

II. OPTIONAL COMPONENTS

Optional components include:

1. Surface polymers such as: – The capsule,
2. Appendages such as:
 - Flagella or cilia
 - Pili (hair-like structures) [common pili and sex pili]
3. Genetic structures such as:
 - Plasmids
 - Transposable genetic elements.
4. Endospores can also be considered optional structures.
5. Capsule

1. Capsule

Definition: A more or less compact layer surrounding the cell wall, produced by many bacteria.

Nature: Gelatinous-viscous organic substances.

Composition: Most often polysaccharide-based, such as dextrans in *Leuconostoc* or levans in *Pseudomonas*.



Chemical Composition: • Generally composed of polysaccharides, and referred to as the glycocalyx.

• *Exception:* The genus *Bacillus*, which has a polypeptide capsule.

Presence:

- Capsule production is influenced by certain environmental conditions.
- Carbohydrates play an important role in determining the presence or absence of a capsule.

Microscopic Detection:

• India ink technique: shows a clear, refractive halo.

Function

• Not essential for bacterial survival,

• **However**, its presence determines various specific properties:

- **Adhesion**: Enables bacteria to attach to various surfaces, both inert and living.
- **Protection**: Against environmental factors (physical-chemical conditions such as desiccation) and predation by protozoa. It also prevents bacteriophage attachment.
- **Pathogenicity**: The capsule serves as a carrier for numerous antigens, making encapsulated pneumococci pathogenic.

2. Flagella or Cilia

In general, motility is observed in bacilli, while only a few cocci are mobile.

Types of Motility Several types exist:

1. **Gliding** on solid surfaces: Found in Gram-negative bacilli, e.g., *Flavobacterium succinicans* (mechanism not fully understood).
2. **Swimming**: Observed in liquid or semi-solid media, resulting from the presence of flagella.
3. **Rotation** around a central axis: Observed in spirochetes.


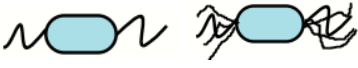
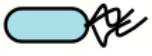
Flagella Fine structures:

- **Diameter**: About 10-20 nm
- **Number**: Varies from 1 to 50
- **Distribution**: Differs between bacterial species.
- **Microscopic detection**: Requires special staining to thicken the flagella, making them visible.


Distribution Systems

Two main distribution systems and several flagella arrangements on the cell surface:

- **Polar system**

1. A single polar flagellum  - monotrichous
2. A tuft or one flagellum at each pole  - amphitrichous
3. A tuft of polar flagella  - lophotrichous

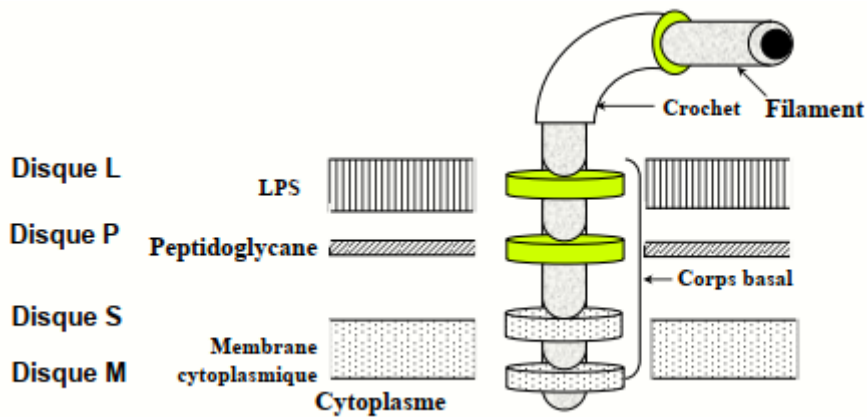
- **Peritrichous system** :

Peritrichous arrangement:  Flagella surrounding the bacterium

Structure

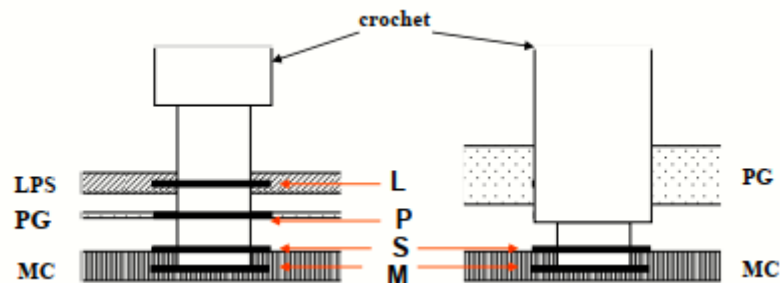
Flagella consist of three parts:

1. A helical filament; length Less than or equal to (\leq) 10 μ m, composed of flagellin protein
2. A hook, flexible and curved
3. A basal body: Fixed S, P, and L discs, and a mobile M disc



Structure of the Basal Body of the Flagellum

Insertion Mode



Gram-negative bacteria

Gram-positive bacteria

Function

1. *Movement*: The primary role of flagella, allowing bacteria to escape predators, unfavorable conditions, and seek food or oxygen.
2. *Attachment to surfaces*: It is possible that cilia also contribute to bacterial attachment.
3. *Antigenic properties*.
4. *Virus entry*: Some viruses penetrate bacteria through the hollow flagellar tube.

3. Pili or Fimbriae

Pili (hair-like structures) are external protein-based structures, shorter, thinner, and more rigid than flagella, and have no locomotory function.

- **Types:** Numerous types exist, with specific functions, most of which remain poorly understood.

Two main types:

- Common pili (fimbriae)
- Sex pili

- **Nature:** Polymer of a specific protein (pilin).

Common Pili

- **Characteristics:** Thin, short, rigid, and brittle.
- **Number:** Found in large numbers around the bacterial cell (up to several hundred).
- **Function:**
 - Enable bacterial adhesion to various surfaces.
 - Responsible for bacterial aggregation, forming a viscous pellicle or biofilm on liquid media.

Sex Pili

- **Characteristics:** Longer, reaching up to 20 μ m, and ending with a swelling.
- **Number:** Few, ranging from 1 to 4.
- **Function:**
 - Connect two bacteria (male-female recognition).
 - Facilitate genetic material exchange (bacterial conjugation).
 - Attachment site for bacteria and bacteriophages.



Note: Bacteria capable of producing sex pili are termed "male" bacteria, whereas those that do not are considered "female."