# General Microbiology

# Lecture 2

# (Bacterial Structure and Classification)

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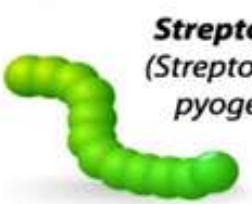
# Shapes and Forms of Bacteria

## 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.

**Diplococci** (*Streptococcus pneumoniae*)

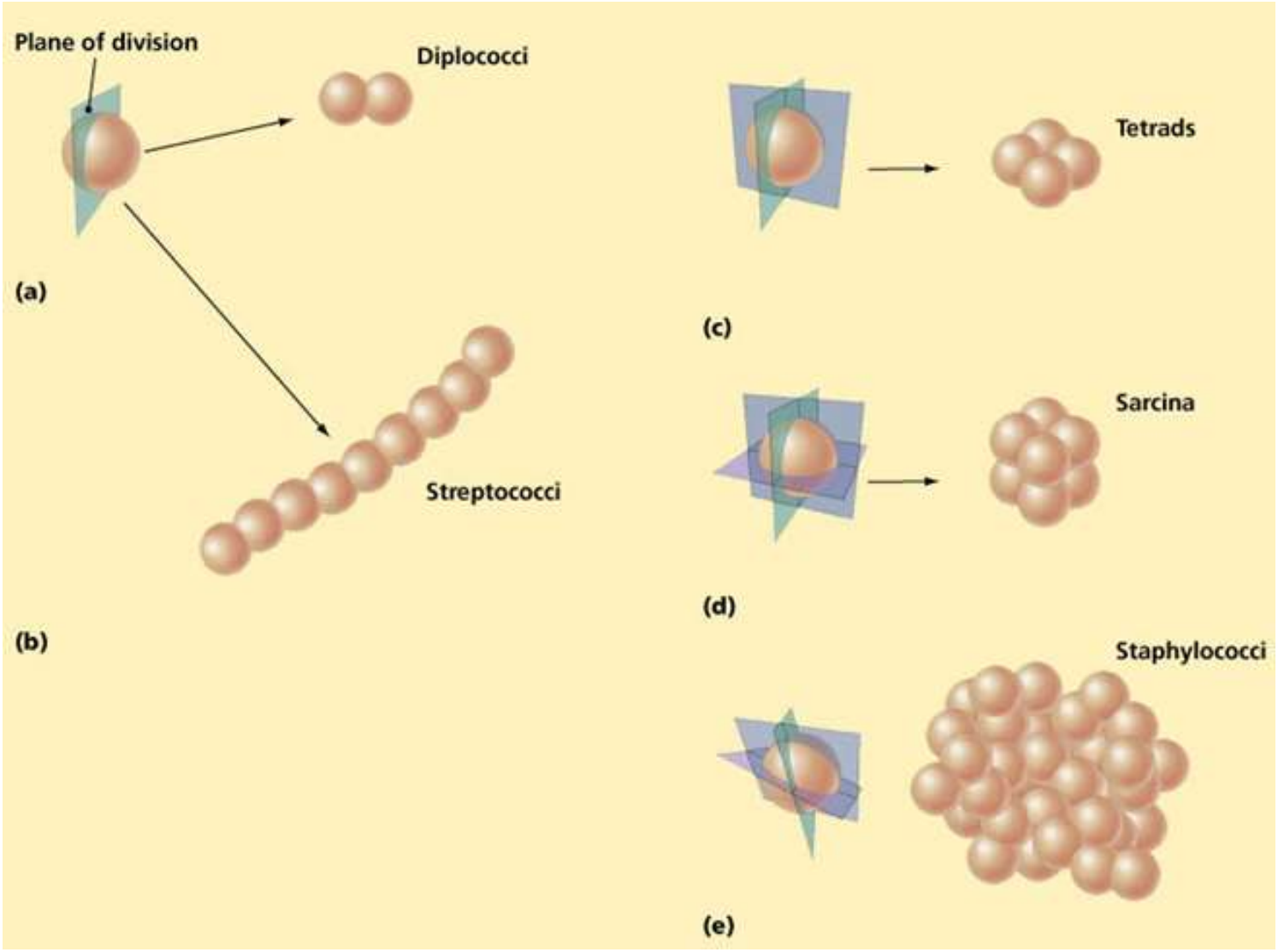


**Streptococci** (*Streptococcus pyogenes*)

**Staphylococci** (*Staphylococcus