General Microbiology

Lecture 2

(Bacterial Structure and Classification)

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Shapes and Forms of Bacteria

Different shapes have been recognized:

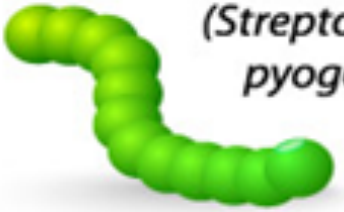
1. Spherica/Cocci:

- Cocci has originated from a greek word; kokkos = seed.
- (0.5µ -1.25µ in diameter)
- On the basis of arrangements cocci are further classified as follows:
  a. Micrococci: appears singly.
  b. Diplococcus: appear in a pairs of cells.
  c. Streptococci: appear in rows of cells or in chains.
  d. Staphylococci: arrange in irregular clusters like bunches of grapes e.g. *Stapllyloccolls aureus.*
  e. Tetracoccus: arrange in a sequence of four.
  f. Sarcinae: arrange in cuboidal or in a different geometrical.

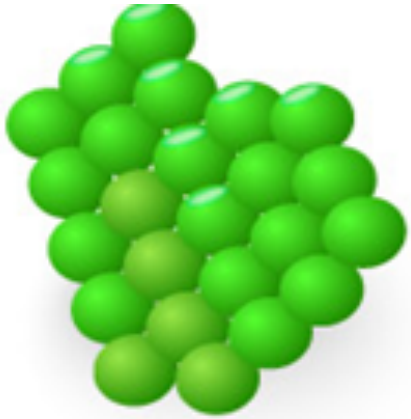
Shapes and Forms of Bacteria

SPHERES (COCCI)

Diplococci
(Streptococcus pneumoniae)

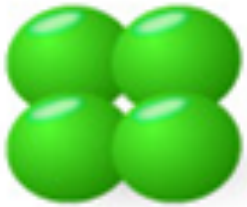


Streptococci
(Streptococcus pyogenes)

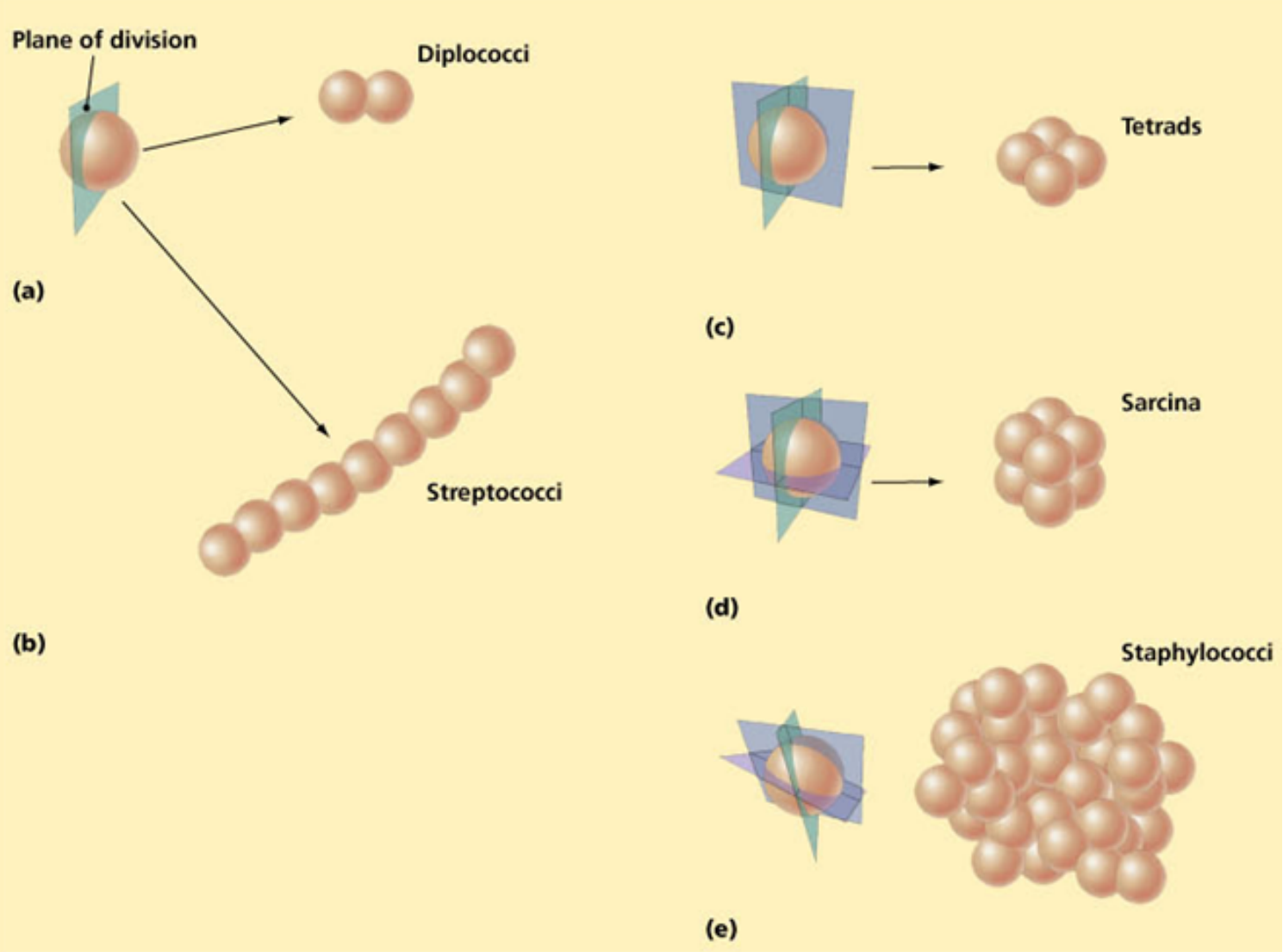


Staphylococci
(Staphylococcus aureus)

Tetrad



Why do bacterial cells have different arrangement?

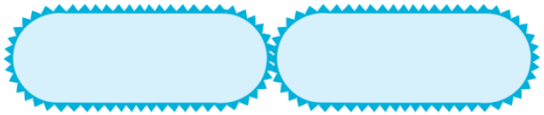


Shapes and Forms of Bacteria

2. Rod Shaped Bacteria or Bacillus:

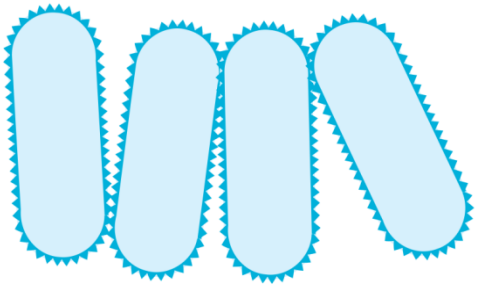
- From greek word, bacillii means rod or stick.
- There ends are rounded flat or pointed.
- 0.5-1.2µ in diameter and 3- 7µ in length.
- Flagellated or non-flagellated.
- They may be of following types:
  - ✓Monobacillus: arrange singly.
  - ✓Diplobacillus: present in a group of two.
  - ✓Streptobacillus : in chains.
  - ✓Palisade: Very rarely the bacillus arrange in a palisade arrangement.

bacilli



diplobacilli

Streptobacilli

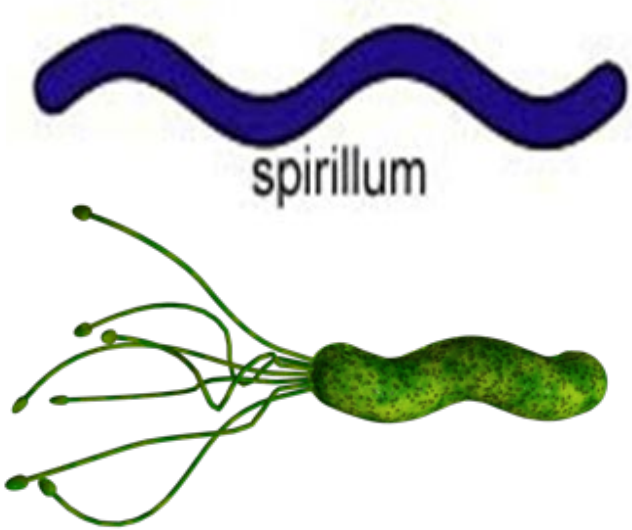


palisades.

Shapes and Forms of Bacteria

3. Spiral or Helical

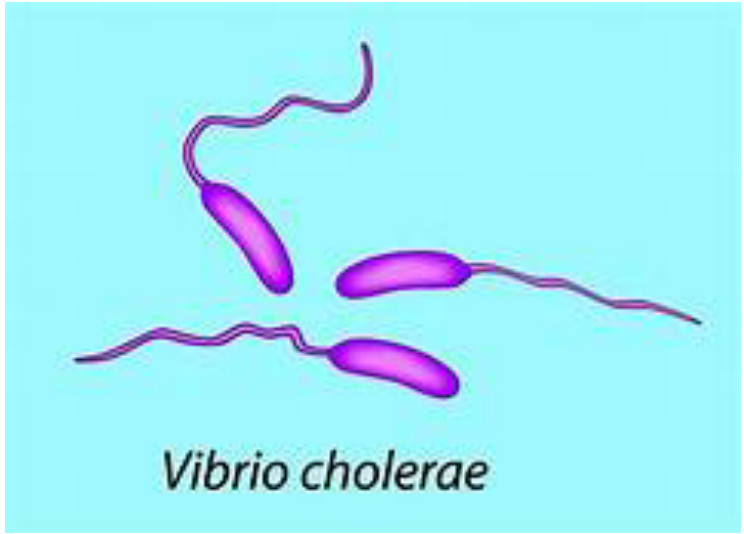
- From greek word; spira means coiled.
- A single spirillum has more than one turn of helix.
- 10-50µ in length and 0.5 - 3µ in diameter.
- They are flagellated



Shapes and Forms of Bacteria

4. Vibrio or Coma:

- They bear flagella at their end.
- 1.5-1.7µ in diameter and upto 10µ in length
- e.g. *Vibrio cholarae.*



