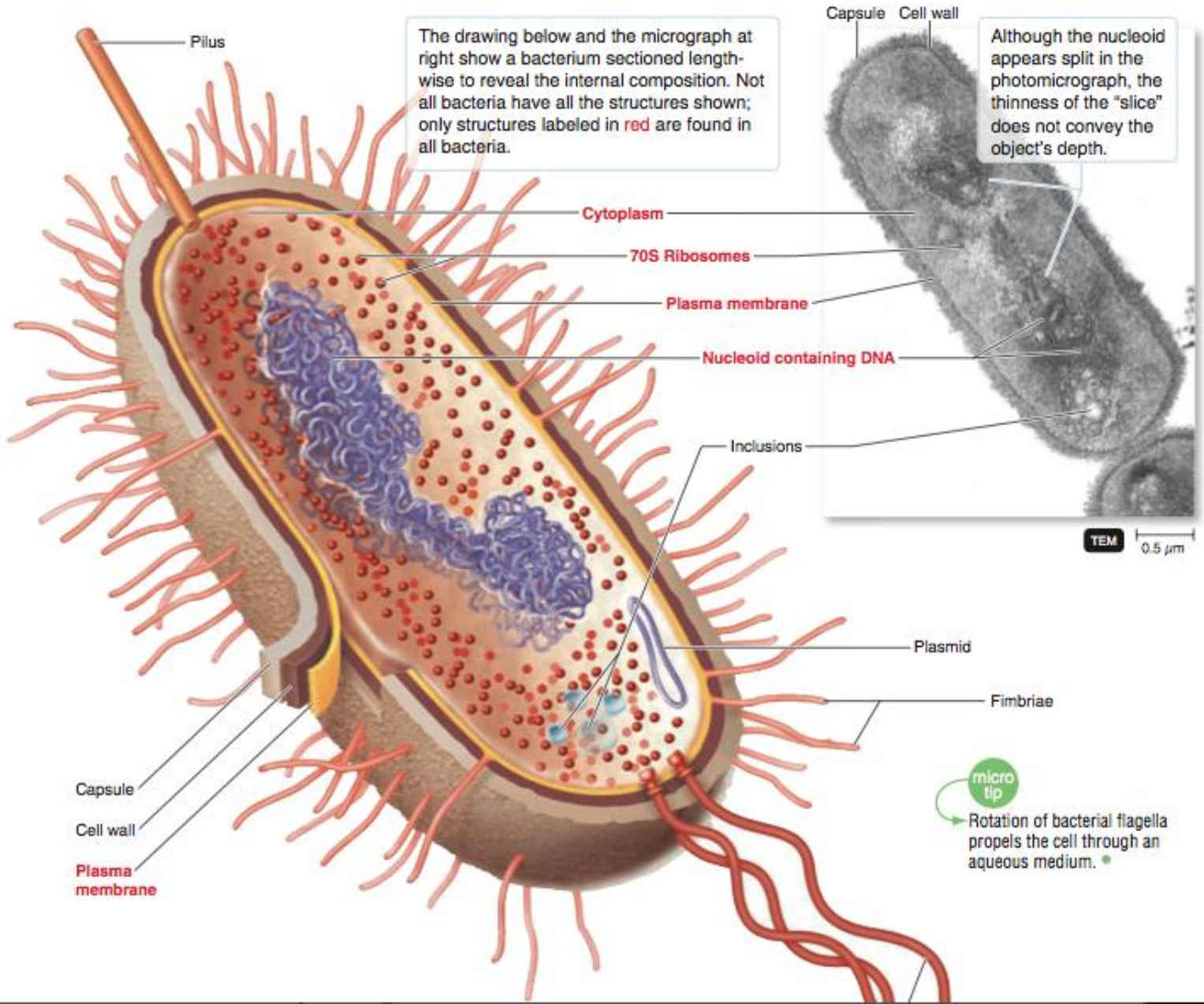
Anatomic Structure of the Bacteria

- External Structure
  - Cell wall
  - Capsula
  - Flagella
  - Fimbriae (pilus)
- **Internal Structure**
  - Cytoplasmic membrane
  - Mesosom
  - Nucleotid
  - Ribosome
  - Cytoplasmic granuls
  - Spore
  - Others (plasmid, phage, pigment, transposon, trace element)

The Structure of a Prokaryotic Cell



Cell wall

- Out of cytoplasmic membrane
- All bacteria have it except for Mycoplasma and L form.
- When various chemical treated; occur protoplasts or spheroblasts
- It is not essential for the survival of bacteria (under appropriate conditions)

- **Duties**
  - Protects bacteria from environmental effects
  - Gives shape to the bacteria
  - Provide permeability and osmosis
  - Have a role in bacterial division and spore formation
  - It has antigenic properties
  - Have a role in virulence
  - It includes receptors of structure (phage, antibody, bacteriocin)

Structure of the cell wall

Gram positive bacteria:

