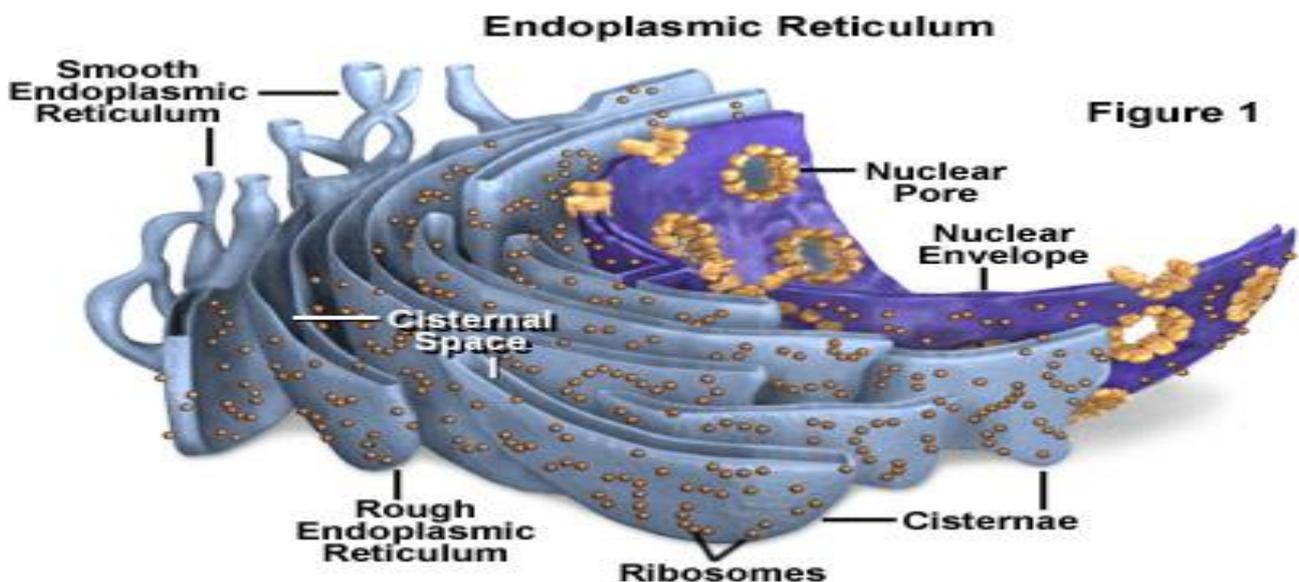


### ❖ Endoplasmic Reticulum

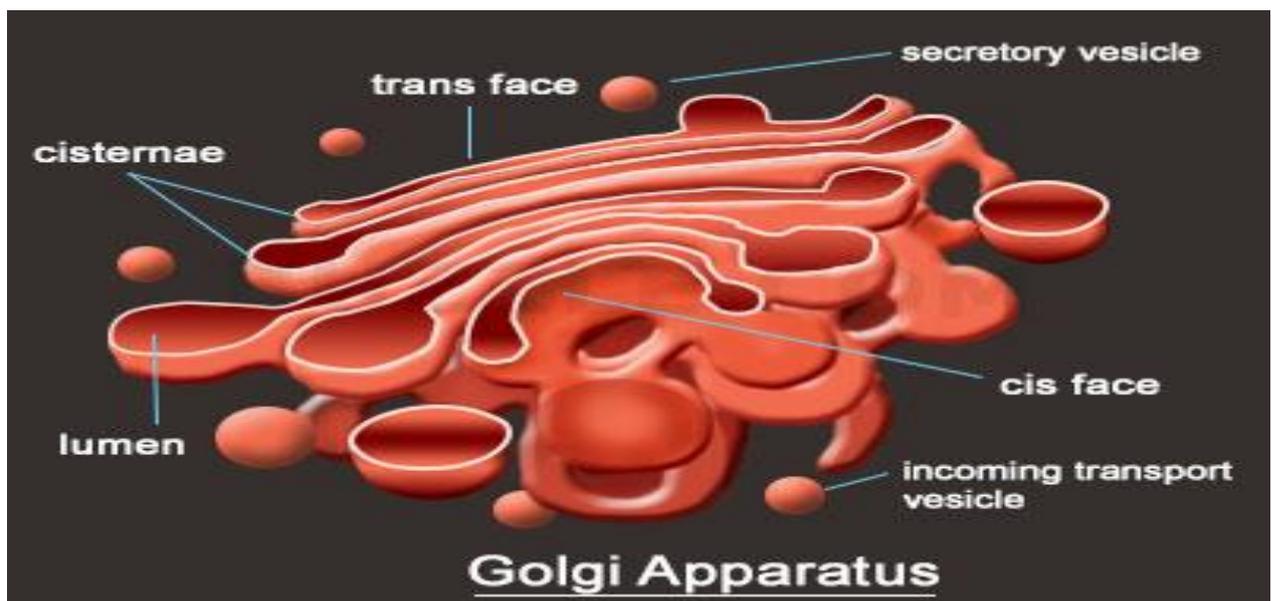
- ✓ Cells have an elaborate network of internal membranes called **endoplasmic reticulum (ER)**.
- ✓ ER is **continuous** with the outer membrane of nuclear envelope (but not plasmalemma).
- ✓ The ER lumen of one cell is connected to adjacent cell via plasmodesmata.
- ✓ **There are two types of ER**, smooth and rough, which are interconnected.