Shapes and Forms of Bacteria

5. Spirochaeta:

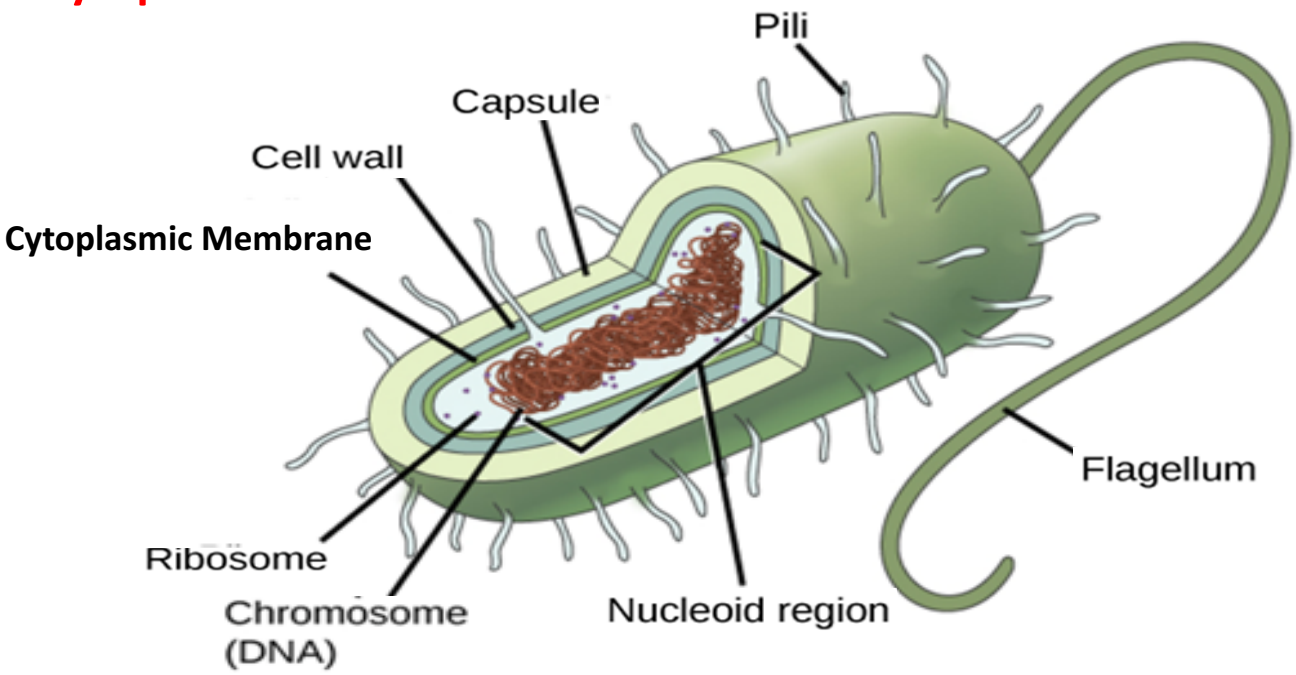
- These bacteria appears like a corkscrew and atrichous.
- Their length is more as compared to their diameter.
- Their body is more flexible.

The Ultrastructure of Bacterial Cell

The Ultrastructure of bacterial cell

Structures external to the cytoplasmic membrane:

- Cell wall
- Capsule
- Flagella
- Pili (Fimbriae)



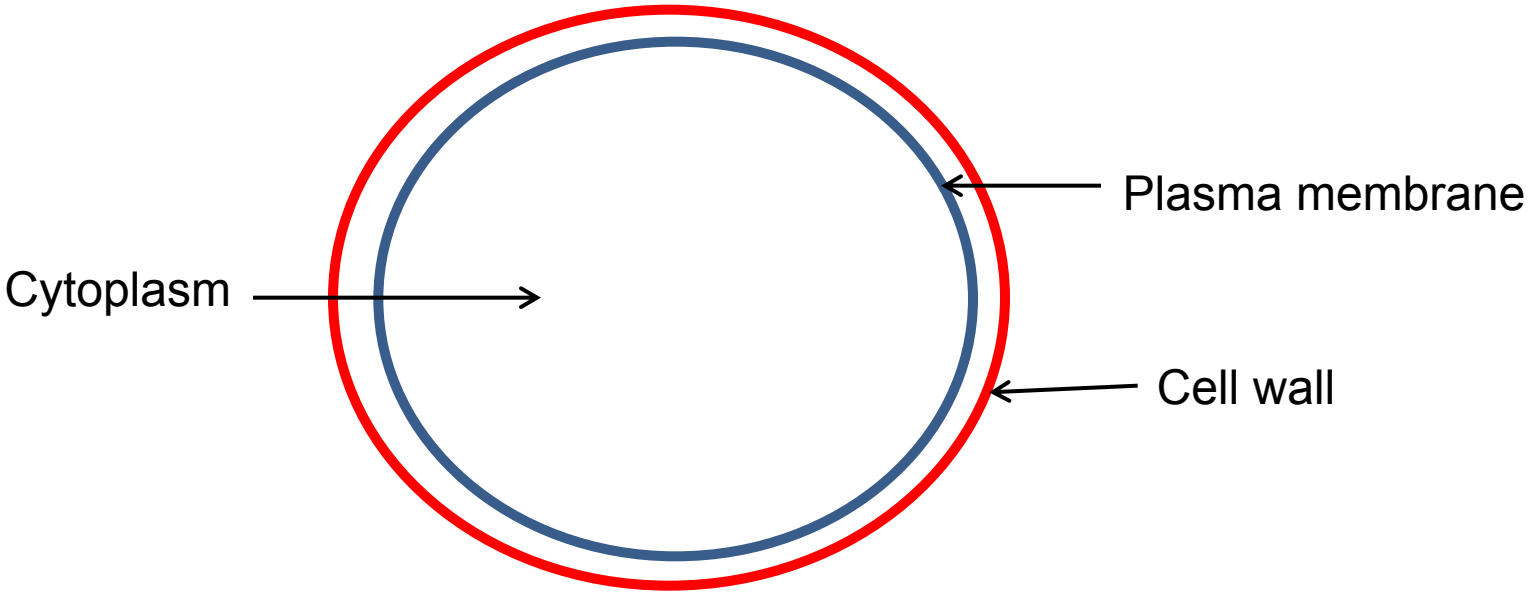
Structures internal to the cell wall:

- Cytoplasmic Membrane
- Mesosomes
- Ribosomes
- Cytoplasm
- Inclusion Bodies
- Chromosome (DNA)
- Plasmid
- Episome

The cell wall

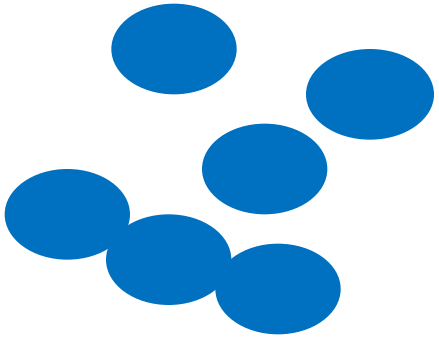
Functions

- Very rigid structure **and provide definite shape to the cell**
- P**reventing the cell from** expanding and eventually **bursting** because of uptake of water
- **Resistant to extremely high pressure**.
- **Essential for the growth and division of bacteria**
- Cell wall protects against osmotic lysis

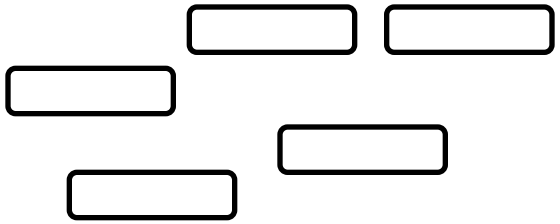


Cell wall and Gram Staining (History)

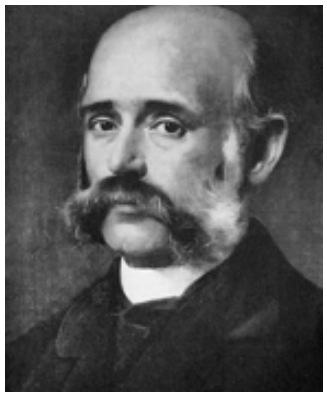
Danish scientist Hans Christian Gram (1853–1938)



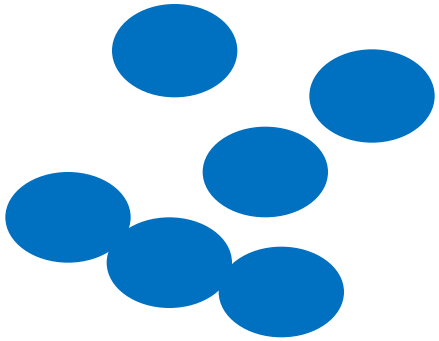
S. pneumoniae



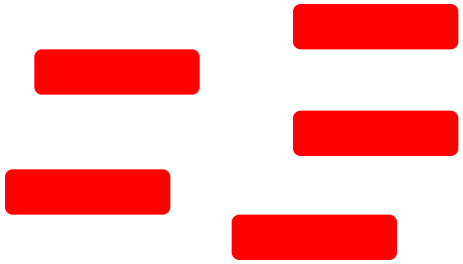
K. pneumoniae



German pathologist Carl Weigert (1845- 1904)