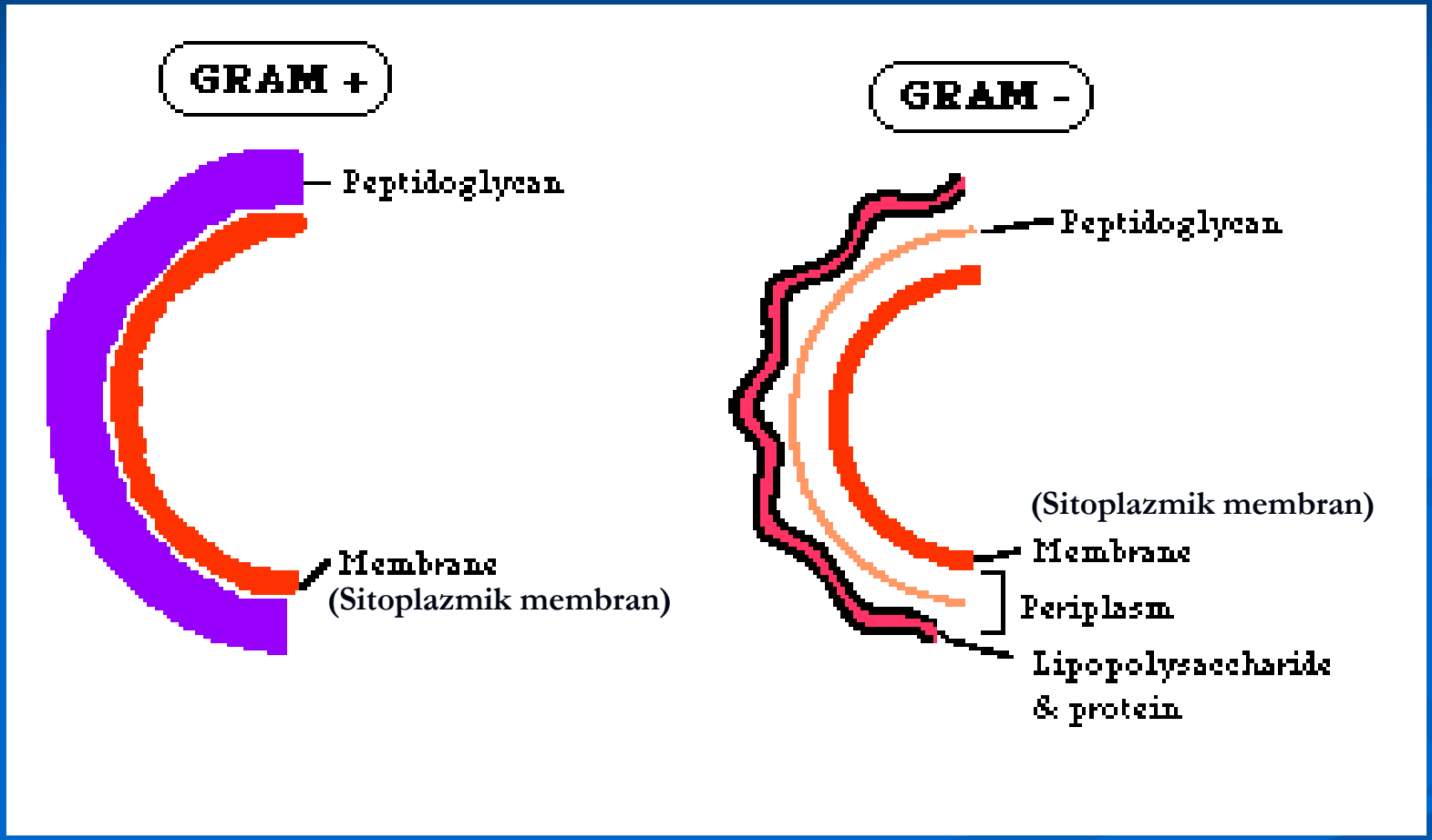
- It has 40-90% peptidoglycan(murein)
- Peptidoglycan consists of nama and naga molecules junction with B-1,4 glycoside bonds
- NAMA has short tetrapeptide chain molecules(L-alanine, D-glutamic asit, D-lysine, D-alanine)
- Two NAMA molecules connected with pentapeptide bonds
- Has teichoic acid (teichuronic) and lipoteichoic acid
- Teichoic acid contains that carbonhydrate, choline, D-alanine and forms antigenic structre.
- There are two types of teichoic acids; cell Wall and membrane
- Protoplasts occurs when peptidoglycan destroyed

Structure of the cell wall

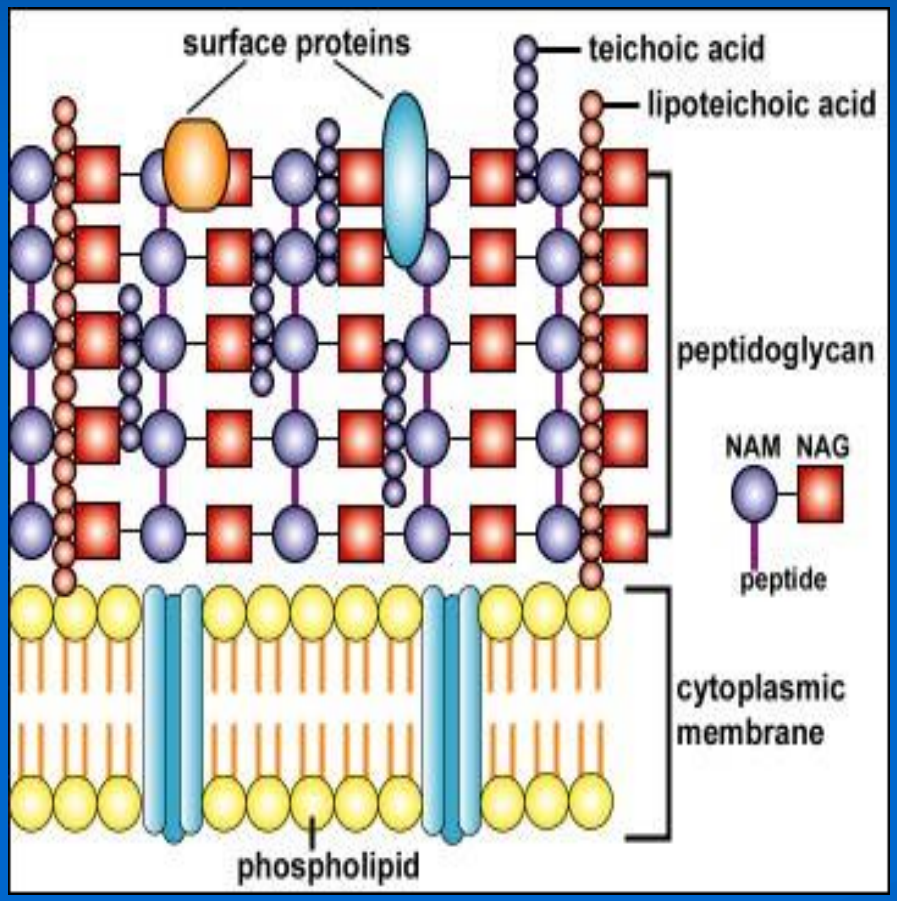
Gram negative bacteria:

