulates entry and exit of ions, nutrients, and waste molecules through the membrane
3. Electrochemical gradients: Establishes and maintains an electrical charge difference across the plasma membrane
4. Communication: Contains receptors that recognize and respond to molecular signals and controlling interaction between cells



**Cytoplasm**

**Structure**: Cytoplasm represents everything enclosed by the plasma membrane, with the exclusion of the nucleus. It consists mainly 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. The cytoplasm is also the 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**: The cytoplasmic cytoskeleton is a 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 types.

**Functions**:

1. **Structural:** Provides structural support to cell; stabilizes junctions between cells

2. **Movement:** Assists with cytosol streaming and cell motility; helps move organelles and materials throughout cell; helps move chromosomes during cell division.

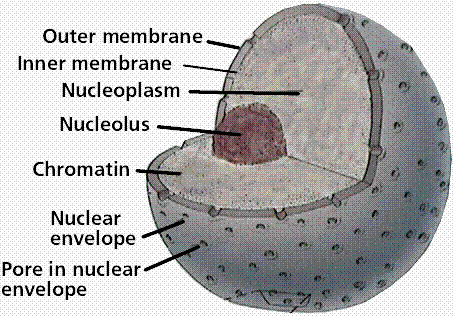


**Nucleus**

**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 **deoxyribonucleic acid** (DNA) of chromosomes.

1. **The nuclear envelope:** surrounds the nuclear material and consists of two parallel membranes separated by a narrow (30-50 nm) perinuclear space. These membranes fuse at intervals, forming openings called **nuclear pores** in the nuclear envelope.
2. **Nucleolus:** The nucleolus is a generally 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.

**Function.** The nucleus directs protein synthesis in the cytoplasm via **ribosomal ribonucleic acid** (rRNA), **messenger RNA** (mRNA), and **transfer RNA** (tRNA). All forms of RNA are synthesizedin the nucleus.



**Mitochondria**

**Structure.** Mitochondria are 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:**The endoplasmic reticulum consists of 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, 20nm 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 ERresponsible for protein synthesis**.** Smooth ER is the primary site of synthesis of lipids and sugars and contains degradative enzymes, which detoxify many organic molecules.

**Golgi apparatus:**

**Structure.** The Golgi apparatus consists of several membrane-bounded **cisternae (saccules)** arranged in a **stack** and positioned and held in place by microtubules. Cisternaeare disk-shaped and slightly curved, with flat centers and dilated rims, buttheir size and shape vary.

**Function**: it involved in the 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.