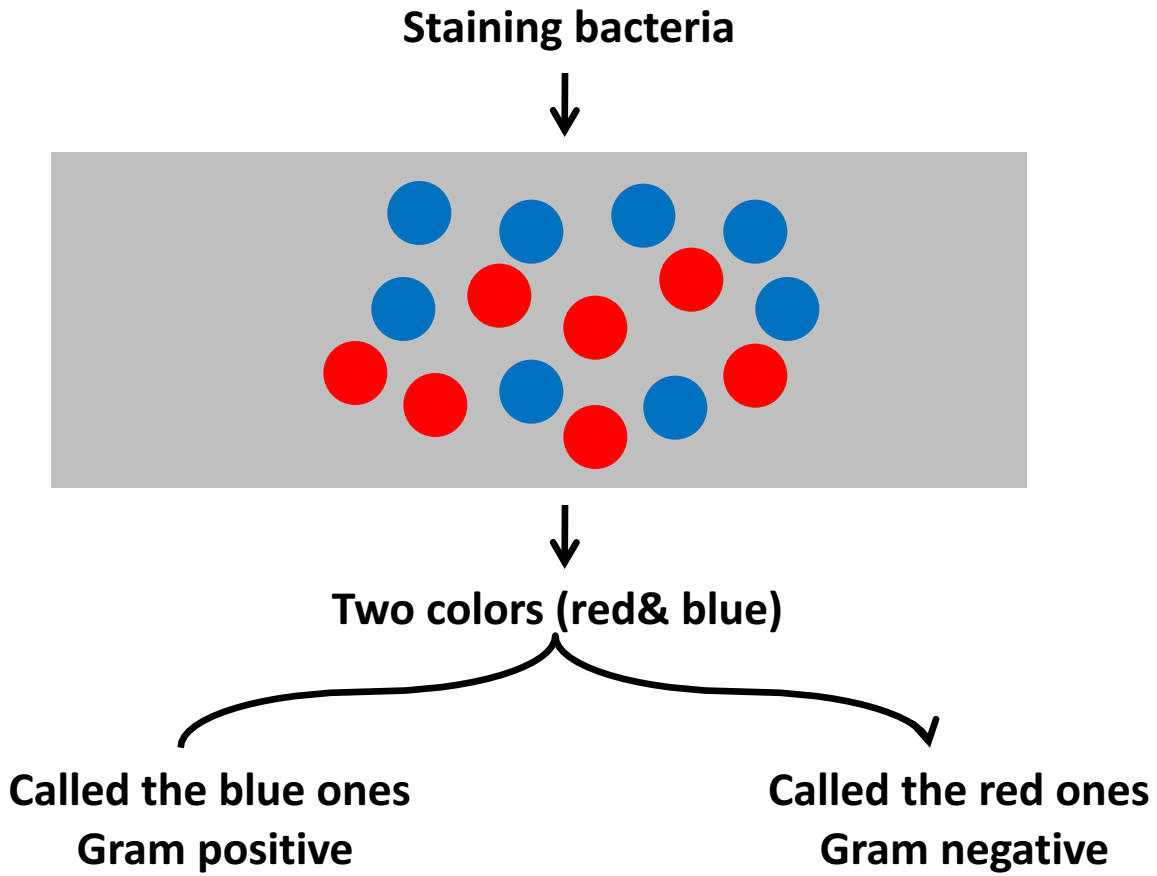
S. pneumoniae



K. pneumoniae

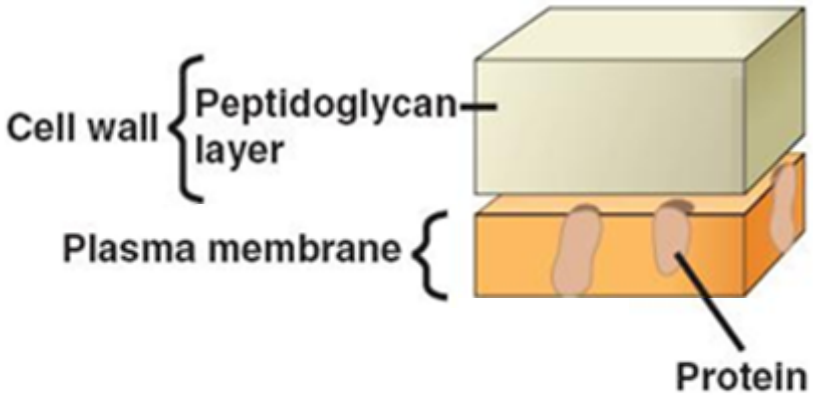
The Ultrastructure of bacterial cell

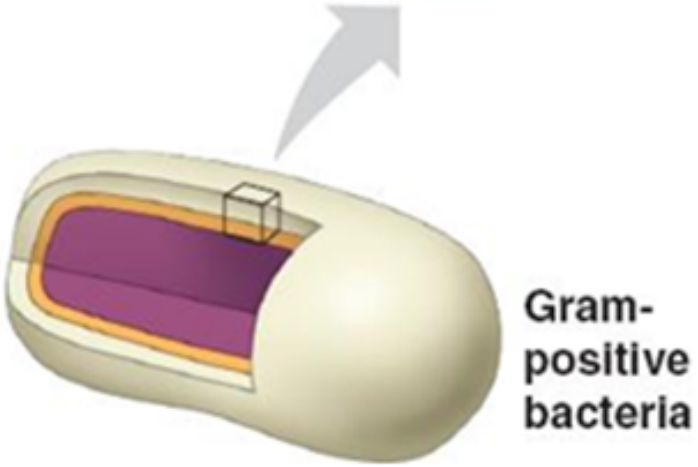
The cell wall



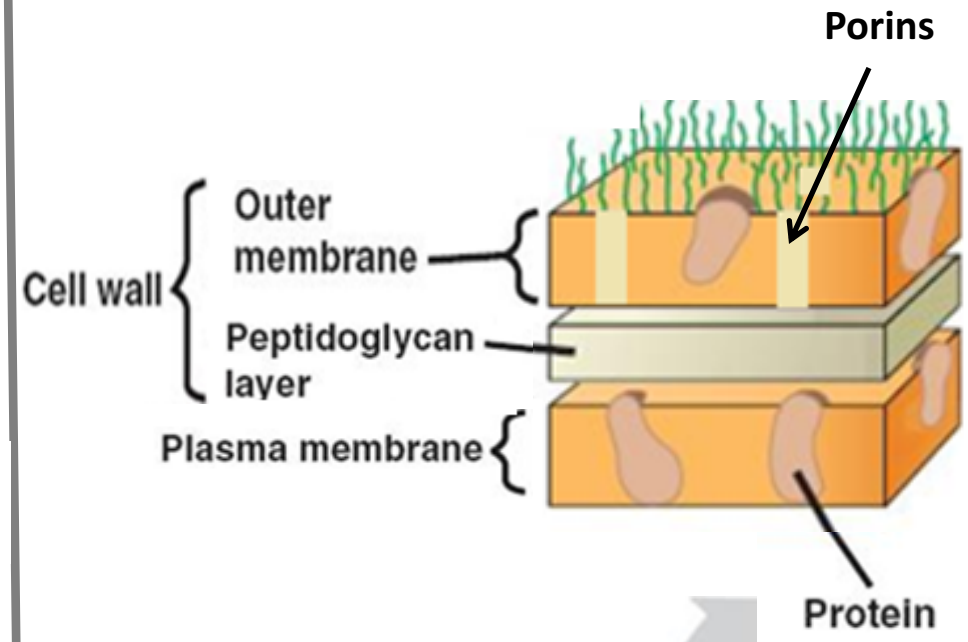
The Ultrastructure of bacterial cell

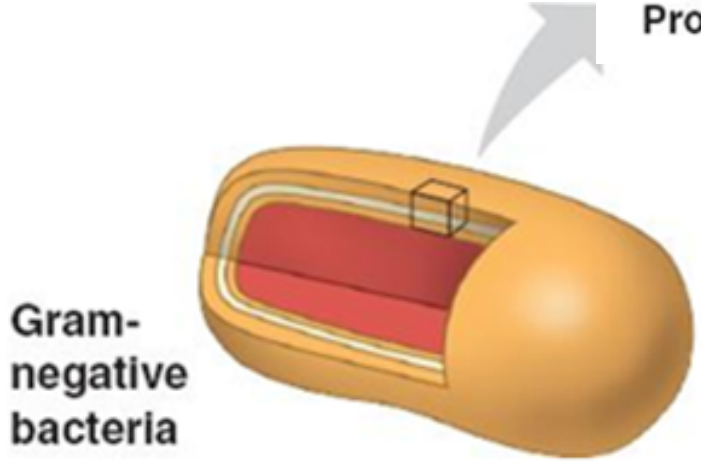
Gram positive bacteria





Gram negative bacteria



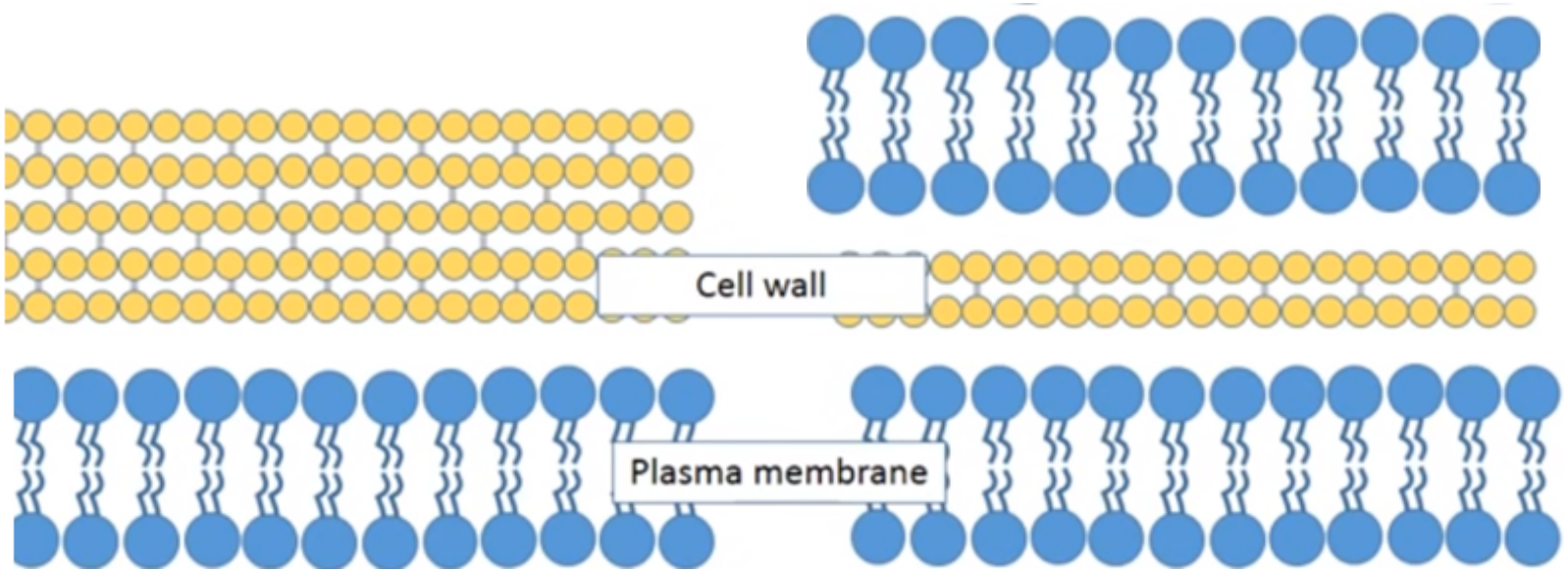


Gram positive

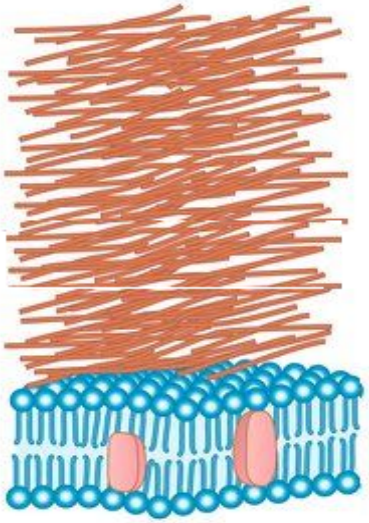
- Inner most plasma membrane
- Thick peptidoglycan cell wall
- More easily treatable with antibiotics
- Stain purple/violet after Gram Stain.
- Peptidoglycan forms 40-80% of the cell dry weight.

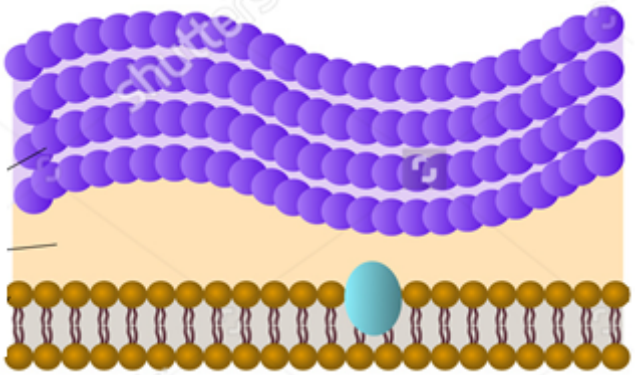
Gram negative

- Inner most plasma membrane
- Thin peptidoglycan cell wall
- Another outer plasma membrane
- Harder to treat with antibiotics
- Stain red/pink after Gram Stain
- Peptidoglycan forms 5-10% of the cell dry weight.