- Complicated than Gram-positive bacteria
- Peptidoglycan layer thinner (5-10%)
- Has not Teichoic acid
- It has porin protein
- Except for peptydogylican
  - outer membran
  - lipoprotein
  - lipopolysaccharide (LPS, endotoxin) has layers

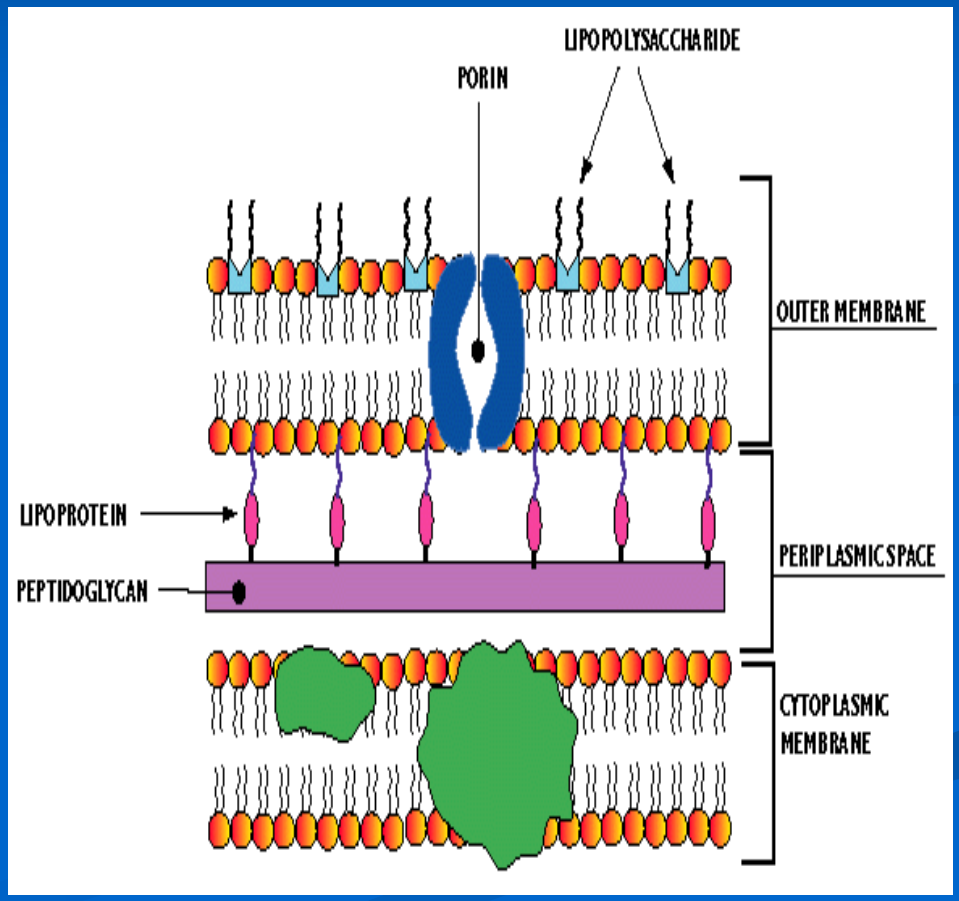
- Spheroplast occurs when peptidoglycan destroyed


GRAM +
Peptidoglycan
Membrane
(Sitoplazmik membran)
GRAM -
Peptidoglycan
(Sitoplazmik membran)
Membrane
Periplasm
Lipopolysaccharide
& protein