- ✓ **Rough ER** is covered with ribosomes which synthesize proteins to be delivered to lumen of ER.
- ✓ **Smooth ER** lacks ribosomes.
- ✓ **Smooth ER** is the site of lipid synthesis and membrane assembly.
- ✓ **Both types of ER** are involved in secretion.



### ❖ Golgi Apparatus

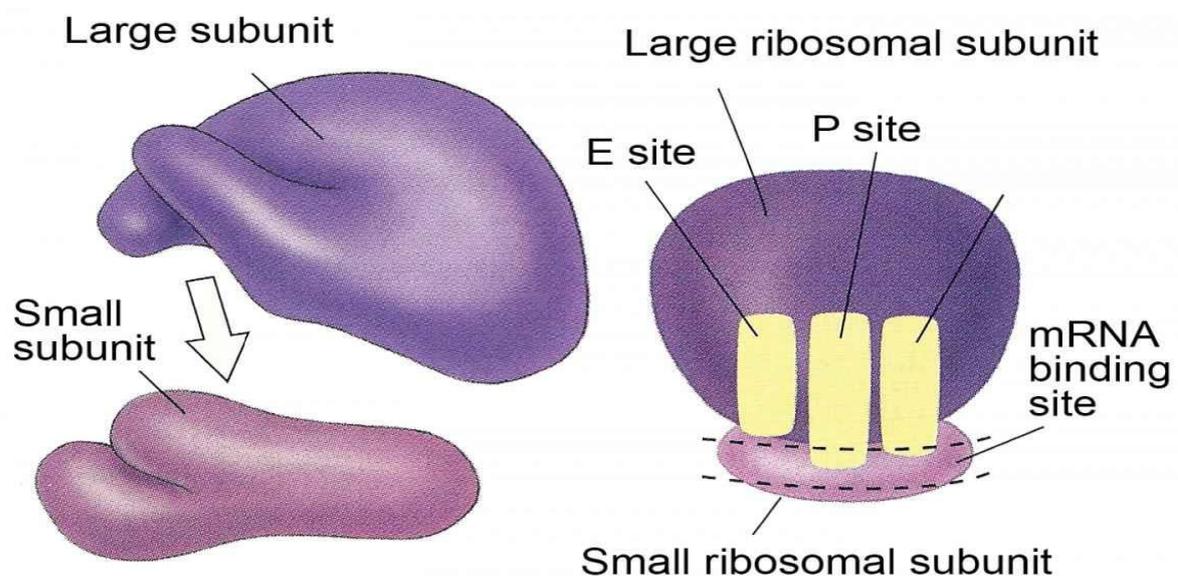
- ✓ **Golgi apparatus (or Golgi complex) is made of** one or more dictyosomes (or Golgi bodies) which are stacks of 3-10 flattened sacs (cisternae) and vesicles.