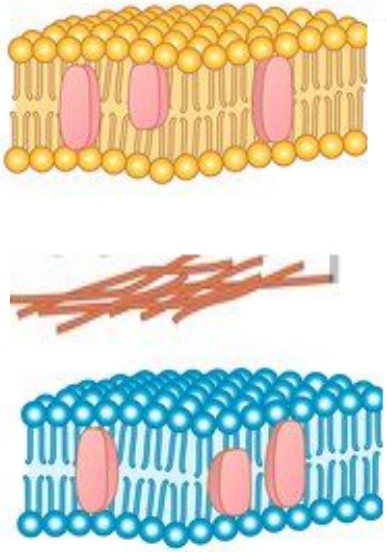


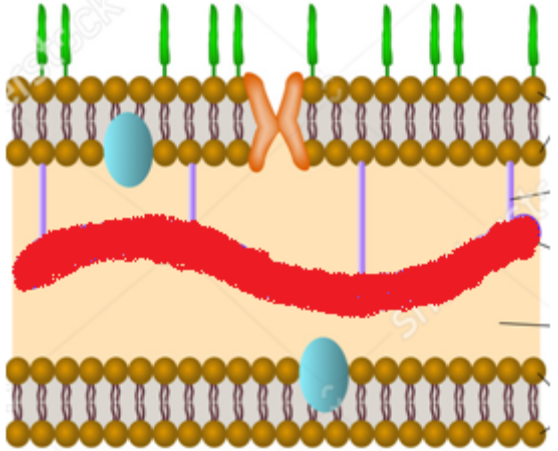
Gram positive





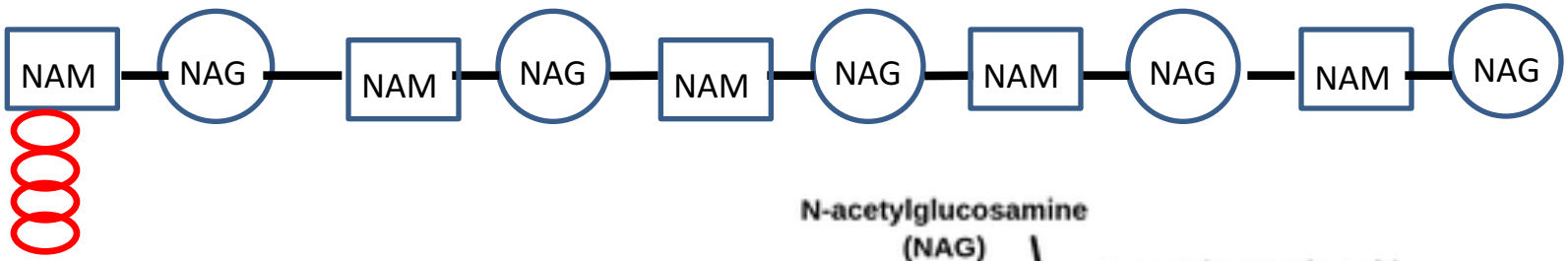
Gram negative

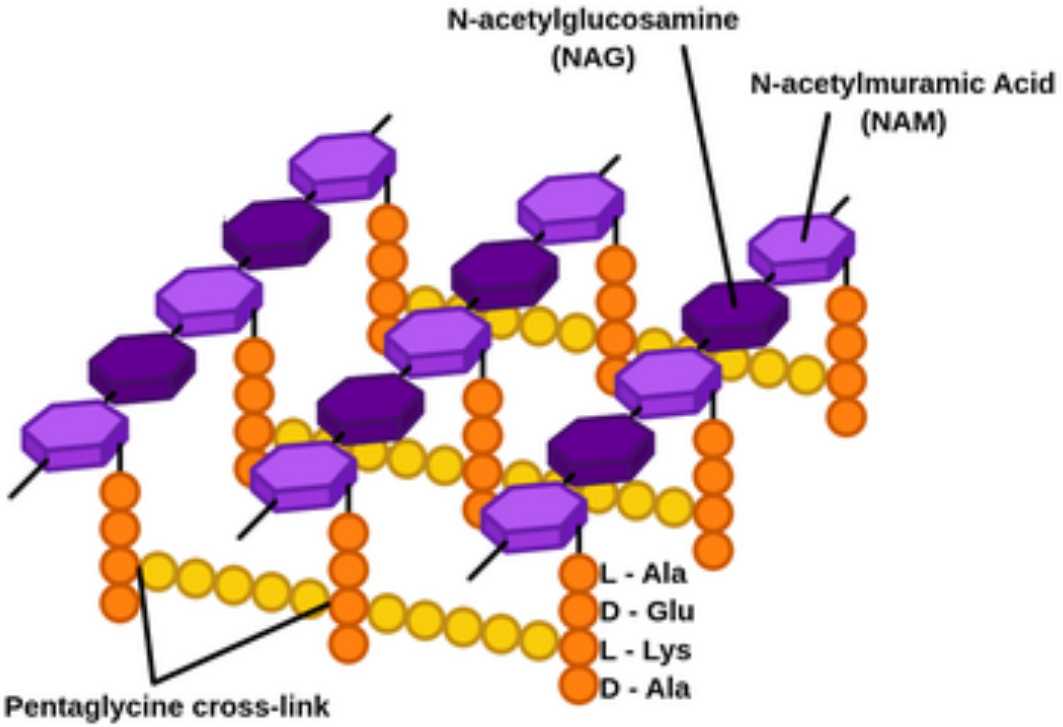




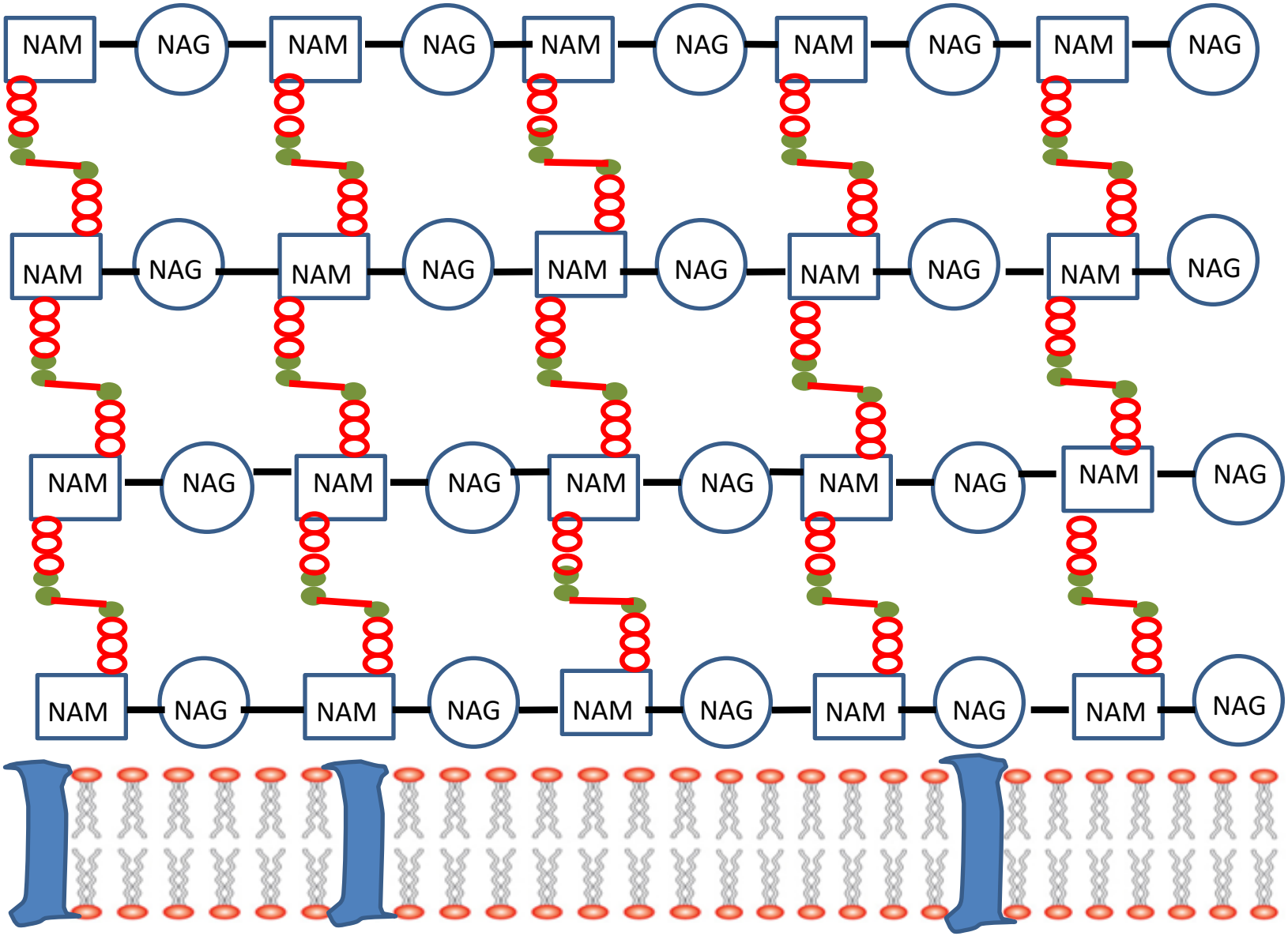
Peptidoglycan

- Peptidoglycan is a rigid mesh made up of ropelike linear polysaccharide chains made up of repeating disaccharides of **N-acetylglucosamine (NAG) and N-acetylmuramic acid (NAM) .**
- Tetrapeptide attached to NAM.