aureus*)

**Tetrad**

# Why do bacterial cells have different arrangement?

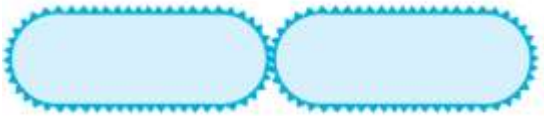


# Shapes and Forms of Bacteria

## 2. Rod Shaped Bacteria or Bacillus:

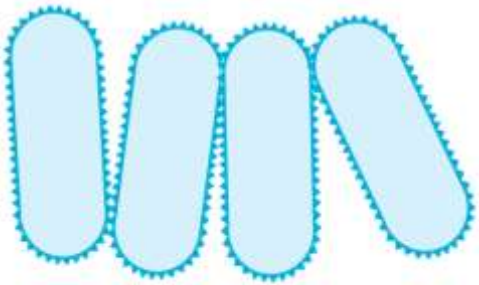
bacilli

- From greek word, bacilli 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.



diplobacilli

Streptobacilli

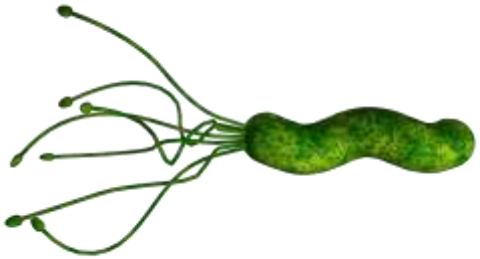


palisades.