- ✓ **Plant cells contain up to several hundred Golgi bodies** dispersed in cytoplasm.
- ✓ **The cisternae close to plasmalemma are called trans face**, and the cisternae close to center of cell are called *cis* face.
- ✓ **The medial cisternae** are between *trans* and *cis* cisternae.
- ✓ **Golgi body is a dynamic structure**; new cisternae are continuously produced from endoplasmic reticulum at *cis* face while old cisternae are lost in the form of vesicle at *trans* face.
- ✓ **Golgi apparatus** has intermediary position between ER and extracellular space.
- ✓ **It is involved** in the transport and processing of many substances that are produced in ER and eventually discharged outside the cell via Golgi. It plays a key role in synthesis and secretion of complex polysaccharides and in processing of glycoproteins.
- ✓ **Various proteins (including enzymes)** are first synthesized in rough ER then they reach to Golgi via vesicles that bud off from ER and fuse with Golgi.
- ✓ **Vesicles** formed from membrane of outer face of Golgi apparatus move to different locations in cell. At plasma membrane they discharge their contents as secretions.



❖ Ribosomes

- ✓ **Ribosomes are composed** of rRNA and protein.
- ✓ **Ribosomes play an important role** in protein synthesis.
- ✓ **Plant cells contain three distinct types of ribosomes**, which occur in cytoplasm, mitochondria and chloroplast.
- ✓ **The mitochondrial and chloroplastic ribosomes** are smaller (70 S) than cytoplasmic ribosomes (80 S).
- ✓ **The cytoplasmic ribosomes may be found** in cytosol or attached to endoplasmic reticulum.
- ✓ **The rRNA molecules of cytoplasmic ribosomes are formed** by transcription of nuclear genes in nucleolus. Whereas rRNA of mitochondrial and chloroplastic ribosomes are formed by transcription of mitochondrial and chloroplastic genes respectively.
- ✓ **The proteins of cytoplasmic ribosomes are coded** by nuclear genes and synthesized in cytosol.
- ♣ Most of the proteins of mitochondrial and chloroplastic ribosomes are also synthesized in cytosol by nuclear genes.



❖ **Mitochondria**

- ✓ **Mitochondria** are cytoplasmic organelles.
- ✓ **Mitochondria are the sites** of oxidative phosphorylation (ATP synthesis).
- ✓ **Mitochondria are surrounded by** two membranes. The outer membrane is smooth and the inner membrane is highly convoluted. The folds of inner membrane are called 'cristae'.
- ✓ **The components of respiratory electron transport chain are found in inner membrane.**
- ✓ **The inner membrane is also characterized** by the presence of stalked particles with spherical heads containing ATPase. ATPase catalyses the synthesis of ATP.
- ✓ **The inner membrane** is highly impermeable to the passage of protons (H<sup>+</sup>), which allows the formation of electrochemical gradient necessary for ATP synthesis.
- ✓ **The compartment enclosed by inner membrane is called 'matrix'**. Matrix contains the enzymes of Krebs cycle (TCA cycle or citric acid cycle).
- ✓ **Mitochondria contain** their own protein synthesizing machinery (ribosomes, tRNA etc.).
- ✓ **Mitochondrial ribosomes** are smaller (70 S) than those found in cytosol (80 S).
- ✓ **Mitochondria contain** circular, histone-free DNA molecule, similar to those of bacteria.
- ✓ **Mitochondrial genome of plants consists of** about 200 kb (200,000 base pairs), which is much larger than animal mitochondria.

