1.7. The nucleus

- The nucleus contains most of the genetic information and serves as the center of regulatory activity. The nucleus provides a site for genetic transcription that is segregated from the location of translation in the cytoplasm, allowing levels of gene regulation.

- The main function of the cell nucleus is to control gene expression and mediate the replication of DNA during the cell cycle. Although the DNA-protein complexes that make up the chromosomes are evident only as an irregular network of chromatin during interphase, the individual chromosomes nevertheless occupy discrete domains throughout this part of the cell cycle for gene expression because during this period chromosomes are actively transcribed. A typical interphase plant cell nucleus also contains one to several nucleoli (nucleoplasm).

1.8. Peroxisomes (=microbodies)

- Peroxisomes are composed of a single membrane that surrounds the finely granular peroxisome matrix and they contain a series of special enzymes. Characteristic enzyme of peroxisomes is catalase. This enzyme breaks down H_2O_2.

- H_2O_2 that is produced during cell metabolism is highly toxic for the cell. For example, diluted H_2O_2 solution that has been used to cleanse wounds since it kills harmful bacteria.

***** However if concentrated H_2O_2 solution is used, it also damages the living cells and may delay wound healing!!!

Peroxisomes that are found in plants protect against loss of photosynthesis products during photorespiration.

In germinating fat-storing seeds, peroxizomes participate in lipid mobilization; in leaves of C_3 plant (plants that produce the three-carbon compound phosphoglycerate as the first stable photosynthetic intermediate), they play a key role in photorespiration; and in some legume root nodules, they are involved in the conversion of recently fixed N_2 into nitrogen-rich organic compounds. So-called unspecialized peroxisomes, also found in living cells of roots and many other plant tissues, contain catalase, glycolate, oxidase, urate oxidase, and enzymes for β-oxidation, but what functions they perform in the cells are not yet known.

1.9. Plastids

Plastids are major organelles found only in plant and algal cells. **They are responsible for photosynthesis**, for the **storage of a wide variety of products** and for the **synthesis of key molecules required for the basic architecture and functioning of plant cells. Like mitochondria, plastids are enclosed in an envelope (a pair of concentric membranes)**. Plastids also **resemble mitochondria** in being **semiautonomous** and containing **the genetic machinery** required **to synthesize a few of their own proteins.**

- Among the plastids, chloroplasts are very important since they have a role in photosynthesis. They are found in leaves and other green parts of the plant. Chlorophyll, the main photosynthetic pigment of plants is found within chloroplasts.
- Plant and algal cells may contain one or more chloroplasts; an average 40-50 chloroplasts are per cell as a general rule.

1.10. Mitochondria

Mitochondria are found in nearly all eukaryotic cells. These essential organelles house the respiratory machinery that **generates ATP** by way of the **citric acid cycle** and **associated electron transfer chain**. Mitochondria also supply various compounds, including **organic acids** and **amino acids** that are used as **building blocks in synthetic reactions** elsewhere in the cell.

- Like plastids, mitochondria are bounded by two membranes. The inner membrane which is much larger in area than the outer, folds into **cristae** that, extend deeply into the **mitochondrial matrix**. The aqueous space between the two envelope membranes, called the **intermembrane space**. The inner membrane (including cristae) contains membrane-associated protein and mitochondrial lipid, including a small amount of an unusual phospholipid, cardiolipin (diphosphatidylglycerol). The **matrix** is composed of **soluble enzymes**, **mitochondrial DNA** (mt DNA) and **ribosomes**.

2. The Cell Wall

- The main function of the cell wall is to make up for the pressure that cell membrane is exposed to. Cell wall provide protection against osmosis stress and help in the protection against attacks of pathogenic microorganisms.

- And it also gives the shape of the cell.The shape of a plant cell is dictated largely by its cell wall. When a living plant cell treated with cell-wall-degrading enzymes to remove the wall, the resulting membrane-bound protoplast is invariable spherical.

- The plant cell wall is a dynamic compartment that changes throughout the life of the cell. The new primary cell wall is formed in the cell plate during cell division and rapidly increases its surface area during cell expansion in some cases by more than a hundred-fold.

- Primary cell wall: Thin and flexible portion of the wall, made of cellulose and pectin.
- Middle lamella: thin layer between primary walls of adjacent cells.
- Secondary cell walls: found in some cells (between the plasma membrane and the primary cell wall and it is impregnated with lignin for strength).