Gram positive



Gram negative



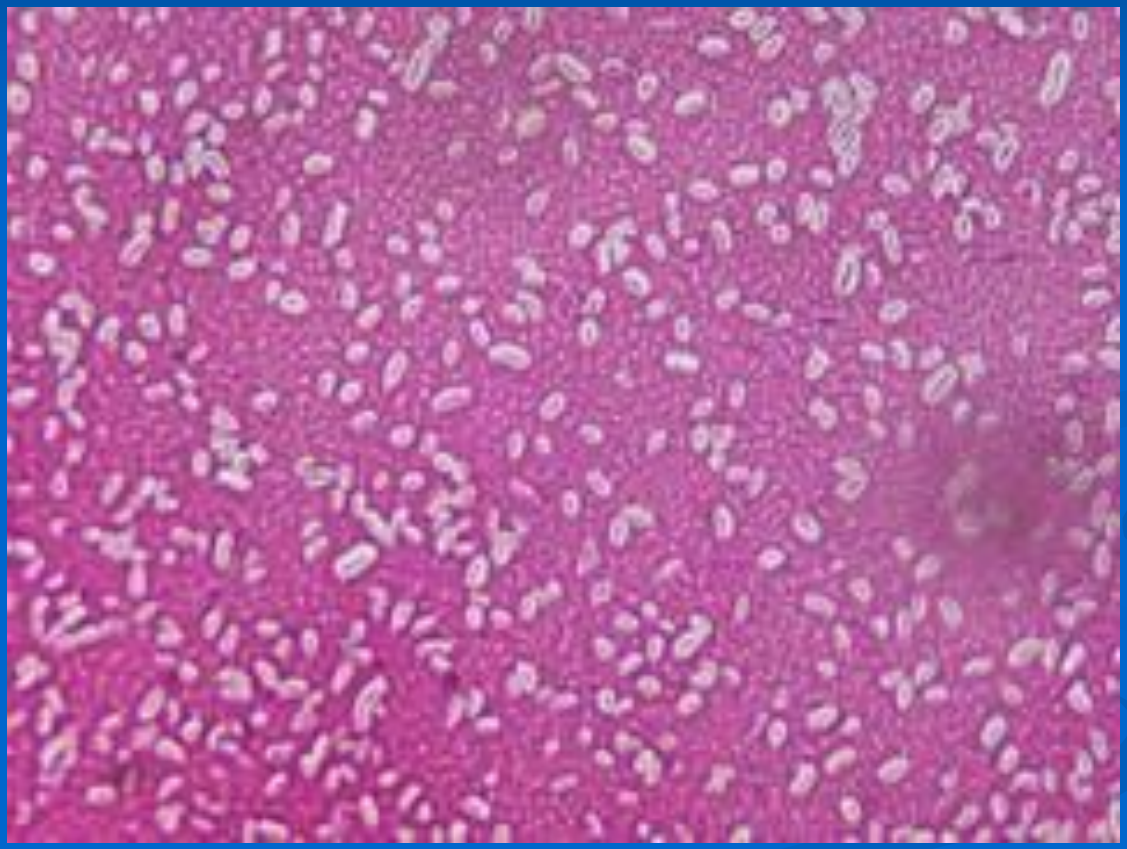
Capsule

- Outside of the cell wall with a thickness of 0.2- 10 μm in some bacteria
- It is gelatinous, elastic, mucoid
- They can stained with negative staining and special staining methods (Giemsa, Hiss)
- In composition depending on environmental condition
- Capsulated bacteria occurs "S" and "M" formed colonies in medium
- It can be encoded in plasmids (B. anthracis)

Capsule

- Structure varies depending on bacteria
- Usually polysaccharides (such as S. pyogenes, P. multocida, C. perfringens)
  - Some of the proteins (B. anthracis)
  - Polisakkarid + protein (B. megaterium)

- Gives various properties to the bacteria
- Antigenic (**“K” antigen**)
- Antifagositik
- Increasing virulence
- Environmental resistance



Microcapsule

- The same structure as the capsule
- Only shown as serological
- Hide somatic antigen (“O”)
- Related to the antigenicity and the virulence of the bacteria
- It has the antigenic structure of the bacterial classification (such as E. coli K1,2,....80)

Mucoid Substance

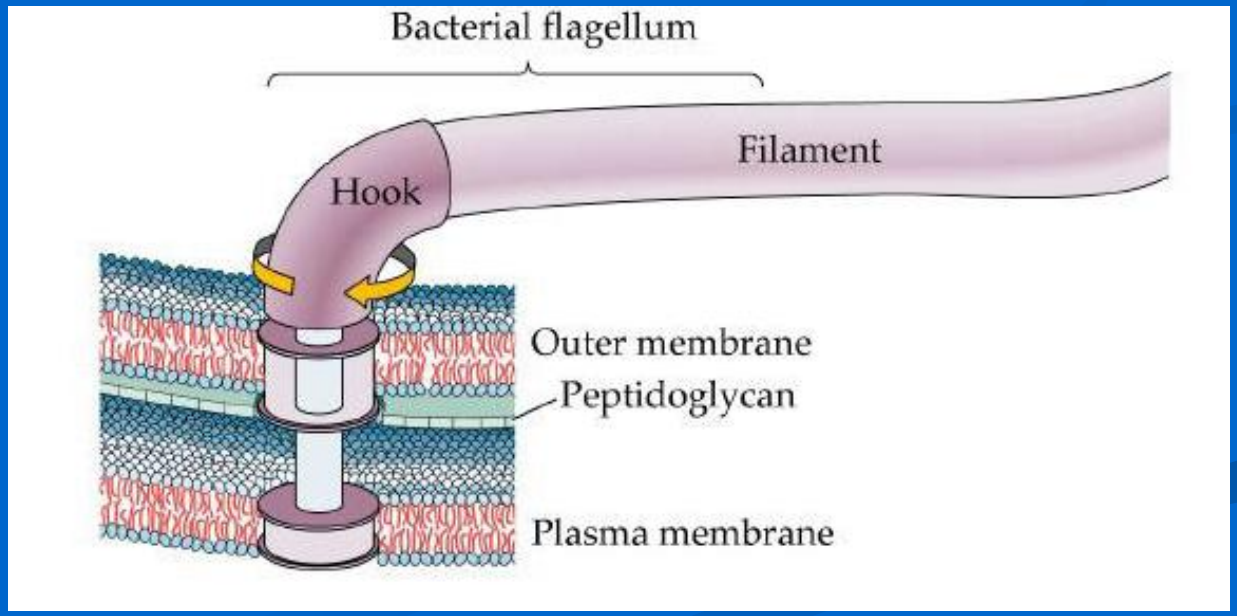
- Some bacteria (S. salivarius, L. mesenteroides) has it
- Outside of the cell Wall and similar to the capsule
- Unorganized polysaccharide structure form
- Can pass the broth
- Antigenicity is weak (hapten)