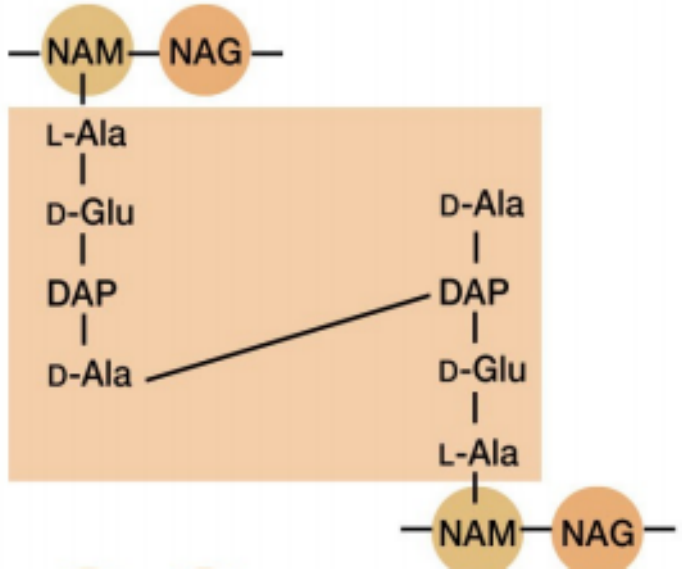


Peptidoglycan

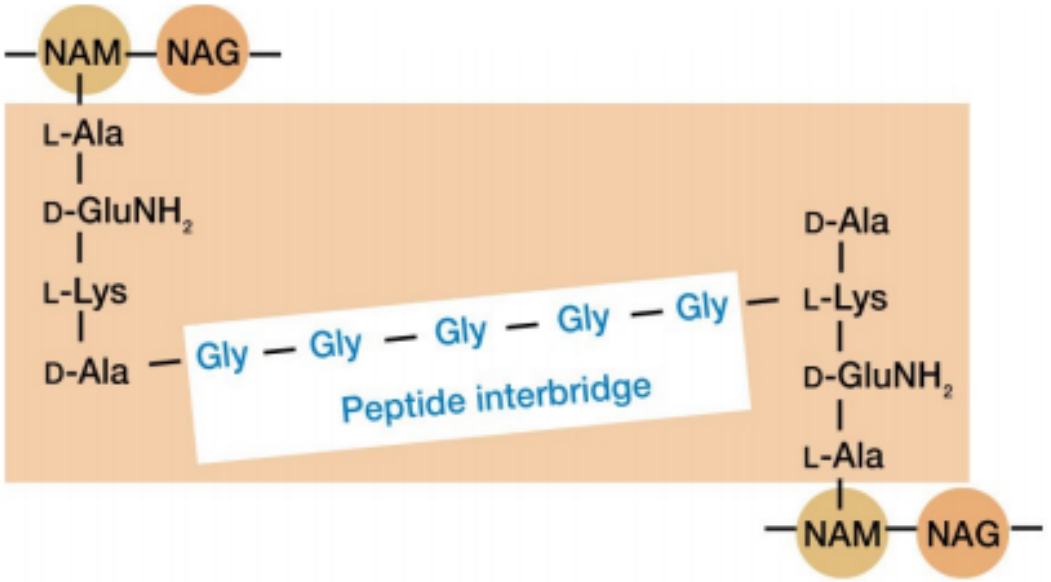


Peptidoglycan

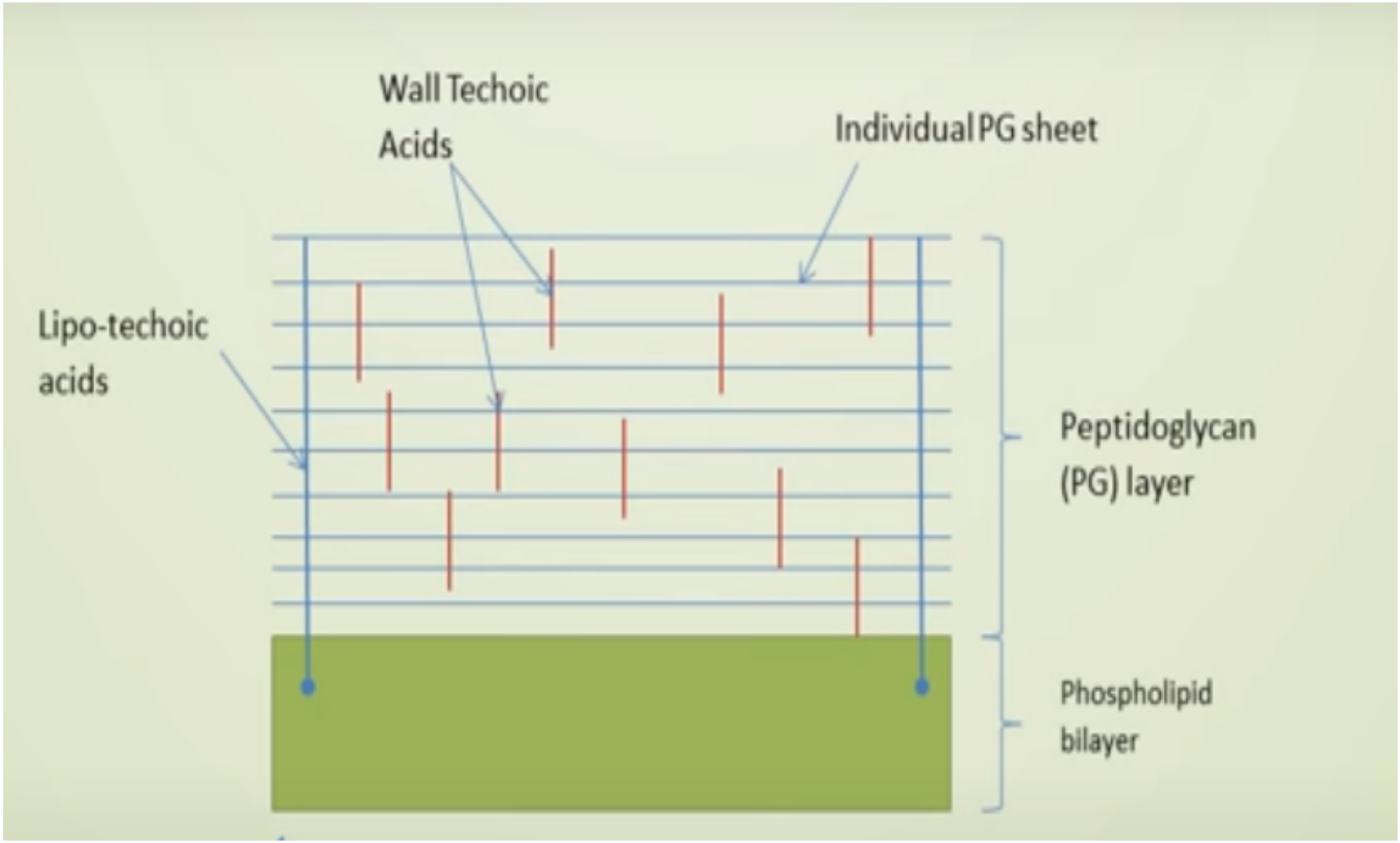
Gram -



Gram +



Anchorage of peptidoglycan layers to the plasma membrane

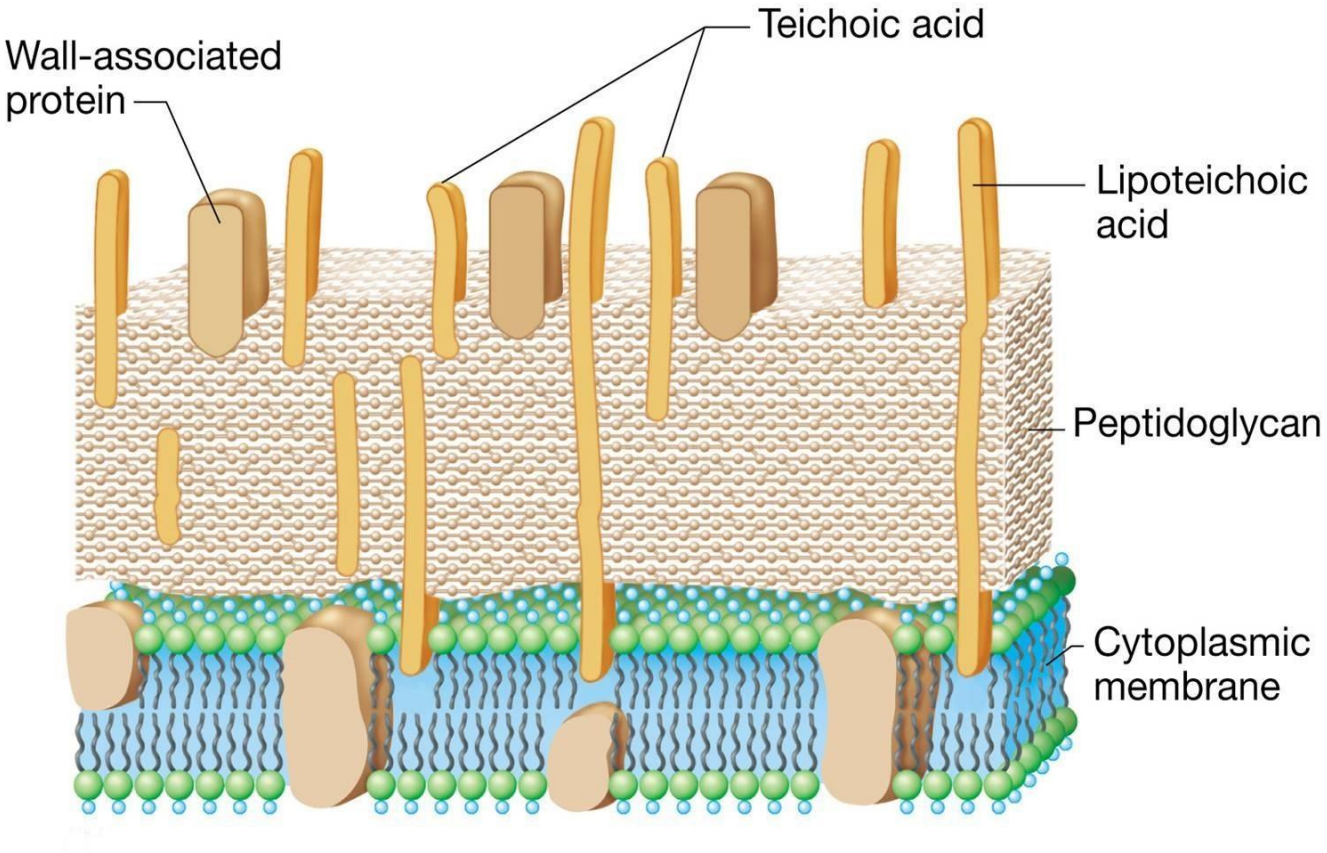


Teichoic Lipoteichoic acids

- Teichoic acids are copolymers of glycerol phosphate or ribitol phosphate and carbohydrates linked via phosphodiester bonds.
- Lipoteichoic acids (LTA)Long chains of ribitol or glycerol phosphate.

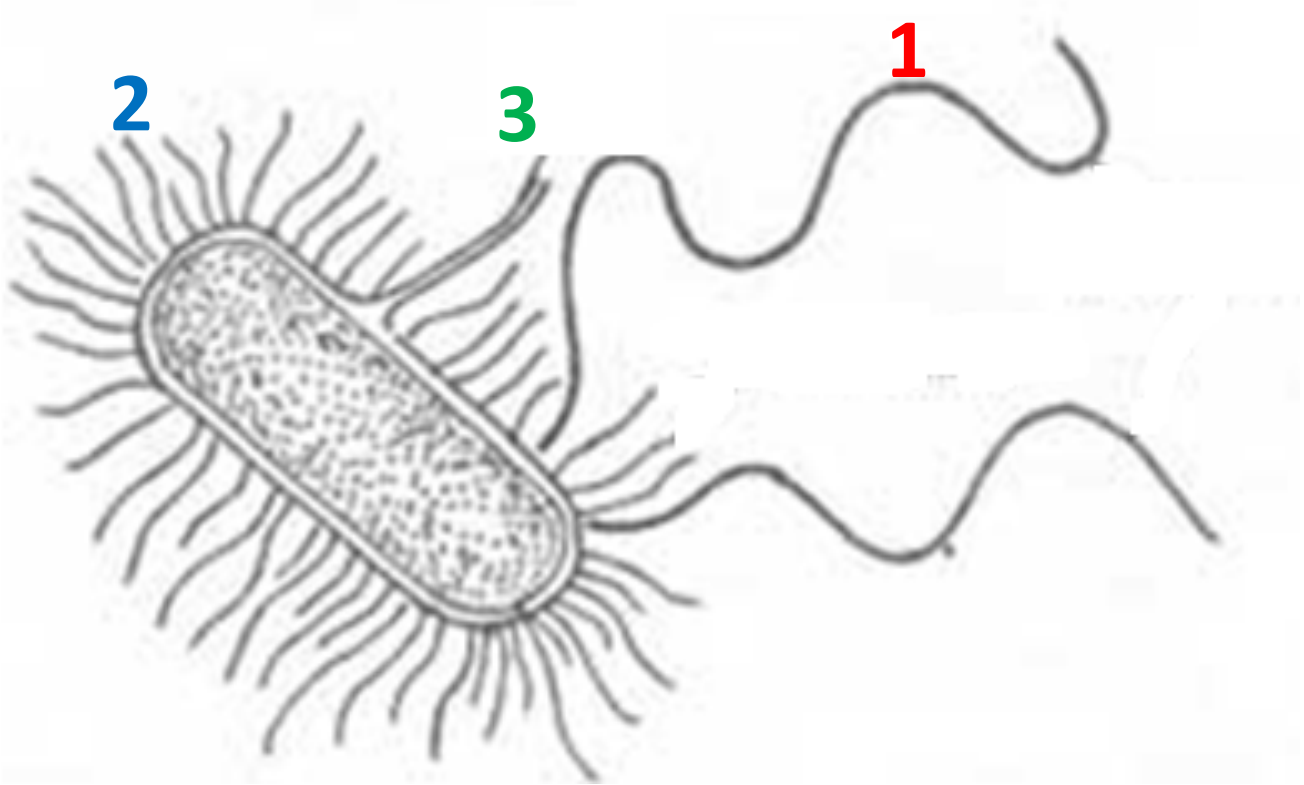
Functions:

- Anchor peptidoglycan layers to the plasma memebrane