During the growth process, plant cells only have a single layered cell wall called primary cell wall. This primary cell wall expands with the growing cell. During the growth and volume increase, cell wall components are loosened as controlled and central vacuole performs water uptake. The increasing water pressure within the vacuole provides the strength that is requires for the stretching of the cell and the cell wall. When plant growth or volume increase stops, secondary cell wall substances (cellulose microfibrils and other polysaccharides) start to accumulate on the inner surfaces of the primary wall. The cell loses its ability to expand after the formation of the secondary wall.

Both primary and secondary cell walls permit the passage of water and water soluble substances. In addition, some mature plant cells (e.g. vessels) accumulate a layer of lignin in time. Lignine is a polymer consisting of phenolic structures. Lignine does not pass water, it provides hardness to the cell membrane and also provides resistivity to microorganism attacks. Since it does not pass water, tissues containing lignine work as water pipes.

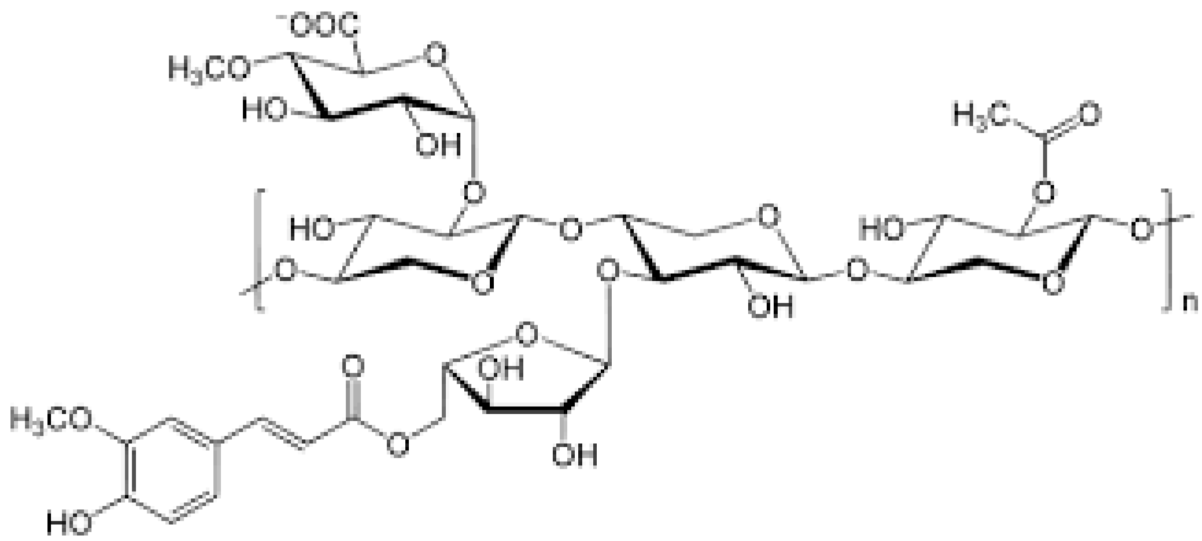
The middle lamella forms the interface between the primary walls of neighbouring cells. Finally at differentiation, many cells elaborate within the primary wall a second cell wall, building complex structures uniquely suited to the cells function.

- The cell wall is a highly organized composite of **many different polysaccharides**, **proteins** and **aromatic substances**.
- **Polysaccharides**, polymers of sugar, are the principal components of the cell wall and form its main structural framework. Polysaccharides are long chains of sugar molecules covalently linked at various positions, some being decorated with side chains of various lengths. Almost all cell wall sugars are aldoses. **Many sugars empirical formula $(CH_2O)_n$,** from which the term carbohydrate is derived.

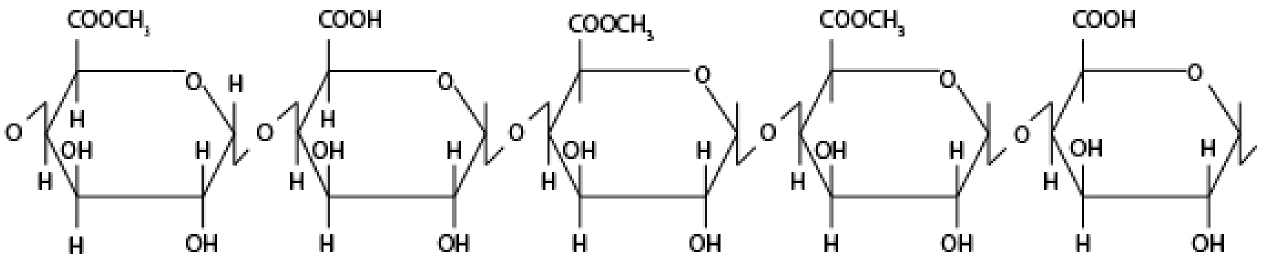
- **Cellulose is the principal scaffolding component of all plant cell walls.** Cellulose is the most abundant plant polysaccharide, accounting for 15% to 30% of the dry mass of all primary cell walls and an even larger percentage of secondary walls. Cellulose is very strong and durable since it exists in the form of microfibrils and these microfibrils attain a stable structure with numerous hydrogen bonds.