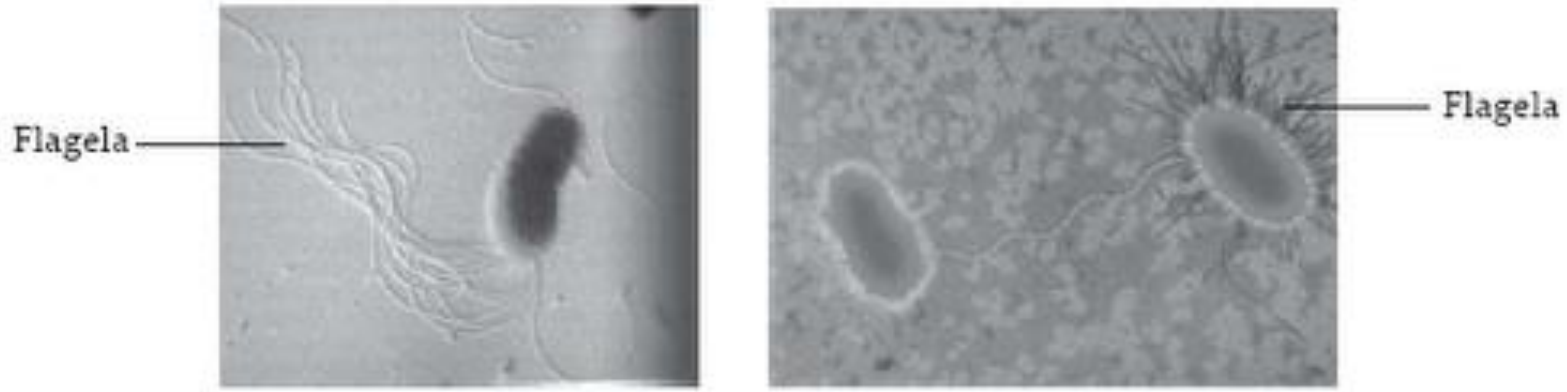
Flagella

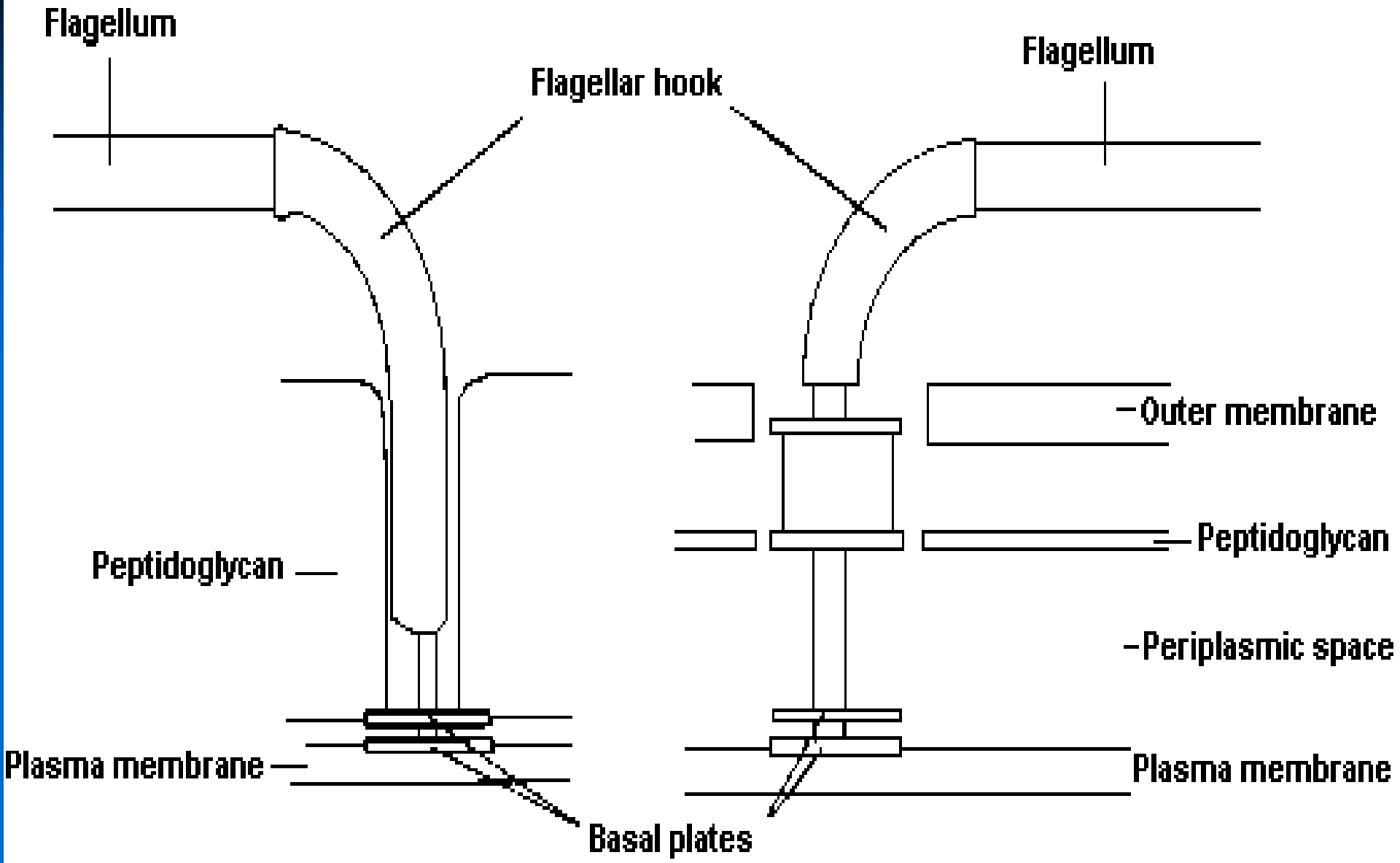
- Movements organ of the bacteria and appears in some bacteria
- Long and thin than lenght of bacteria
- Location and number varies according to the bacteria
- They can shown with special staining methods (Leifson, Kodaka)
- Their number and structure can be different depending on the environmental conditions
- It has protein structure and called "**flagellin**"
- Fagellin has antigenic characteristics (**"H" antigen**)
- The structure of flagellin is various among Gram positive and Gram negative bacteria
- Fagella can destroyed by mechanical or chemical ways
- Flagella is originated from basal granules (blepharoplasty)

Flagella

- It consist of three parts:
  - Basal body
  - Hook
  - Filament




Flagela
Flagela
(a)
(b)



Flagellum in a Gram-positive bacterium

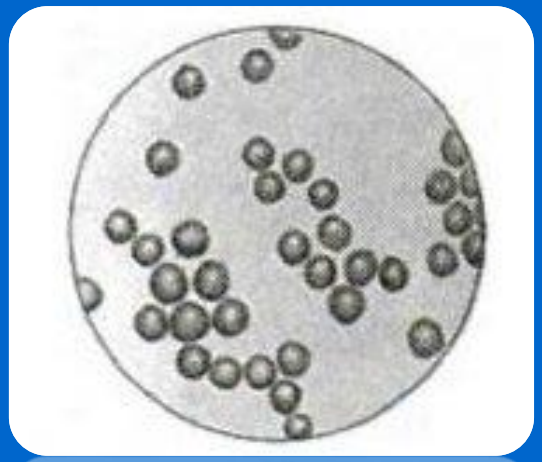
Flagellum in a Gram-negative bacterium

Flagellum Location

- **Atric**
- **Monotric** (monopolar)
- **Polytric** (multitrik)
  - *Amfitric (bipolar politrik)*
  - *Lofotric (monopolar veya bipolar politrik)*
  - *Peritric*
  - *Monolateral*

