CHAPTER 3

3 THE CELL WALL

3.1 Introduction

Found in **plants** and **prokaryotes** cells

General Functions of the Cell wall

i) Prevents cell from burst from the inflow of water by osmosis i.e. prevents cells from osmotic and mechanical injury.
ii) Determines cell shape because of its rigidity.
iii) In higher plants it provides physical strength for supporting the entire plant.
iv) Acts as a permeable barrier especially when cuticle is present, also acts as a site of many enzymatic reactions (these enzymes are hydrolytic).

3.2 Structure of Prokaryote Cell wall

Consist of (a) Capsule (b) cell wall (c) periplasmic space- separate the cell wall from the plasma membrane.

3.2.1 Capsule layer

i) is transparent zone or gelatinous material of varying thickness surrounding the cell wall in some strains of bacteria.
ii) sometimes it is called the slime layer when it is less organized and more loosely associated with the cell surface.

Function of capsule

i) Influence ability of bacteria to cause disease.

3.2.2 Bacteria Cell wall

Classified in terms of staining

a) Gram positive
b) Gram negative

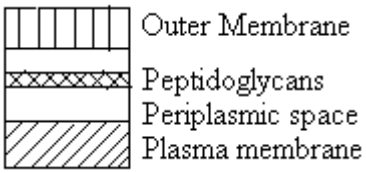


Fig. 3.1 Structure of bacteria cell wall

3.2.1 Periplasmic space

i) Located between the cell wall and the cell membrane.

ii) Most prominent in gram positive organisms because of the outer membrane.
iii) In gram negative bacteria periplasmic space is not defined.

i) Prevents loose of molecules from outer membrane to an external medium.
ii) Contains enzymes which are hydrolytic in nature e.g. alkaline phosphatase, 5'-nucleotidase, phosphertase, ribonuclease and deoxyribonuclease.

In gram negative (where PS is less well defined) these same enzymes are found on cell surface or are secreted in the medium. They degrade macromolecule that are too large to pass through the plasma membrane and the cell.

3.2.4 Peptidoglycans or murein in Grampositive and Gram Negative bacteria

Gram positive bacteria

Thickness of cell is 30-100nm

i) Polysaccharide-peptide complex called peptidoglycans or murein forms the bulk of the cell wall.
ii) Polysacharides, polypeptides and teichoic acids -are found intertwined with petidoglycans.

Gram Negative bateria

i) Peptidoglycan layer is thinner(3.8 nm) than that of gram positive bacteria
ii) This difference result to difference in gram staining.
iii) The thinner wall of gram negative bacteria allow removal of gram stain while the thicker layer prevent the dye from being extracted.
iv) Gram negative have an extra structure called outer membrane outside the peptidoglycan layer.
v) Outer membrane- lipopolysaccharides account for about 1/2 the mass of this membrane.
vi) Lipoplysaccharides are amphpathic.
vii) Protein and lipid composition of the outer membrane is different from that of plasma membrane.
viii) Lipopolysacharides are endotoxines-hosts infected by gram negative have inflammatory response. Exotoxins are toxins actively secreted by the bacteria.
ix) Outer membrane of the gram negative cell wall and also have protein e.g. matrix porins OMP A proteins.
x) Matrix proteins- function have general pores for facilitating the movement of hydrophilic solutes across the outer membrane.
xi) OMP A protein-important in maintaining cell morphology and outer membrane integrity.
xii) Penicillin inhibits formation of cell wall i.e. prevent transpeptidation, thus producing bacteria which are susceptible to bursting. Gram negative have outer membrane which makes them less susceptible to penicillin than gram positive. Example of bacteria without cell wall-mycoplasma.

3.3 PLANT CELL WALL AND RELATED STRUCTURES IN EUKARYOTES

In Eukaryotes plant cell have cell wall and animal cell have external coat that is analogous to a cell wall called glycocalyx

3.3.1 Chemical composition of plant cell wall

i) It is a rigid multilayer structure
ii) Composition - cellulose, hemicellulose, pectins, ligin.
   a) Proteins (small amounts)
   b) Lipids -waxes and other complex polymers-form cuticle on the external of the cell wall. This cuticle protects cells against injury and desiccation.
iii) Plant cell wall is 10 to several hundreds nanometers think.