# Shapes and Forms of Bacteria

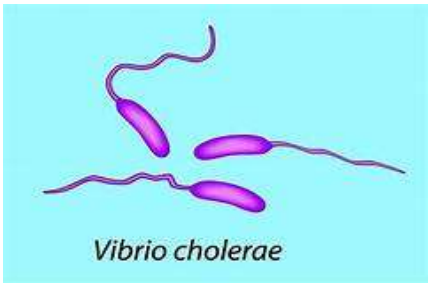
**3. Spiral or Helical**

- 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



**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.




**5. Spirochaeta:**

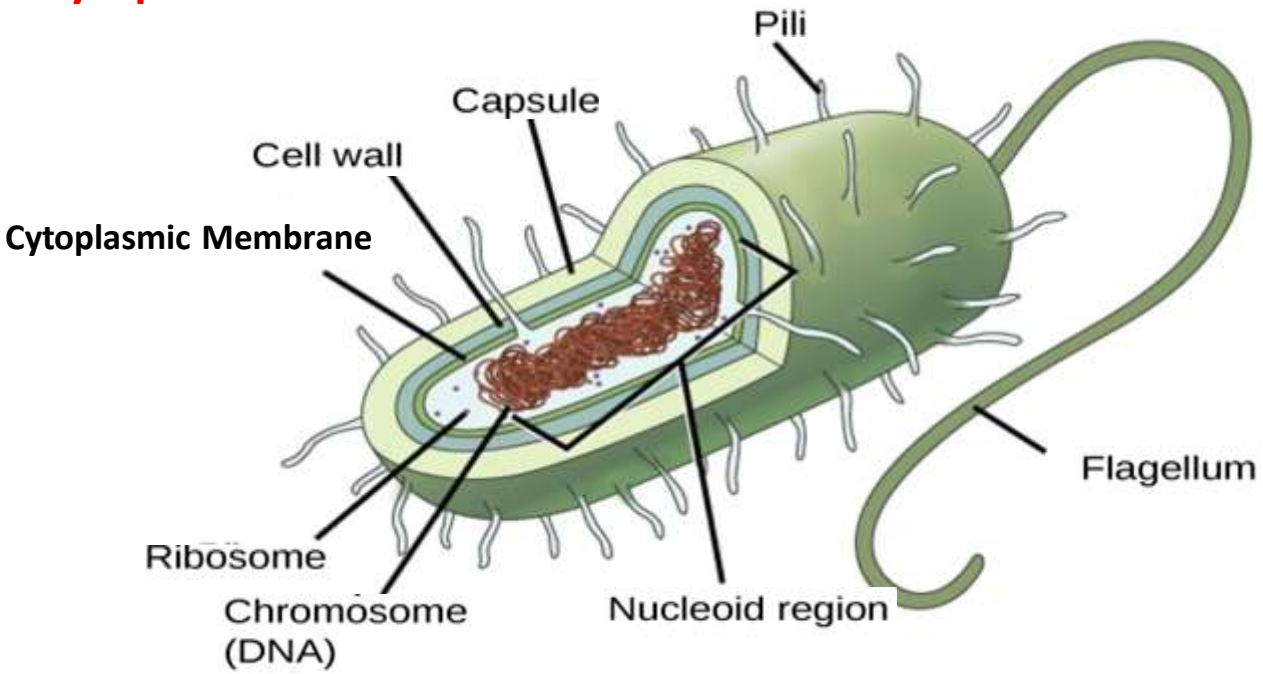
- These bacteria appear like a corkscrew.
- Their length is more as compared to their diameter.
- Their body is more flexible.


# 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

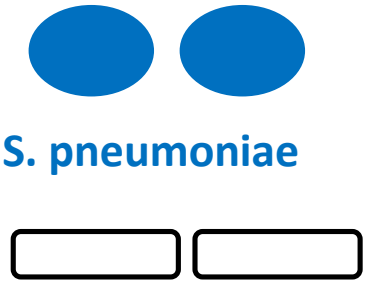
# The cell wall

## Functions

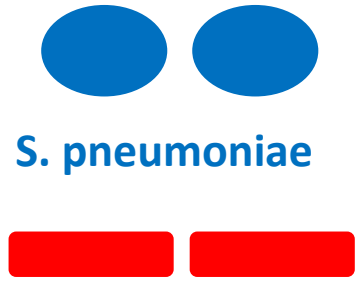
- Very rigid structure **and provide definite shape to the cell**
- P**reventing the cell from** expanding and eventually **bursting** because of uptake of water
- **Resistant to extremely high pressure**.
- **Essential for the growth and division of bacteria**
- Cell wall protects against osmotic lysis.