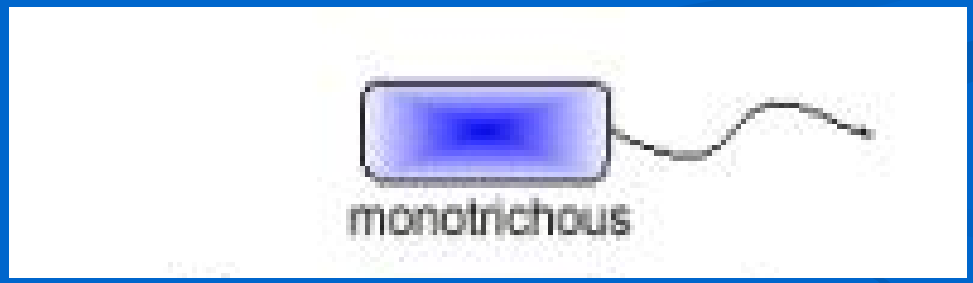
1) Atric

- Bacteria without flagella
- *S. pullorum*, S. gallinarum, *B. anthracis*, Brucella sp., Staphylococcus sp., Streptocuccus sp.



2) Monotric (monopolar)

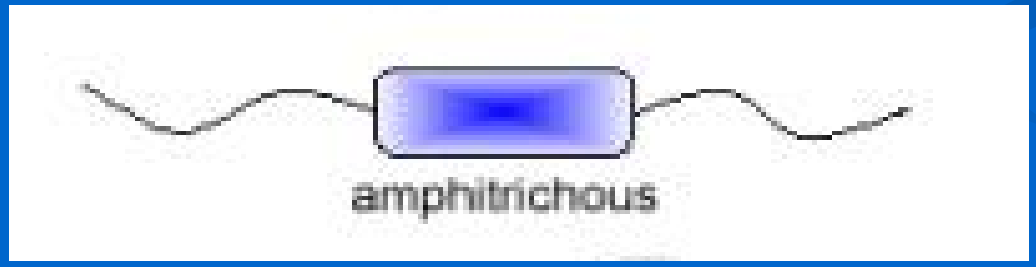
- A single flagellum at one end (*V. metchnikovii*, *C. fetus*)



3) Politric (multitric)

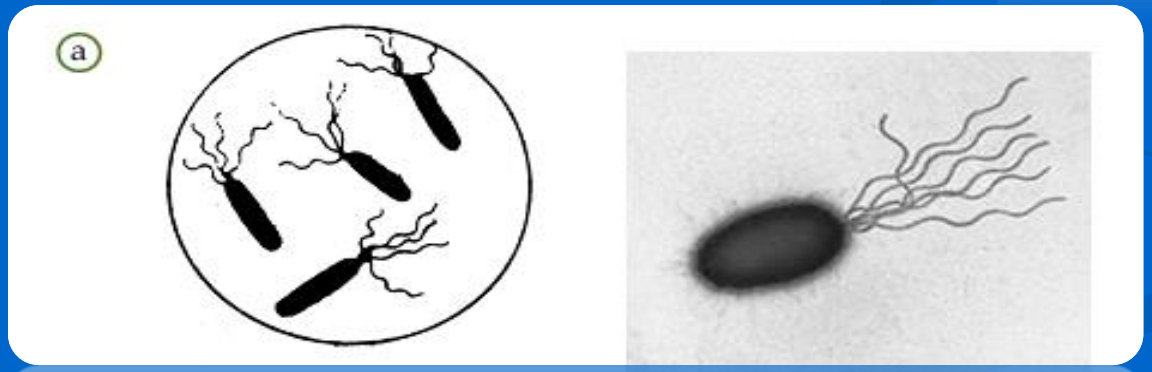
1. Amfitric (bipolar politric)

   Vibrio sp., Spirillum sp.



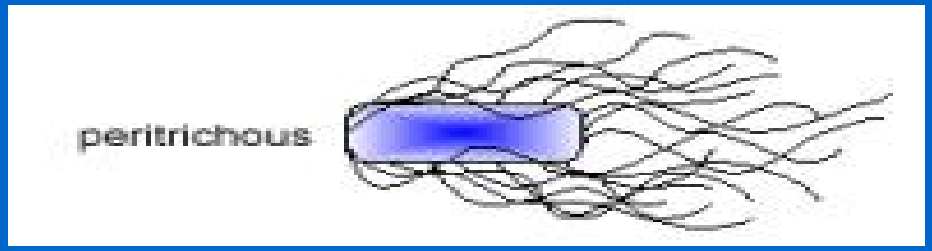
2. Lofotric (monopolar or bipolar politric)

