[PLANT CELL WALL]

Functions of Cell Wall

• Maintaining and determining cell shape.
• Provide mechanical support and allows the plants to grow tall.
• Prevents the cell membrane rupture due to water pressure (turgor pressure).
• Provide mechanical protection from insects and pathogens.
• Biochemical activity in wall contributes to cell-cell communication.

Structure of Cell Wall

Cell wall contains 3 types of layers, middle lamella, primary wall and secondary wall.

Middle lamella:
  • It is the first layer formed during cell division.
  • It is the outermost layer of the cell.
  • It is shared by adjacent cells.
  • It is composed of pectic polysaccharides and proteins.

Primary Wall:
  • It is formed after middle lamella.
  • It is composed of pectic polysaccharides, cellulose, hemicellulose and protein.
  • All plant cells have a middle lamella and primary wall.

Secondary Wall:
  • It is formed after cell enlargement is completed (or cell growth stopped).
  • It is extremely rigid and often layered.
  • It is made of cellulose, hemicellulose and lignin.

Components of Cell Wall

Pectic Acid:
  • It is the polymer of around 100 galacturonic acid molecules linked by α-1,4 bonds.
  • It is hydrophilic and easily hydrated.
  • It forms salts and salt bridges with Ca\(^{2+}\) and Mg\(^{2+}\) to form insoluble gels.
  • It is major component of middle lamella but also found in primary wall.
Pectin:
- It is polymer of around 200 galacturonic acid molecules.
- Many of the carboxylic groups are methylated (-COOCH$_3$).
- Less hydrated than pectic acid but soluble in hot water.
- It is major component of middle lamella but also found in primary wall.

Cellulose:
- It is a polymer of β-D-glucose, in which about 1000-10000 molecules (residues) of glucose are linked by β-1,4 linkage.
- Cellulose readily forms hydrogen bonds with itself (intra-molecular H-bonding) and with other cellulose chains (inter-molecular H-bonding).
- The H-bonding of many cellulose molecules results in the formation of microfibers.
- Many microfibers unite to form fibers. Cellulose fibers usually contain over 500,000 cellulose molecules.
- H-bonding is the basis of high tensile strength of cellulose.
- Cellulose is the major component of primary and secondary walls.
Hemicellulose:
- It is a polysaccharide composed of a variety of sugars including glucose, mannose, xylose and arabinose.
- Hemicellulose contains linear but shorter (several hundred residues) chain of polysaccharides joined by $\beta$-1,4 (or rarely $\beta$-1,3) glycosidic linkage.
- The backbone contains numerous short side-chains that might be linked by $\alpha$-1,2; $\alpha$-1,3 or $\alpha$-1,6 bonds.
- They do not aggregate with themselves, hence they don’t form microfibers.
- They form H-bonds with cellulose hence they are called as ‘cross-linking glycans’.
- Hemicellulose molecules are very hydrophilic and they are easily hydrated and forms gels.
- Hemicellulose is abundant in primary walls but also found in secondary walls.

Lignin:
- It is polymer of phenolics, especially phenylpropanoids.
- Lignin is primarily a strengthening agent in the wall.
- It also resists fungal and pathogen attack.
Proteins:

*Structural Proteins:*
- Cell wall proteins are glycoproteins (peptide backbone with carbohydrate side-chains on certain amino acids).
- These proteins are particularly rich in amino acids, hydroxyproline, proline and glycine.
- Glycoproteins are hydrophilic and can form H-bonds and salt-bridges (or cross-linked) with cell wall polysaccharides.
- Structural proteins are found in all layer of cell wall but they are more abundant in primary wall.

*Functional Proteins:*
- Functional proteins have enzymatic activities.
- They include oxidative enzymes (peroxidase), hydrolytic enzymes (pectinase and cellulose) and expansin (enzyme that catalyze cell wall creep activity).