## History:

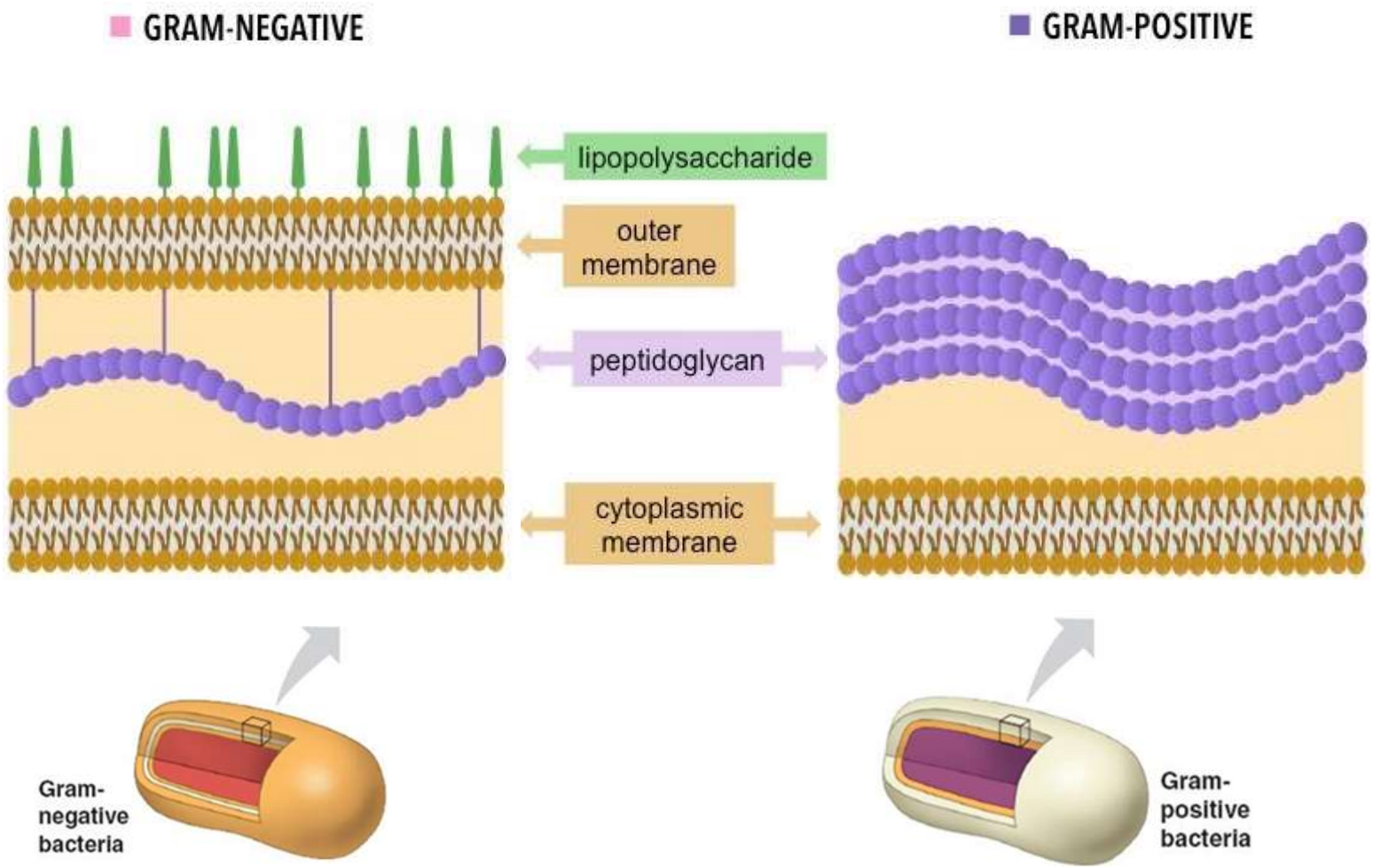
Danish scientist Hans Christian Gram (1853–1938)




German pathologist Carl Weigert (1845- 1904)

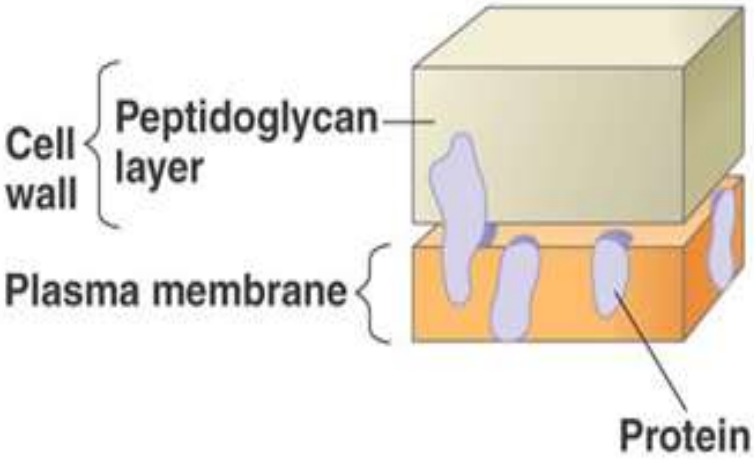


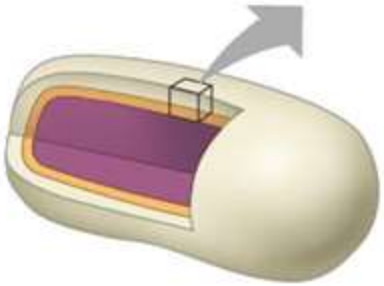
# Gram-Negative Versus Gram-Positive Cell Walls



