Cytoplasm

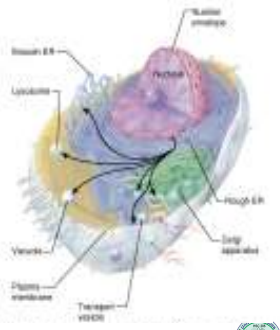
- Cytoplasm – material between plasma membrane and the nucleus
- Cytosol – largely water with dissolved protein, salts, sugars, and other solutes
- Cytoplasmic organelles – metabolic machinery of the cell
- Inclusions – chemical substances such as glycosomes, glycogen granules, and pigment

Cytoplasmic Organelles

- Specialized cellular compartments
- Membranous
  - endoplasmic reticulum,
  - Golgi apparatus,
  - peroxisomes,
  - Mitochondria, and
  - lysosomes,.
- Nonmembranous
  - Cytoskeleton, centrioles, and ribosomes

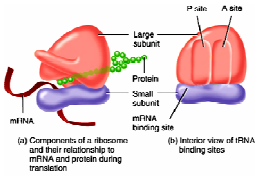
Endomembrane System

- System of organelles that function to:
  - Produce, store, and export biological molecules
  - Degrade potentially harmful substances
- System includes:
  - Nuclear envelope, smooth and rough ER, lysosomes, vacuoles, transport vesicles, Golgi apparatus, and the plasma membrane



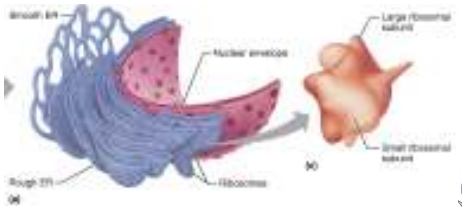
Ribosomes

- Granules containing protein and rRNA
- Site of protein synthesis
- Free ribosomes synthesize soluble proteins
- Membrane-bound ribosomes synthesize proteins to be incorporated into membranes
- Protein Kinase-Getting Proteins to their destination



Endoplasmic Reticulum (ER)

- Interconnected tubes and parallel membranes enclosing cisternae
- Continuous with the nuclear membrane
- Two varieties – rough ER and smooth ER



Pathways through the Endoplasmic Reticulum

- The signal Sequence
- Destination of Proteins
- Signal Recognition Particle (SRP)
- Destination of proteins synthesized by free ribosome:
  - Nucleus
  - Mitochondria
  - Chloroplast, and Peroxisomes

Rough ER

- External surface studded with ribosomes
- Manufactures all secreted proteins
- Responsible for the synthesis of integral membrane proteins and phospholipids for cell membranes

Signal Mechanism of Protein Synthesis

- mRNA – ribosome complex is directed to rough ER by a signal-recognition particle (SRP)
- SRP is released and polypeptide grows into cisternae
- The protein is released into the cisternae and sugar groups are added

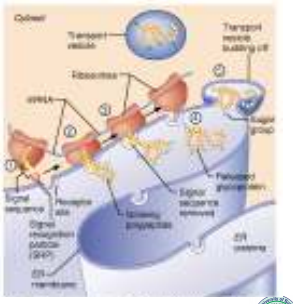


Figure 3.17

Signal Mechanism of Protein Synthesis

- The protein folds into a three-dimensional conformation
- The protein is enclosed in a transport vesicle and moves toward the Golgi apparatus

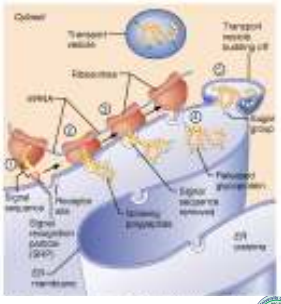


Figure 3.17

Smooth ER

- Tubules arranged in a looping network
- Catalyzes the following reactions in various organs of the body
  - In the liver – lipid and cholesterol metabolism, breakdown of glycogen and, along with the kidneys, detoxification of drugs
  - In the testes – synthesis of steroid-based hormones
  - In the intestinal cells – absorption, synthesis, and transport of fats
  - In skeletal and cardiac muscle – storage and release of calcium

Golgi Apparatus

- Stacked and flattened membranous sacs
- Functions in modification, concentration, and packaging of proteins
- Transport vessels from the ER fuse with the cis face of the Golgi apparatus
- Proteins then pass through the Golgi apparatus to the trans face
- Secretory vesicles leave the trans face of the Golgi stack and move to designated parts of the cell