- Attachment to other bacteria and to specific receptors on mammalian cell surfaces.



Ultrastructure of Bacterial Cell

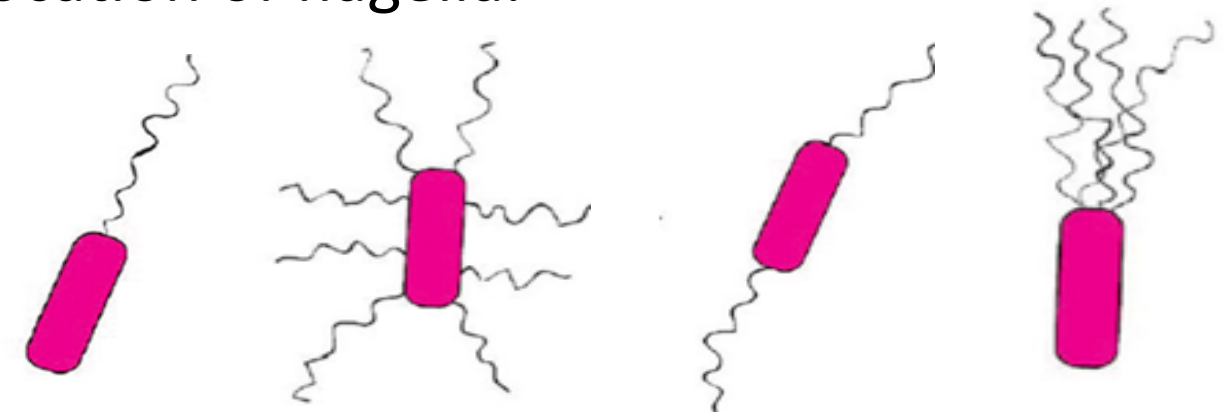
1. Flagella
2. Pili
3. Sex Pili



Ultrastructure of Bacterial Cell

Flagella

- They are flexible, whip like appendage (singular flagellum).
- Measures 4-5 µ long.
- They are made up of protein flagellin (MWt , 40,000)
- The location of flagella varies in various bacteria.
- The bacteria which lack flagella are referred as atrichous.
- Bacteria can be divided into following types based on the the location of flagella.