# Gram positive vs. Gram negative bacteria

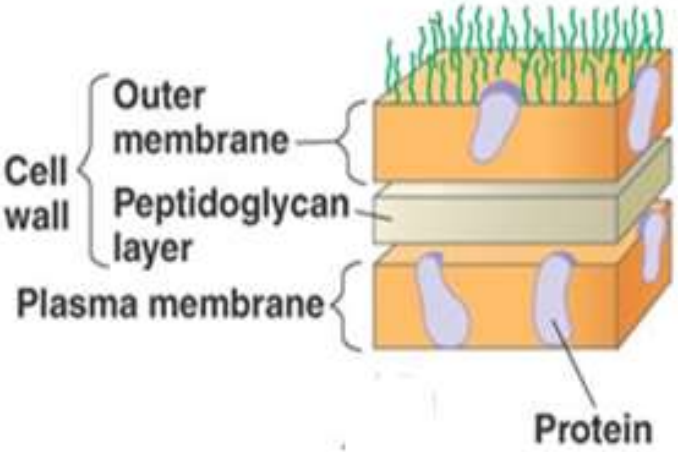
## Gram positive

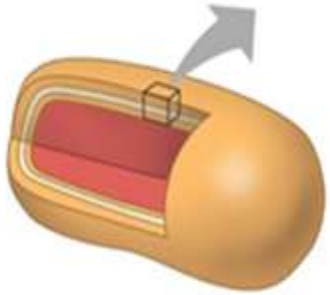


(a) Gram-positive: peptidoglycan traps crystal violet.

## Gram negative



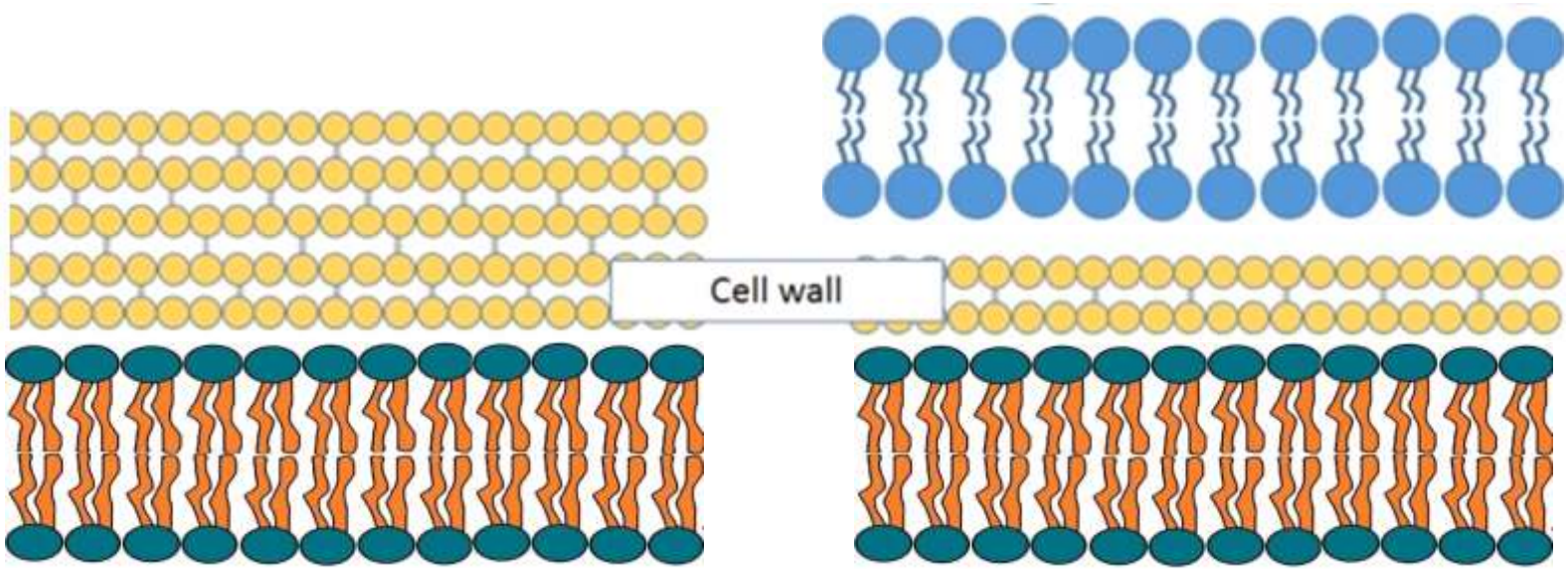
(b) Gram-negative: crystal violet is easily rinsed away, revealing red dye.