Golgi Apparatus

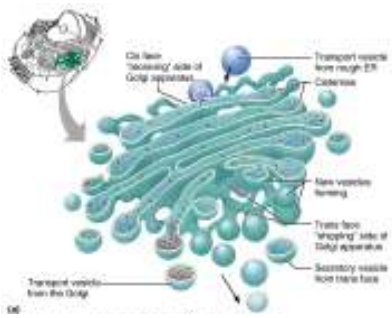
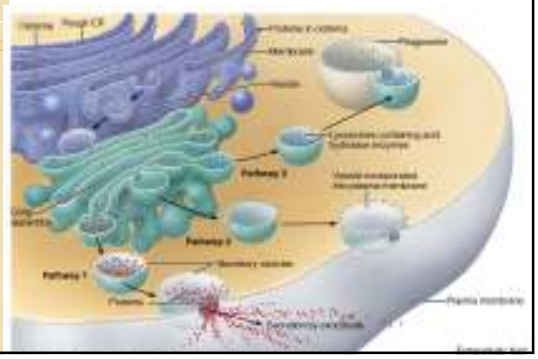


Figure 3.18a

Role of the Golgi Apparatus

1. The Outbound Path
2. The Inbound Path
3. Vesicle Recognition



Lysosomes

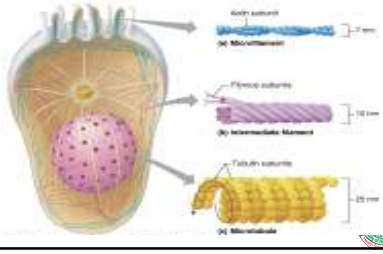
- Spherical membranous bags containing digestive enzymes
- Digest ingested bacteria, viruses, and toxins
- Degrade nonfunctional organelles
- Breakdown glycogen and release thyroid hormone
- Breakdown nonuseful tissue
- Breakdown bone to release Ca^{2+}
- Lysosome storage disease
  - Tay-Sachs Diease and Gaucher's Disease
  - Mucopolysaccharidosis I

Peroxisomes

- Membranous sacs containing oxidases and catalases
- Detoxify harmful or toxic substances
- Neutralize dangerous free radicals
  - Free radicals – highly reactive chemicals with unpaired electrons (i.e., O_2^-)

Cytoskeleton

- The "skeleton" on the cell
- Dynamic, elaborate series of rods running through the cytosol
- Consists of microtubules, microfilaments, and intermediate filaments



Microtubules

- Dynamic, hollow tubes made of the spherical protein tubulin
- Determine the overall shape of the cell and distribution of organelles

Microfilaments

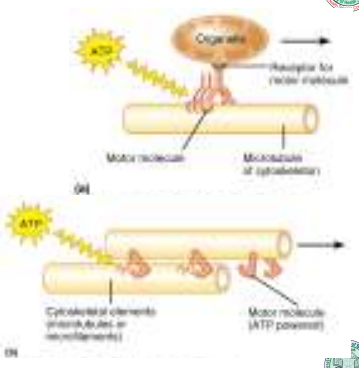
- Dynamic strands of the protein actin
- Attached to the cytoplasmic side of the plasma membrane
- Braces and strengthens the cell surface
- Attach to CAMs and function in endocytosis and exocytosis

Intermediate Filaments

- Tough, insoluble protein fibers with high tensile strength
- Resist pulling forces on the cell and help form desmosomes

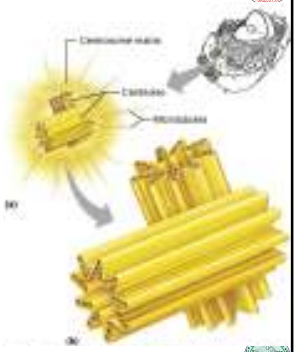
Motor Molecules

- Protein complexes that function in motility
- Powered by ATP
- Attach to receptors on organelles



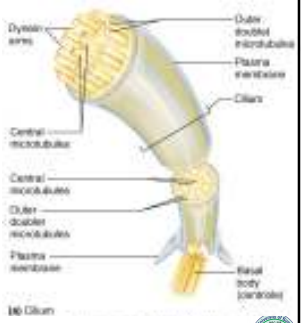
Centrosome and Centrioles

- Small barrel-shaped organelles located in the centrosome near the nucleus
- Pinwheel array of nine triplets of microtubules
- Organize mitotic spindle during mitosis
- Form the bases of cilia and flagella



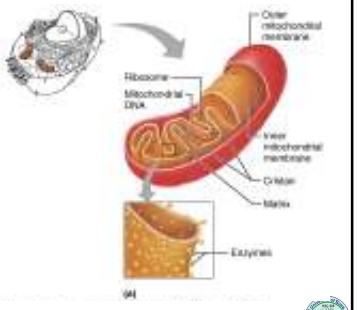
Cilia and Flagella

- Whiplike, motile cellular extensions on exposed surfaces of certain cells
- Move substances in one direction across cell surfaces



Mitochondria

- Double membrane structure with shelflike cristae
- Provide most of the cell's ATP via aerobic cellular respiration
- Contain their own DNA and RNA



Structure of Chloroplast

- The chloroplast is made up of 3 types of membrane:
- A smooth **outer membrane** which is freely permeable to molecules.
- A smooth **inner membrane** which contains many **transporters**: integral membrane proteins that regulate the passage in an out of the chloroplast of
  - small molecules like sugars
  - proteins synthesized in the cytoplasm of the cell but used within the chloroplast
- A system of **thylakoid**