

Bacterial Structure

The basic components of bacterial cells include the structure that form the cell envelope enclosing the cytoplasm, the cytoplasmic constituents, and the external structure that project through or cover the cell envelope.

A. Cell envelope:

- most bacteria have a cell envelope consisting of a cell wall and an underlying cytoplasmic membrane (cell membrane).
- may include a capsule or glycocalyx layer
- contains antigens that frequently induce a specific antibody response.

1. Cell wall:

- refers to that portion of cell envelope that is external to the cytoplasmic membrane and internal to the capsule or glycocalyx.
- provides protection, imparts shape to the cells and confers Gram-staining characteristics.
- Gram-positive bacteria have a relatively thick cell wall, largely composed of peptidoglycan. Other cell wall polymers, for example, teichoic acid, are also present.
(The large amount of peptidoglycan make Gram +ve bacteria susceptible to the enzyme lysozyme and to penicillin).
- Gram-negative bacteria have a thin peptidoglycan, lipoprotein, and an outer phospholipid membrane, which contains lipopolysaccharide.
(Lipopolysaccharide is also called endotoxin. It contains O antigen).
- contains penicillin-binding proteins.
- Protoplasts: complete removal of cell wall.
- Spheroplasts: partial removal of cell wall.

2. Cytoplasmic (cell or plasma) membrane

(The actual barrier between the interior & exterior of the bacterial cell)

- is responsible for selective permeability.
- contains the cytochromes and enzymes involved in electron transport and oxidative phosphorylation (energy system).
- contains carrier lipids and enzymes involved in cell wall biosynthesis.
- is the site of action of certain antibiotics such as polymyxin.

B. Cytoplasmic components

1. Cytoplasm

- contains chromosomal DNA, ribosomes and various type of nutritional storage granules.
- contains no organelles (such as nucleus, mitochondria, Golgi apparatus or ER).

2. Nuclear material (nucleoid or nuclear body)

- is not surrounded by a nuclear membrane (prokaryotic).
- consist of one long, double-stranded, circular DNA molecule.
- smaller extra-chromosomal DNA molecules (plasmids) may also present. Plasmids frequently carry genes that involved in antibiotic resistance (R factor).

3. Ribosomes

- function as the active center of protein synthesis.
- have a sedimentation coefficient of 70S and are composed of 30S and 50S .
- are the site of many antibiotic that inhibit protein biosynthesis. (streptomycin, chloramphenicol and tetracycline).

4. Cytoplasmic inclusion

- sources of stored energy.

C. External structures

1. Flagella

- are long filaments composed of a polymerized protein (flagellin), which produce motility by rotation.
- may be located in only one area of a cell as a single flagellum (monotrichous) or as a small bundle of flagella (polar flagella) or over the entire bacterial cell surface (peritrichous).

2. Fimbriae (pili)

- are rigid surface appendages composed mainly of protein called pilin.
- exist in two classes: ordinary pili (adhesins), involved in bacterial adherence and sex pili, involved in attachment of donor and recipient bacteria in conjugation.
- are, in the case of ordinary pili, the colonization antigens (virulence factor) associated with some bacterial species such as *N. gonorrhoeae* & *S. pyogenes*.

3. Capsule

- surround many bacterial cells and is external to the cell wall.
- most bacterial capsules are composed of polysaccharide.
- some bacteria have polypeptide capsule composed of D-glutamic acid (*B. anthracis*).
- protect the bacteria from phagocytosis.

Bacterial Shape

- is determined by the mechanism of cell wall assembly.
- is usually spherical (cocci), cylindrical (bacilli or rods), or spiral (helical).

May be pleomorphic with some species such as *Bacteroids*.

- can be usually determined with appropriate staining and light microscope.
- may be altered by antibiotic that affect cell wall biosynthesis (e.g., penicillin).

Endospores (spores)

- are formed in response to limitations of nutrients by a complex process (sporulation).
- are metabolically-dormant (inactive). They are highly resistant to adverse environmental conditions and may survive desiccation, heat, or disinfectants.

- contain calcium dipicolinate.
- germinate under favorable nutritional conditions.
- are helpful in identifying some species of bacteria (*Bacillus* & *Clostridia*).