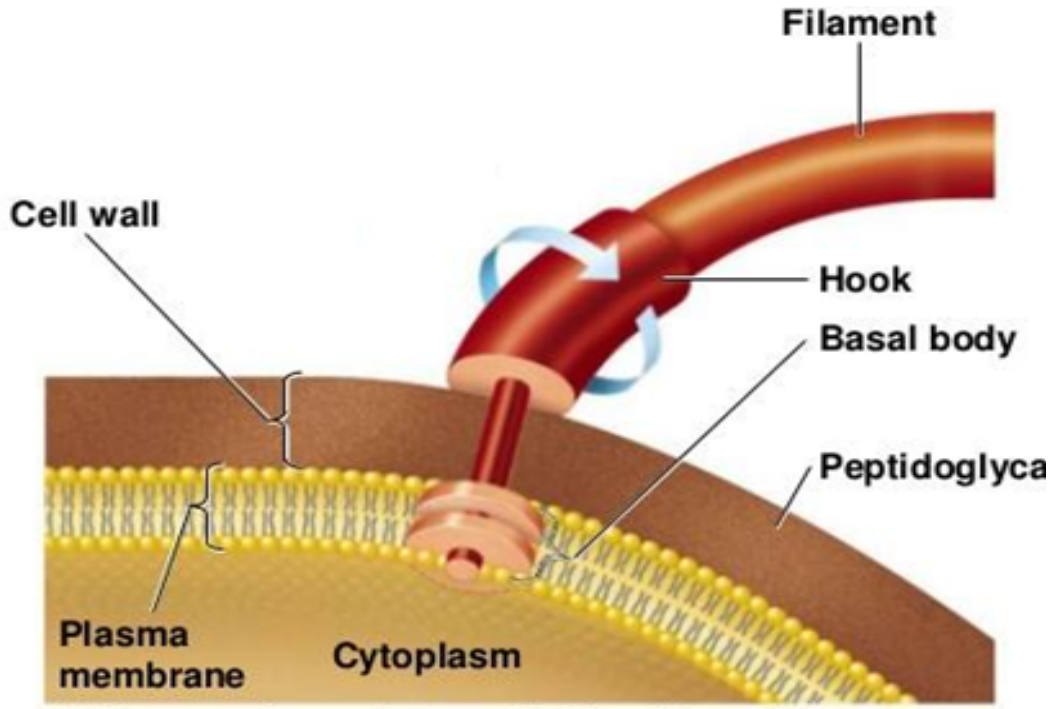


Monotrichous Peritrichous Amphirichous Lophotrichous

Ultrastructure of Bacterial Cell

Ultrastructure of flagellum

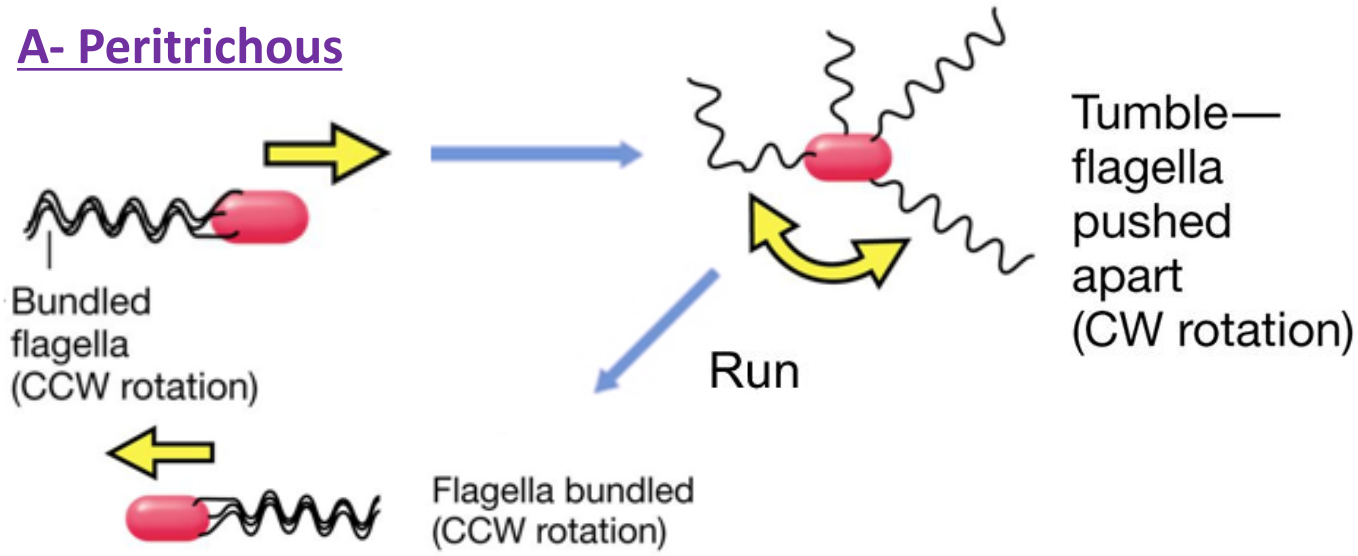
- Each bacterial flagellum is structurally differentiated into three parts
    - basal body.
    - Hook .
    - Main filament or shaft.



Types of Bacterial Motility

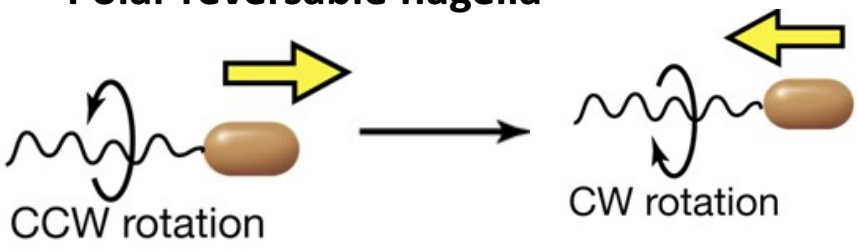
Flagellated: types of rotation by flagella