### Mitochondria Structural Features

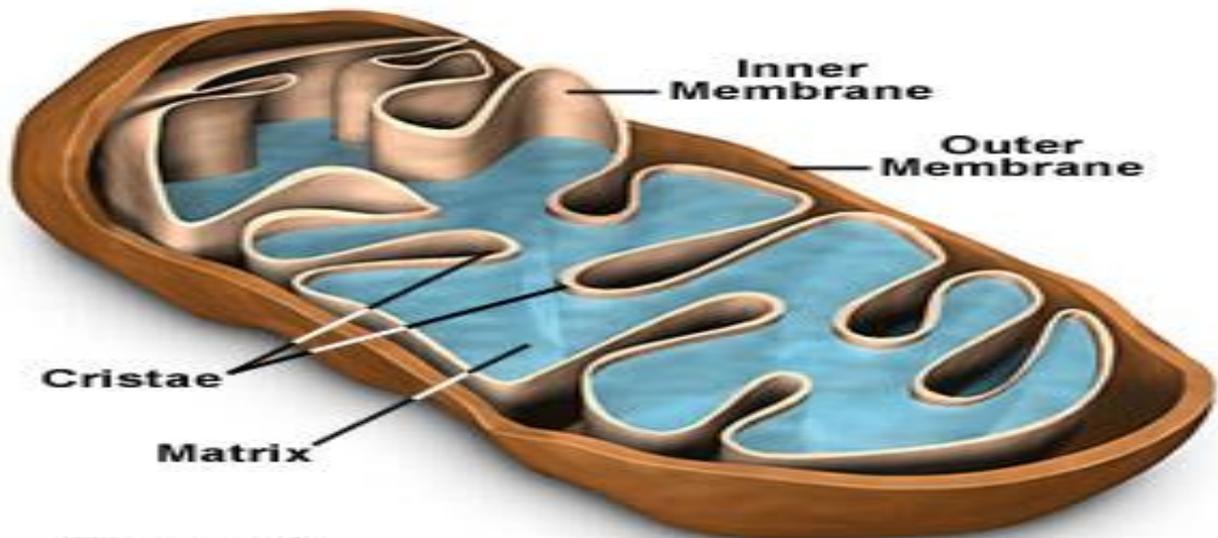


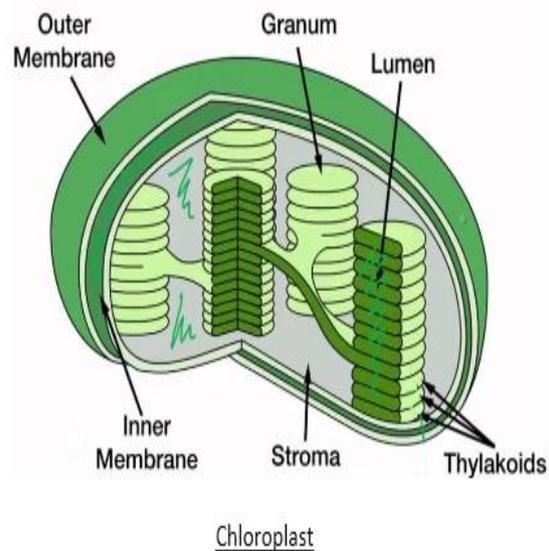
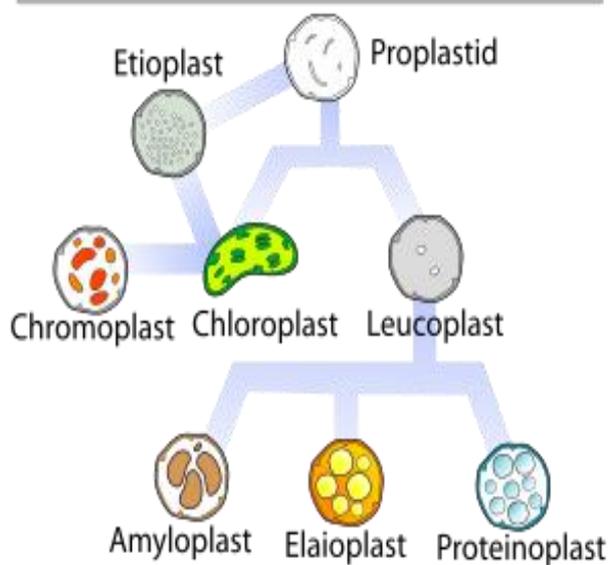
Figure 1