## 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.

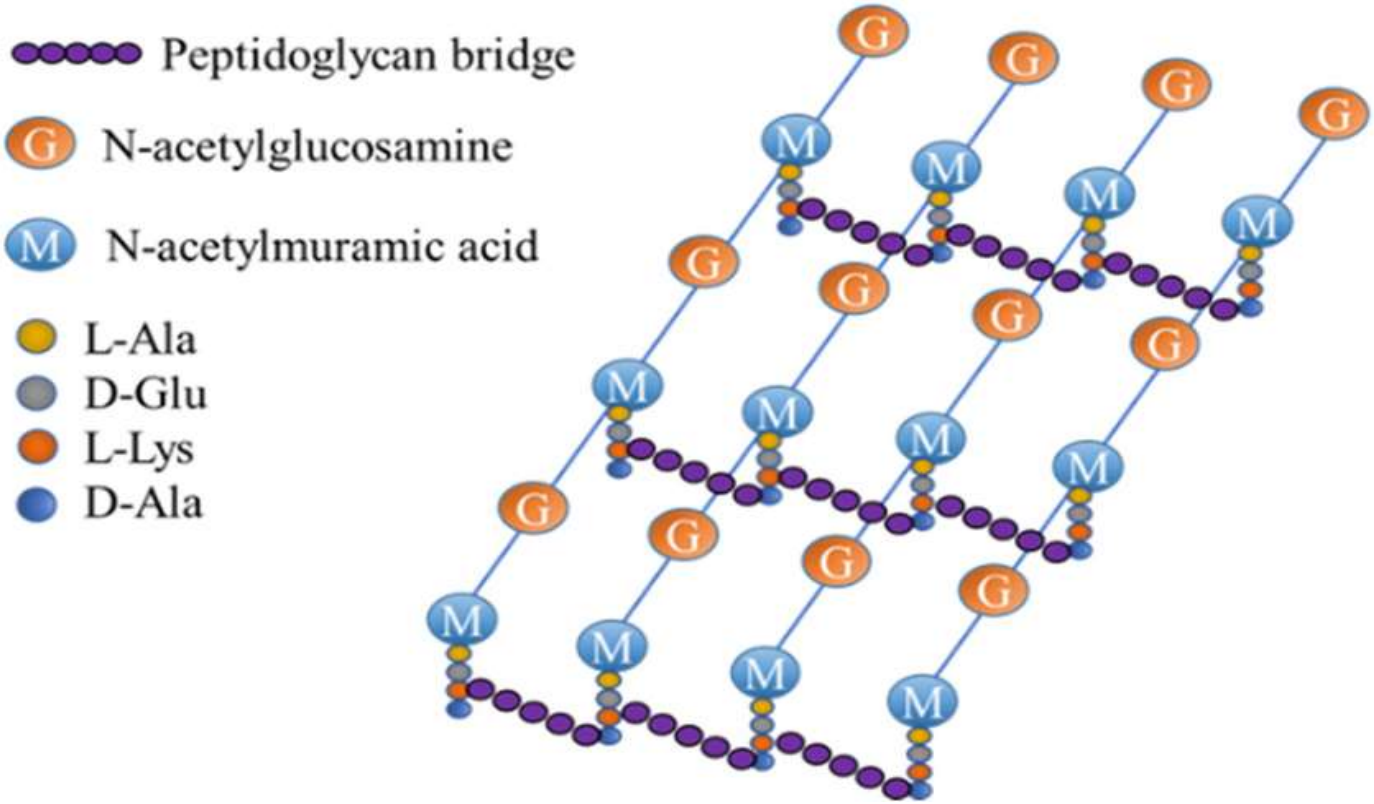
## Gram negative

- 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.