A- Peritrichous

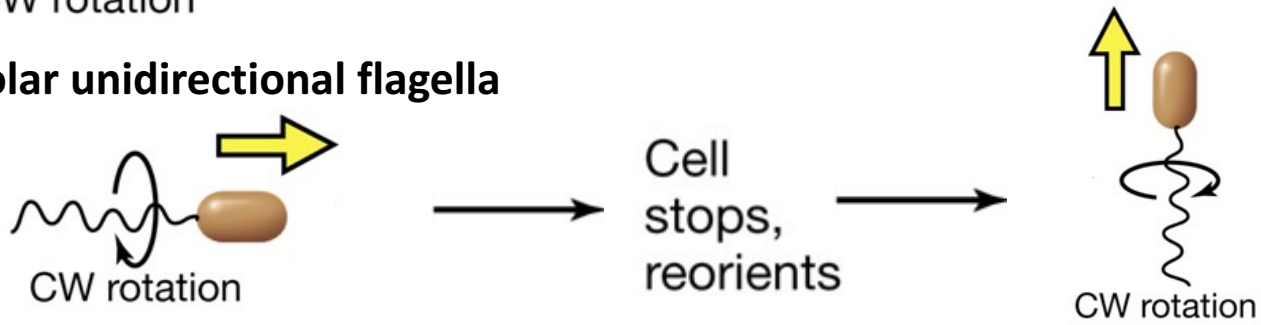


B- Polar

- Polar reversable flagella



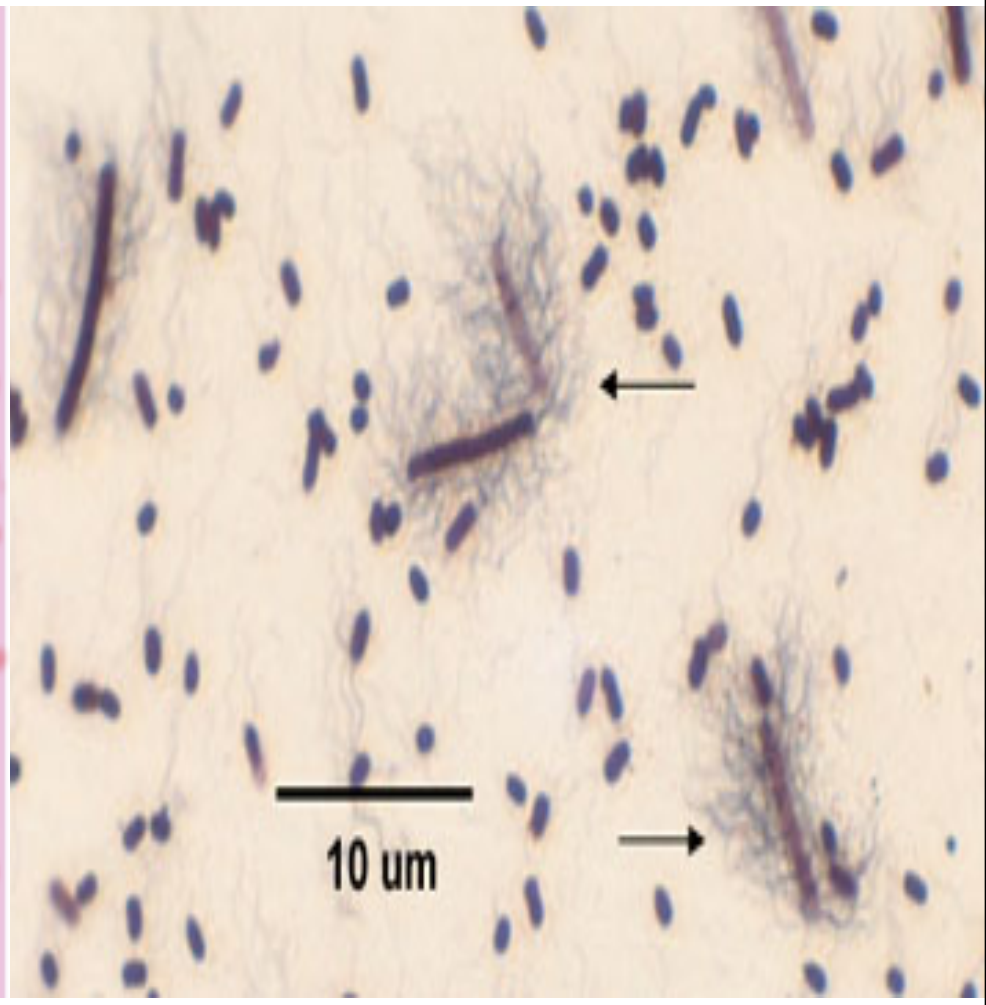
- Polar unidirectional flagella



Flagella stain

Rosanalin dye

Silver nitrate + ferric tannate



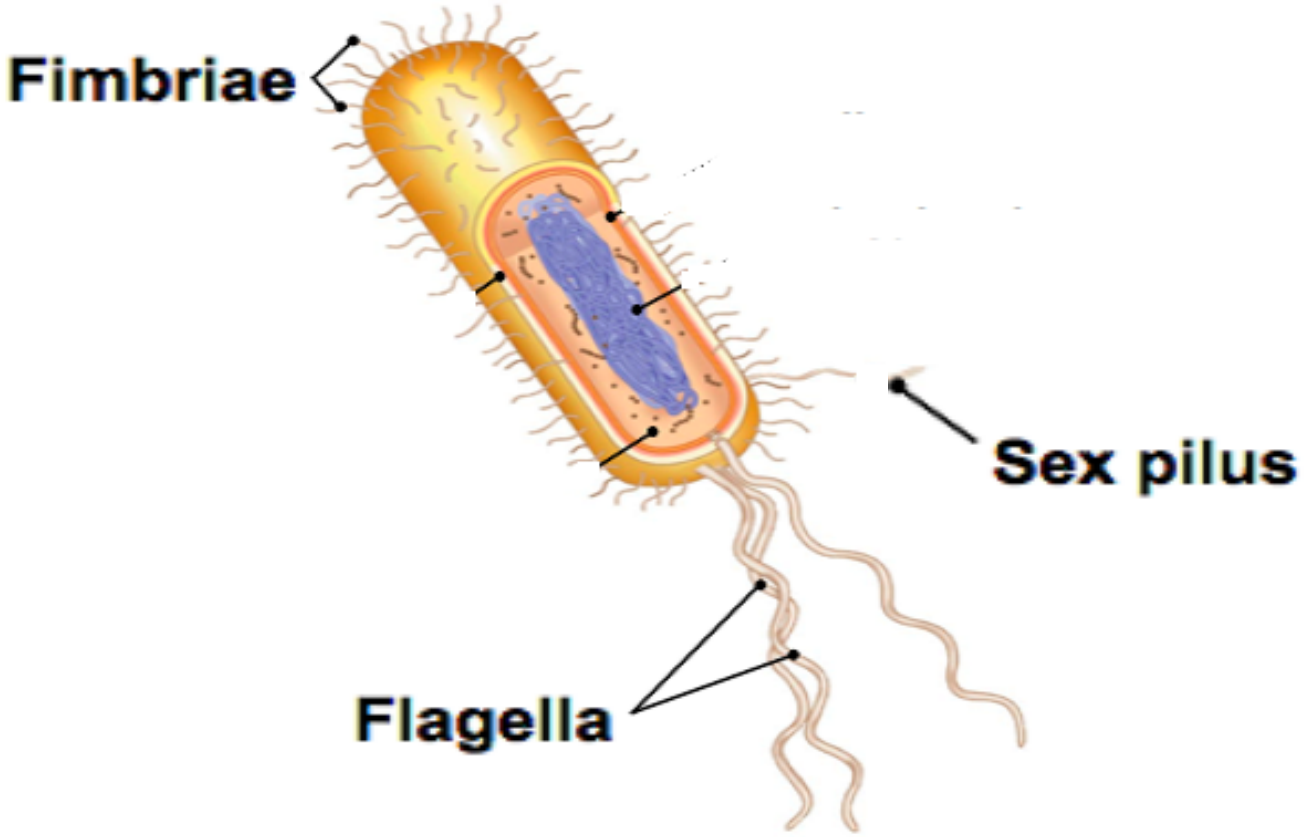
Pili

- These are hair like appendages present on the surface of most of the gram negative bacteria.
- They are smaller than flagella, have no role in the motility of bacteria.
- A single bacterial cells bears about 100-500 pili which are arranged peritrichously.
- There origin is from cytoplasm and penetrate through the peptidoglycan layers of the cell wall.
- Two types: Somatic pili and sex pili or conjugate pili

Pili

Somatic pili:

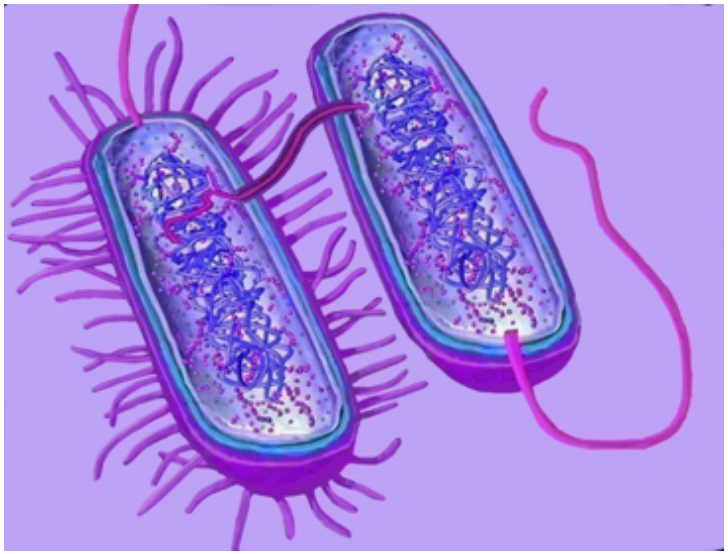
- Each bacterial cell bears about 100 somatic pili.
- Function: is to help the bacterium for attachment to a substratum.



Pili

Sex Pili or Conjugate Pili :

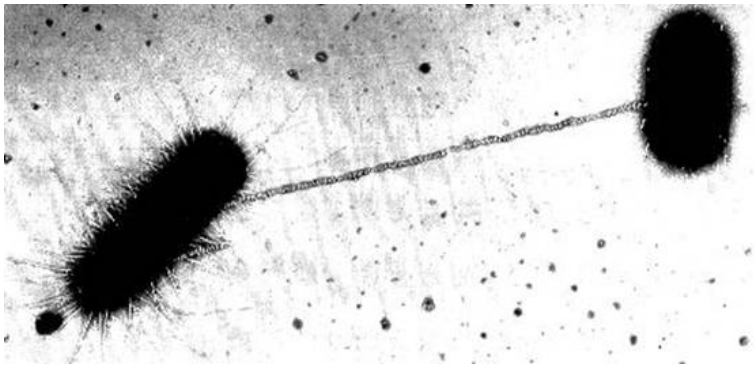
- known as F pili.
- Allow the transfer of DNA between bacteria, in the process of bacterial conjugation. This can result in dissemination of genetic traits, such as antibiotic resistance, among a bacterial population.

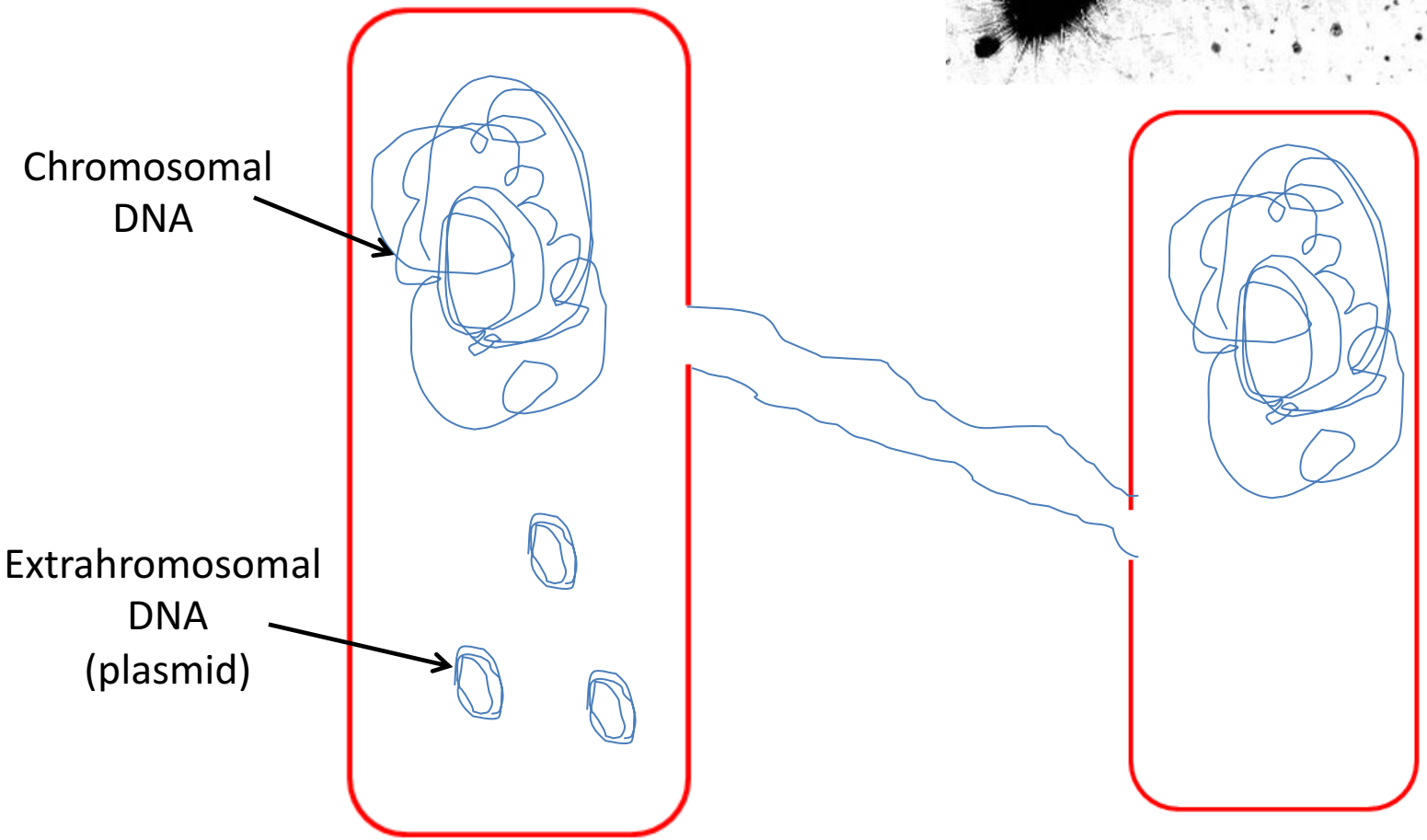


The Ultrastructure of bacterial cell

Pili

- **Conjugative (sex) pili**





Fimbriae

- A fimbria is a short pilus that is used to attach the bacterium to a surface. They are sometimes called "attachment pili".
- Fimbriae are either located at the poles of a cell, or are evenly spread over its entire surface.