#### ❖ Plastids

- ✓ **Plastids** are the organelles which are peculiar to plant cells.
- ✓ **Plastids that contain** high concentration of carotenoid pigments are called 'chromoplasts'. They give yellow, orange and red colors to many fruits (tomato), roots (carrot) and flower petals.
- ✓ **Non pigmented plastids are called** 'leucoplasts'. An important type of leucoplast is 'amyoplast' which is a starch-storing plastid.
- ✓ **Chloroplasts** are the plastids that contain green pigment, chlorophyll. They are found in green tissues of plant, especially leaf. They are absent in roots.
- ✓ **The chloroplast is surrounded by** the inner and outer membranes.
- ✓ **Chloroplasts also contain** third system of membrane called thylakoid. All the chlorophyll is contained within this membrane, which is the site of light reactions of photosynthesis.
- ✓ **Thylakoid membranes** are highly folded and appear like stacked coins. These stacked membranes are known as grana lamellae (or grana thylakoid). The membranes without stacking are known as stroma lamellae (or stroma thylakoid).

- ✓ Each stack is **called** granum.
- ✓ **The inner space** within a thylakoid is known as lumen.
- ✓ **The region of the chloroplast** that is inside the inner membrane and surrounds thylakoids is known as stroma. The carbon reactions take place in stroma.
- ✓ **Chloroplasts contain** their own DNA and protein-synthesizing machinery.
- ✓ **Chloroplast genome** is smaller (145 kb) than mitochondrial genome (200 kb).
- ✓ **Chloroplast DNA** is circular and histone-free.
- ✓ **Ribosomes occur** free in stroma or bound to the outer surface of thylakoid membrane.
- ✓ **As is mitochondria**, most of the chloroplast's proteins are encoded by nuclear genes, synthesized in cytosol and transported to organelle.

#### Plastids



#### ❖ Central Vacuole

- ✓ **Mature plant cells contain** large, water-filled central vacuole (usually one or two).
- ✓ **Central vacuole can occupy** 80-90 % of the total volume of cell.
- ✓ **Each vacuole is surrounded** by a vacuolar membrane or tonoplast.
- ✓ **The vacuole contains** water, inorganic ions, organic acids, sugars and enzymes.

- ✓ **Like animal lysosomes, plant vacuoles contain** hydrolytic enzymes including proteases, ribonucleases and glycosidases.
- ✓ **Vacuole has** storage function as well as to provide rigidity to plant cell.
- ❖ **Microbodies**
- ✓ **Plant cells also contain microbodies**, which are spherical organelles surrounded by a single membrane.
- ✓ **The two main micobodies are** peroxisomes and glyoxysomes.
- ✓ **Peroxisomes are present in** photosynthetic cells of plant leaf. Their function is the removal of potentially toxic hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) using the enzyme catalase.
- ✓ **Glyoxysomes are present in** oil-storing seeds. They can convert stored fatty acids into sugars that can be translocated in the plant to provide energy for growth.
- ❖ **Cytoskeleton**
- ✓ **The cytosol** is organized into a 3-dimensional network of filamentous proteins called 'cytoskeleton'.
- ✓ **Cytoskeleton serves** as scaffolding for the movement of organelles and other components.
- ✓ **Cytoskeleton plays an important role** in maintenance of cell shape as well as in cell division.
- ✓ **Basically two types of cytoskeletal elements** are found in plant cells; microtubules and microfilaments.
- ✓ **Microtubules** are hollow cylinders with an outer diameter of 25 nm.
- ✓ **Microtubules are composed of** polymers of the globular protein 'tubulin'.
- ✓ **A single microtubule consists** of thousands of tubulin monomers arranged in 13 columns called protofilaments.
- ✓ **Microfilaments** are solid with 7 nm diameter.

- ✓ **Microfilaments are composed of** protein globular actin (or G-actin).
- ✓ **A microfilament consists** of two chains of polymerized actin subunits that interwind in a helical fashion.