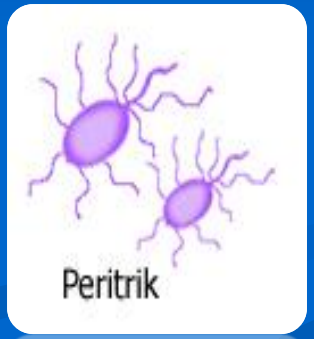
Örn: P. aeruginosa

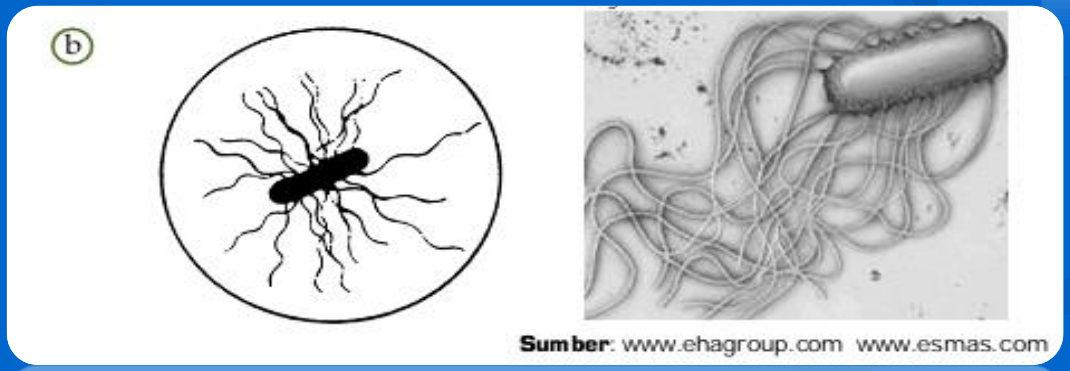


3. Peritric

Flagella is located all around the bacteria. E.g. : E. coli, Salmonella sp., Proteus sp., Pseudomonas sp.





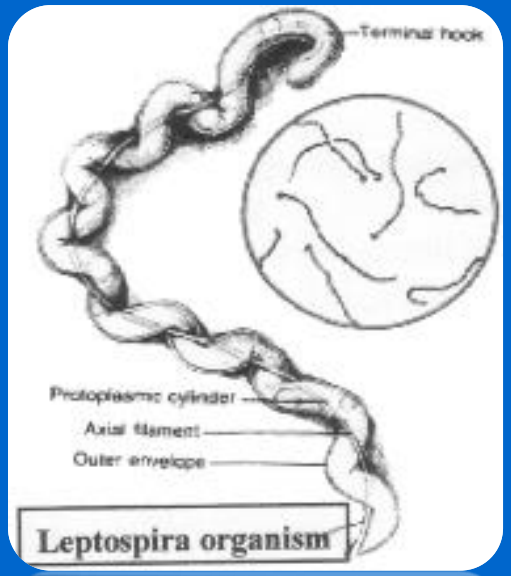


4. Monolateral

Flagella is located one side on bacteria(*Selenomas ruminantium*)

Axial flament

- Spirochetes have it
- It is different from flagella and it consists of 2-8 filaments and a cover that surrounds them
- Located in between cytoplasmic membrane and outer membrane



Bacterial Action

- Flagella
- Axial filament
- Sliding movement
- Passive action(Brownian movement)

Movement Examination

- Between the lamellae-microscope slide method
- Hanging Drop Method
- Dark Field Microscopy
- Semisolid Media
- Flagella Staining
- Electron Microscopy

Fimbria (Pili or Pilus)

- Different from flagella; short, straight, thin and numerous
- It is originated from cytoplasmic membrane
- It can be found in Gram positive, Gram negative bacteria and in mobile and inmobile bacteria
- It is not related with movement
- Environmental conditions are effective in formation
- Antigens in protein structure that are found in pilus called is "**pilin**"

- Fimbriae are divided into two groups; **normal** and **fimbriae of sex**
- Sex fimbriae are thicker and longer; these are called as **F-pili** or **sex pili**

- Middle of sex pili is empty and shaped of channel. It takes a role to transfer the genetic material from a bacteria to other bacteria(conjugation)
- Normal pilus has not channels in the middle of it and takes a role in adhesion to the cells

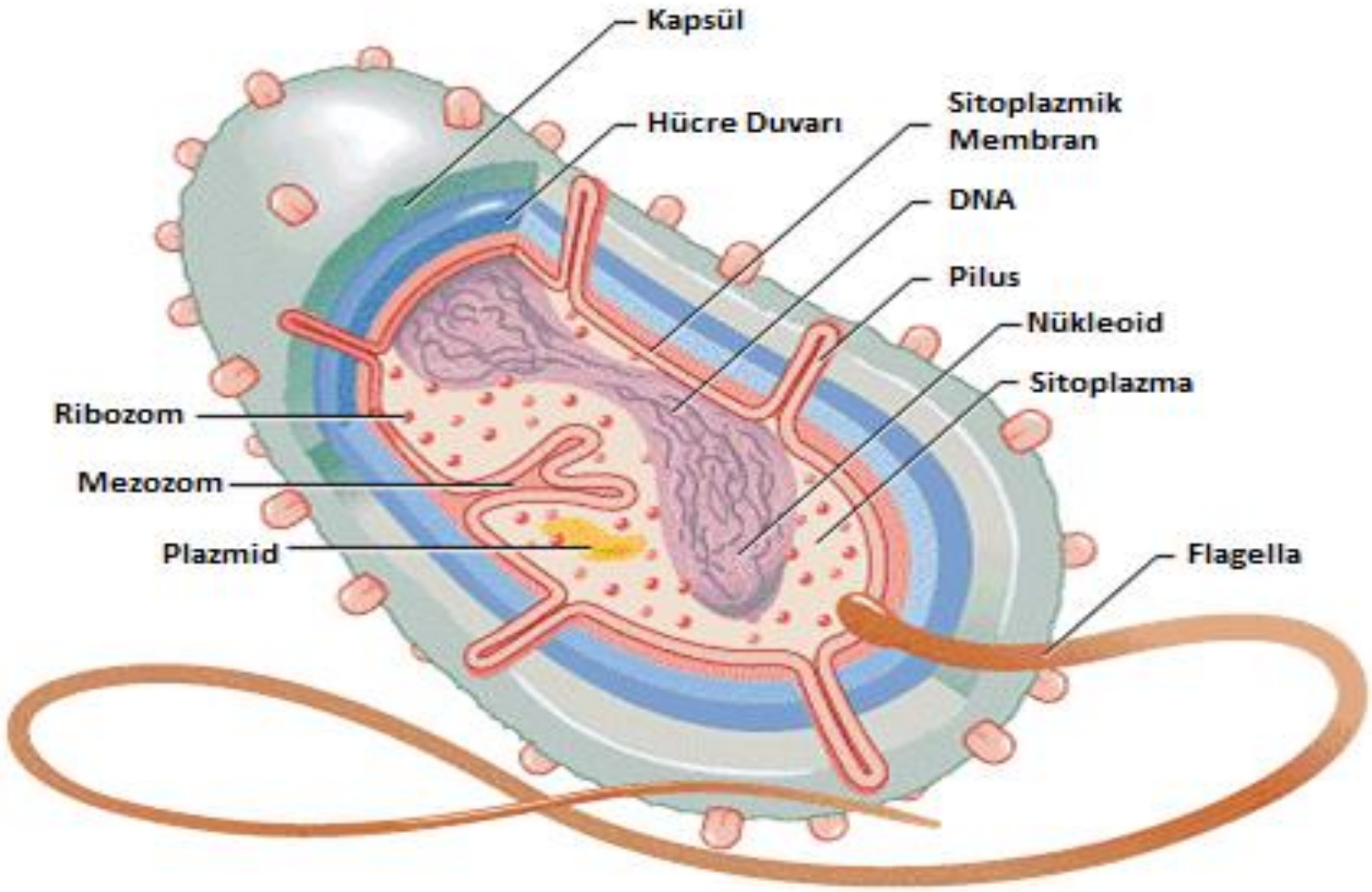
- Antifimbrial serum and some carbohydrates (mannose) inhibits fimbriae to bind to the cells
- It can be encoded by plasmids (E. coli K88, K99)