- **Non-cellulosic components of the cell:**

Hemicellulose is a polymer that is produced with glucose and other sugars and this polymer binds cellulose fibrils together.



- **Pectin** is a mixture of heterogeneous, branched and highly hydrated polysaccharides rich in D-galacturonic acid. It forms a gel-like matrix by attaching itself to calcium ions and water. This matrix substance fills the spaces between the cellulose fibrils and between the cells.
- Pectin extracts obtained from the plants have the property of gelling, therefore they are used in the making of jam, sugar and other foods.



Their functions in brief:

- determining wall porosity and providing charged surfaces that modulate wall pH and ion balance;
- regulating cell-cell adhesion at the middle lamella;
- serving as recognition molecules that alert plant cells to the presence of symbiotic organisms, pathogens and insects.

Membrane Transport

- The selective movement and redistribution of ions and small organic molecules is essential for plant growth and cellular homeostasis. Because of this, plants have evolved **numerous proteins** that **facilitate the transport** of **minerals, sugars, metabolites** and **other compound through the limiting membranes of cells** and **organelles.** These membrane transporters are selective for the compound being transported and activities are often tightly regulated.
- In plant cells, membrane transport underpins a wide range of essential processes, including the following:
- **Turgor generation**
- **Nutrient acquisition**
- **Waste product excretion**
- **Metabolite distribution**
- **Compartmentalization of metabolites**
- **Energy transduction**
- **Signal transduction**

Protein Sorting and Vesicle Traffic

- A typical plant cell contains 5000 to 10 000 different polypeptide sequences and billions of individual protein molecules. If such a cell is to function properly, it must direct these proteins to specific metabolic compartments, cytoplasmic structures and membrane systems. Accurate protein sorting is required at all times, both when cellular structures are formed in dividing and differentiating cells and when proteins in mature structures are degraded and replaced. Examples of the proteins that must be sorted include soluble enzymes, intrinsic membrane proteins and structural proteins in the cell wall matrix.

- **Most proteins have hydrophilic surfaces and therefore do not readily pass through the hydrophobic core of lipid bilayer.** Translocation through a membrane involves a protein-like pore or channel through which a protein passes, not in its globular form but it an extended or unfolded configuration. Cytosolic chaperones interact with newly synthesized proteins, keeping them unfolded so they can pass through a protein pore to an appropriate compartment or membrane.

The first sorting event for all proteins made in the cytosol separates them into **two groups. Proteins in the first group** are released in the cytosol and may either remain in that compartment or be **targeted to a variety of destinations, including plastids, mitochondria, peroxisomes and nuclei.**

- **By contrast, proteins in the second group are targeted to the ER by signal peptides located in the N terminus. Translation of a signal peptide causes the ribosome to bind to the ER during protein synthesis. ER studded with such ribosomes is referred to as rough ER. Proteins synthesized on the rough ER enter the secretory pathway, an intracellular system of vesicles and cisternae (flattened sacs) that includes the ER, Golgi complex, tonoplast and plasma membrane. These proteins can then be secreted or targeted to the various compartments of the secretory system.**

- The transport of the both soluble and membrane proteins is mediated by vesicles that carry proteins from one compartment to the next. Thus, vesicles are constantly being formed, transported and fused with a compartment different from the one in which they originated. Such transport implies that vesicles can recognize their destination according to the cargo they carry.

3. The Cytoskeleton

- **Spatial organization within the eukaryotic cell and directed movements of the cell or its contents are mediated by the cytoskeleton, a network of filamentous protein polymers that permeates the cytosol.** The cytoskeleton comprises three major families of proteins: **intermediate filaments**, **actin** and **tubulin**.
- **Functions of cytoskeleton:**
- Anchorage
- Motility
- Information
- Polarity