B.Sc. Botany (Hons.) I

Paper- I

Ultra Structure of Bacterial Cell

The simplest organisms living on earth today are bacteria, and biologists think they closely resemble the first organisms to evolve on earth. Too small to see with the unaided eye, bacteria are the most abundant of all organisms and are the only ones characterized by prokaryotic cellular organization.

A closer examination of bacterial cell through electron microscope shows following structures-

i. Surface appendages
ii. Surface adherents- capsule & slime layer
iii. Cell wall
iv. Plasma membrane
v. Cytoplasm
vi. Cell organelles
vii. Cell inclusions or reserve food materials
viii. Nucleoid
ix. Plasmid

i. **Surface appendages**: There are of two types-
   (a) Flagella
   (b) Pili (single pilus)

(a) **Flagella**: Bacteria may be motile or non-motile. The motile form shows by means of flagella. Chemically they are made up of proteins. Externally they are hair like structure and appear to be attached to cell wall. They originate from blepharoplasty found just beneath the cell wall. Typical flagellums are about 120 A^o thick and 5µ long.

There are two main types of arrangements of flagella, the polar and rperitrichous arrangement. In the polar types the bacteria may be monotrichous (single flagellum at one or both the ends and amphitrichous (one flagellum at each end). The peritrichous type is characterized by flagella distributed.

(b) **Pili:** These appendages do not add to the mortality power of a cell but their presence gives the cells property of stickiness. The pili are found on both motile and non-motile bacteria. The pili are much smaller than the flagella and are present in great numbers.

ii. **Surface adherents:** Some bacteria have a gelatinous covering around them. If the covering is a loose mass it is called slime layers, when it is relatively narrow and well defined it is called 'Capsule'.

Depending on the thickness the capsule is of two types-

(a) Macrocapsule- It is more than 0.2µ thick.

(b) Microcapsule- It is less than 2.2µ thick.

iii. **Cell wall:** The cell wall is made up of two types of polymers are composed of saccharides sub-unit and other of amino acids sub-units. Therefore the bacterial cell wall is a glucopeptide or mucopeptide.

Chiristian Gram, a Danish bacteriologist in 1884 divided bacteria (Eubacteria) by a staining methods into two major groups- the gram-positive and gram-negative.

The wall of gram-positive bacteria is homogenous containing of 85% or more of mucopeptide and simple polysaccharide. It does not contain lipid. The wall is much rigid due to the presence of greater amount of mucopeptide.

The cell wall of gram-negative bacteria contains only 3-12% mucopeptide, the rest being lipoproteins are lipo-polysaccharides, under electron microscope it appears tripartite (three layer).

The wall is less rigid due to plastic nature of lipid-protein polysaccharide complex.

In making of the cell wall, the saccharides sub-units is composed of long chain of alternating units of n-acetyl muromic acid (NM) and n-acetyl glucose amine (NG) linked together by a glycosidic bond (a bridge that includes an oxygen atom). Small peptides are attached to the n-acetyl muramic acid (NM) which is formed by 4 amino acids.

Basic structure of mucopeptide in gram-positive bacteria in which two adjacent peptides are connected by Pentaglycine Bridge. Basic structure of mucopeptide in gram-negative bacteria in which two adjacent peptides are connected by direct covalent bridge.

iv. **Plasma membrane**:

Beneath the cell wall the cytoplasm is surrounded by plasma membrane. In both gram-positive and gram-negative bacteria this seems to be similar. In gram-positive bacteria (rarely in gram-negative bacteria) the membrane appears to be in folded of localized enfolding are known as mesosomes.

v. **Cytoplasm:** It is the complex mixture of water, proteins, carbohydrates, lipids, minerals, nucleic acid and organic matter in the colloidal state.

vi. **Cell organelles:** The following cell organelles are embedded in the cytoplasm-

(a) **Ribosomes**- Approximately 10,000 to 15,000 70S ribosomes are present in one bacterial cell which constitutes about 30% of the total weight of the bacterium. They are found in free floating condition and are randomly distributed in cytoplasm. During protein synthesis a number of ribosomes are held together by mRNA forming polyribosomes.

(b) **Lamellae and Chromatophores**- Photosynthetic bacteria have lamellae consisting of two parallel unit membranes, which may be small or long. They are distributed throughout the cytoplasm.

The chromatophores are hollow, spherical structure about 900A^{o} in diameter. Much of the cytoplasm appears occupied by them.

The bacterial photosynthetic apparatus, the pigments together with enzyme and the electron transport system for the photosynthetic phosphorylation of the light reaction. They are devoid of the enzymes associated with dark reaction of photosynthesis.

vii. **Cell inclusions**- Under electron microscope the cytoplasm appears granular due to reserve food materials which can be classified into following three categories-

(a) Organic polymer- Polysaccharides, lipids etc.

(b) Inorganic metaphosphate granules- Volutin granules are an intracytoplasmic storage form of complexed inorganic polyphosphate.

(c) Elemental sulphur- It is present in sulphur oxidizing bacteria.

viii. **Nucleoid:** Under electron microscope the nuclear material of bacteria appears to be fibriler and made up of DNA without nuclear wall. No structure is referred to as nucleoid or nuclear body or nuclear equivalent.

ix. **Plasmids:** They are circular, double stranded molecule of DNA and exist independently of chromosomal DNA in bacterial cells.

Two types of plasmids have been identified-

(a) Conjugative plasmids- It carries gene that promote the transfer of plasmids from host cell to a recipient cell by conjugation.

(b) Non-conjugative plasmid- It cannot promotes its own transfer by conjugation.

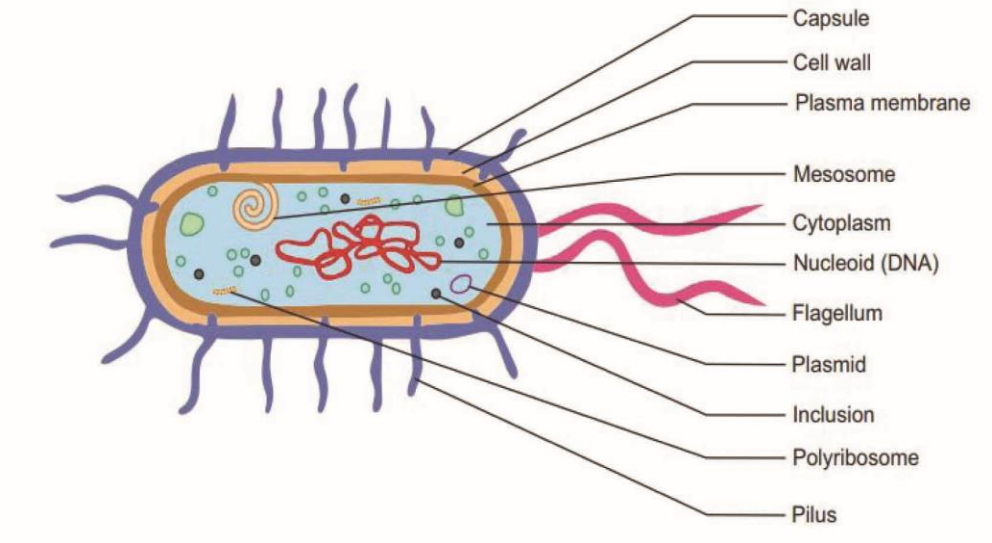

Fig. Ultra structure of a Bacterial cell