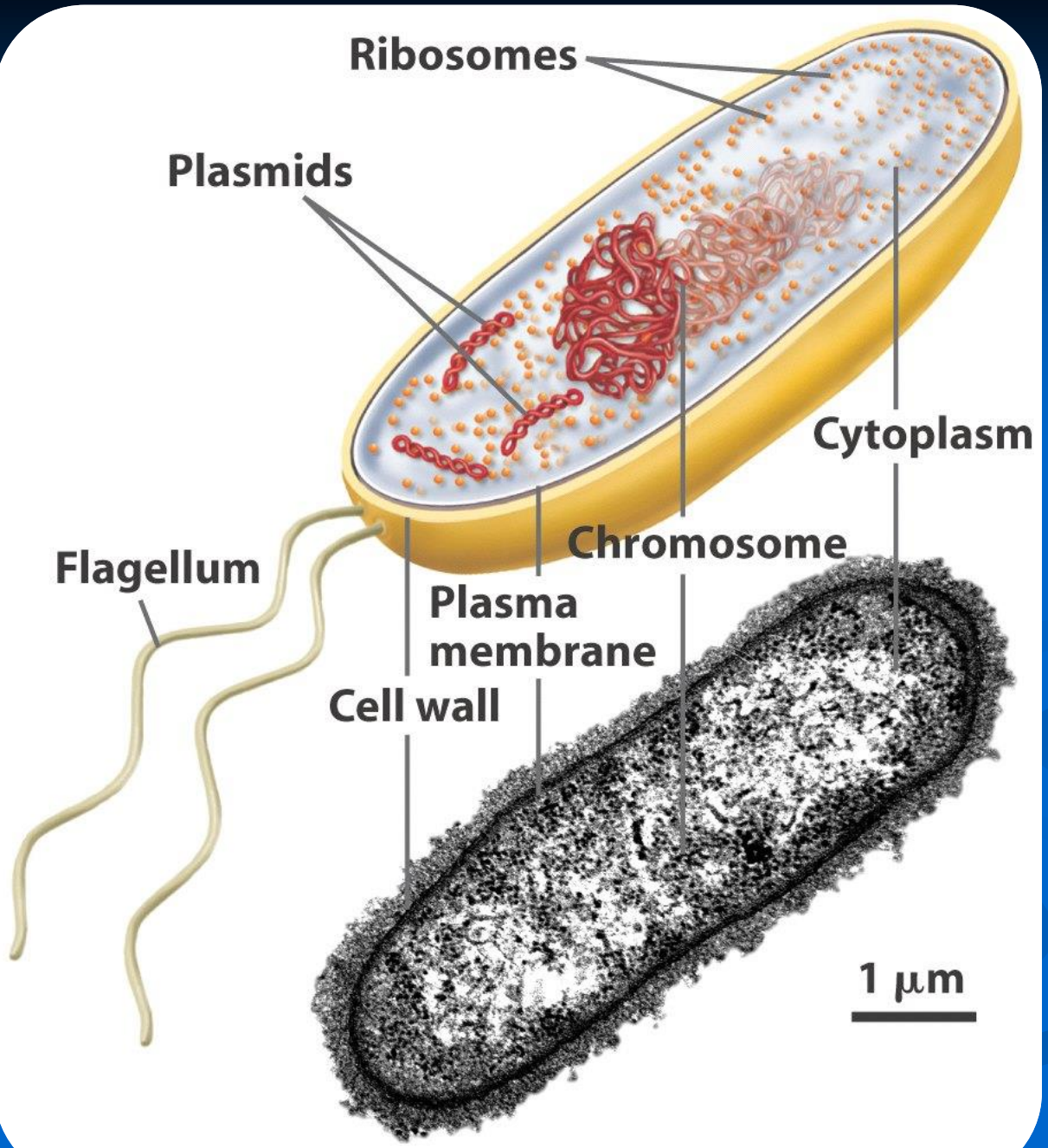
- **Functions of fimbriae**
  - Binding to the erythrocytes (Haemagglutination)
  - Binding to the cells (Adhesion)
    - ETEC, UPEC
  - Binding to the latex (Agglutination)
  - Antigenic
  - Virulence
  - Conjugation (F-pilus)
  - Receptor for some phages

Fimbriae classification

- Type-1, agglutinate to erythrocytes, sensitive to mannose
- Type-2, not agglutinate erythrocytes
- Type-3, When it be treated tannic acid, agglutinate to erythrocytes
- Type-4, agglutinate to erythrocytes, resistant to mannose
- Others, agglutinate to erythrocytes, sensitive to mannose

Internal Structure





ure 7-1 Biological Science, 2/e