3.3.2 Parts of a cell wall (CW)

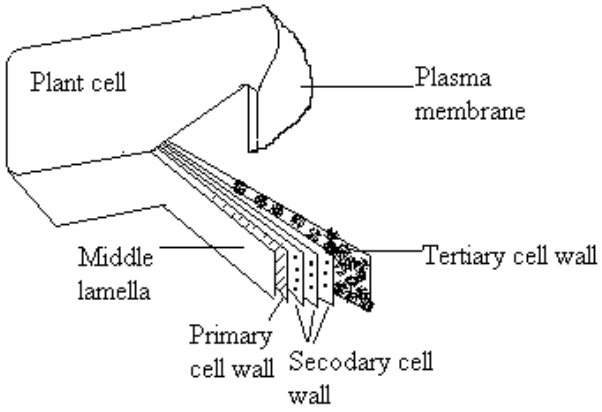
It consists of the following parts: 1) Middle lamella 2) Primary (CW) 3) Secondary (CW) 4)Tertiary (CW)

1) Middle lamella (ML)

i) It is found in multicellular plants.
ii) ML is the outer most layer
iii) It is made up of pectins (derivatives of polygalacturonic acid)

Function of ML is to hold adjacent cells together.

2) Primary cell wall
i) It is the first zone to appear in cell wall formation.
ii) **Composition:** cellulose (polysacharide) which is made by linking many β-glucose together into long chain.



iii) Cellulose are organized into microbrils that measure 10-25 nm in diameter.
iv) Celloluse in microfibrils are in parallel arrangement.

v) Microfibrils are randomly distributed in amorphous matrix

vi) Amorphous nature allow the matrix to be flexible and capable of expansion during cell growth

3) Secondary Cell Wall (CW)
   i) Is a multilayer structure
   ii) Superimposed on the inner surface of primary wall after cell growth has ceased.
   iii) Composition- densely packed cellulose microfibrils.

Function of Secondary CW: - provides mechanical strength and rigidity to the cells, this is responsible for the characteristic strength of the woody tissues.

4) **Tertiary cell wall (lamella)**
   i) It is thin compared to secondary cell wall
   ii) It lacks cellulose microfibrils.

5) Plasmodesmata

   i) Are small openings on the cell wall

   Function: allow contact of cells through cytoplasmic extensions.

3.4 ANIMAL CELL GLYCOCALYX

i) Is a polysaccharide coat analogous to cell wall in plants.
ii) Polysaccharide coats are collectively referred to as glycocalyx (sweet husk)

Parts of glycocalyx

i) Attached glycocalyx- attached to plasma membrane and cannot be removed mechanically without simultaneously removing the plasma membrane.
ii) Unattached glycocalyx (extraneous coat)-consists of materials external to the plasma membrane, that can be mechanically removed without affecting the viability of the cell or without disrupting the plasma membrane.

Functions of Glycocalyx (unttached glycocalyx)

i) Cell adhesion - Binds cells together so that tissues do not fall apart
ii) Protection of the cell surface- Cushions the plasma membrane and protects it from chemical injury
iii) Creation of permeable barrier.
iv) Doffense against cancer: Changes in the glycocalyx of cancerous cells enable the immune system to recognize and destroy them.
v) Transplant compatibility: Forms the basis for compatibility of blood transfusions, tissue grafts, and organ transplants
vi) Inflammation regulation: Glycocalyx coating on endothelial walls in blood vessels prevents leukocytes from rolling/binding in healthy states.
vii) Recognition e.g. during fertilization it enables sperm to recognize and bind to the eggs. In embryonic development it guides embryonic cells to their destinations in the body.
viii) Immunity to infection: enables the immune system to recognize and selectively attack foreign

organisms

3.5 The extra-cellular Matrix (ECM)

i) These are materials secreted from the surface and accumulates in the space between cells e.g. in connective tissues such as bones, tendon, cartilage and dermis.
ii) Basal lamina is extra-cellular matrix organized into a thin sheet of material, which supports the underlying cells and separate them from connective tissues.
iii) Components of extra-cellular matrix-collagens, proteoglycans and noncollagenous glycoproteins.
iv) Texture - can be watery, gelatinous, elastic or rigid depending of the relative content of the ingredients (above).