# 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.

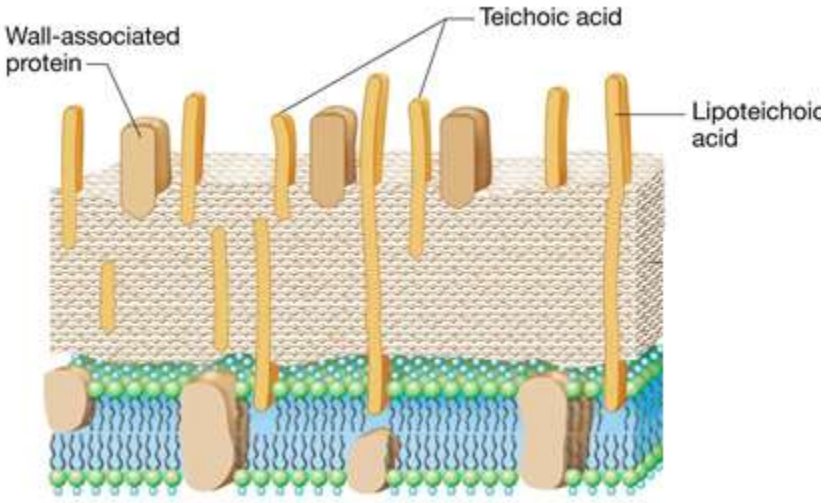


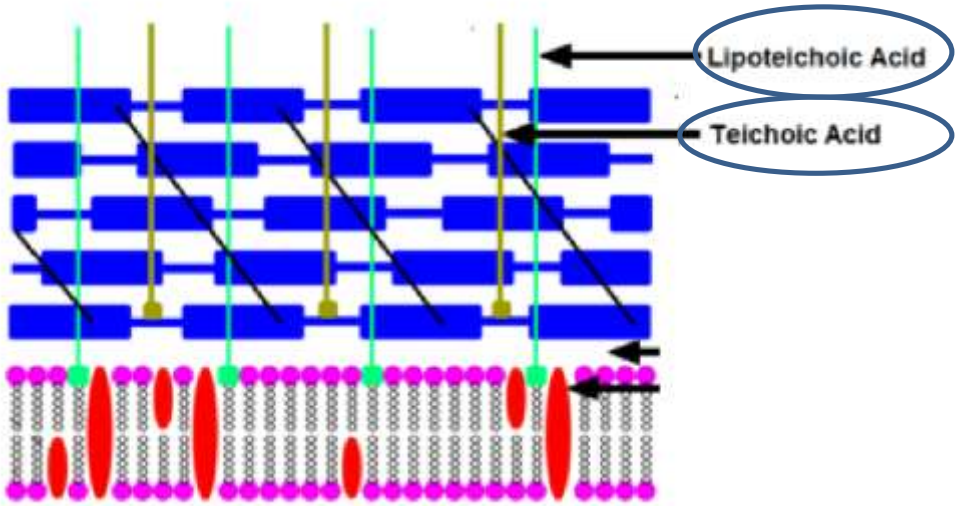
# Teichoic and Lipoteichoic acids

- 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:

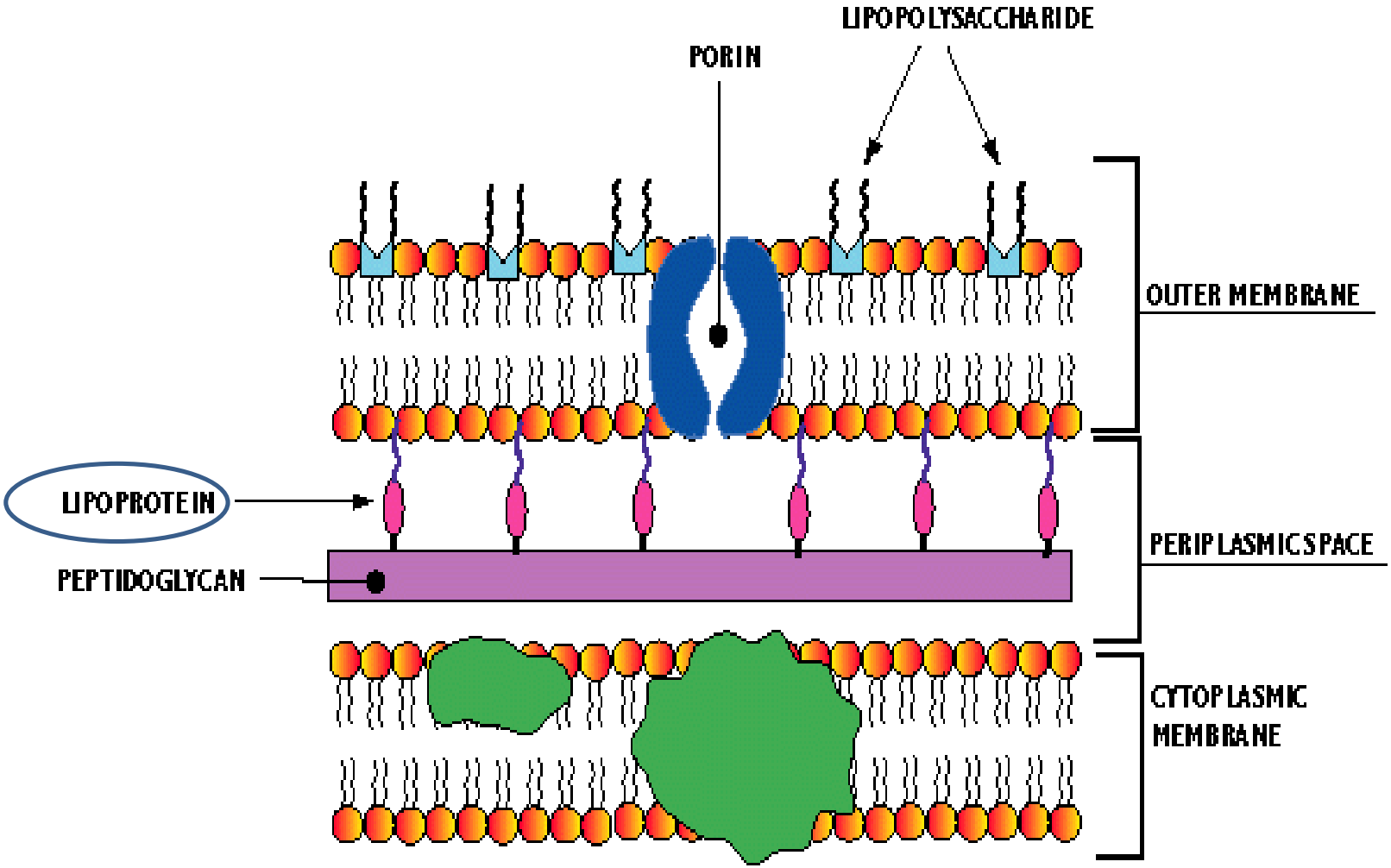
- Anchor peptidoglycan layers to the plasma memebrane
- Attachment to other bacteria and to specific receptors on mammalian cell surfaces.



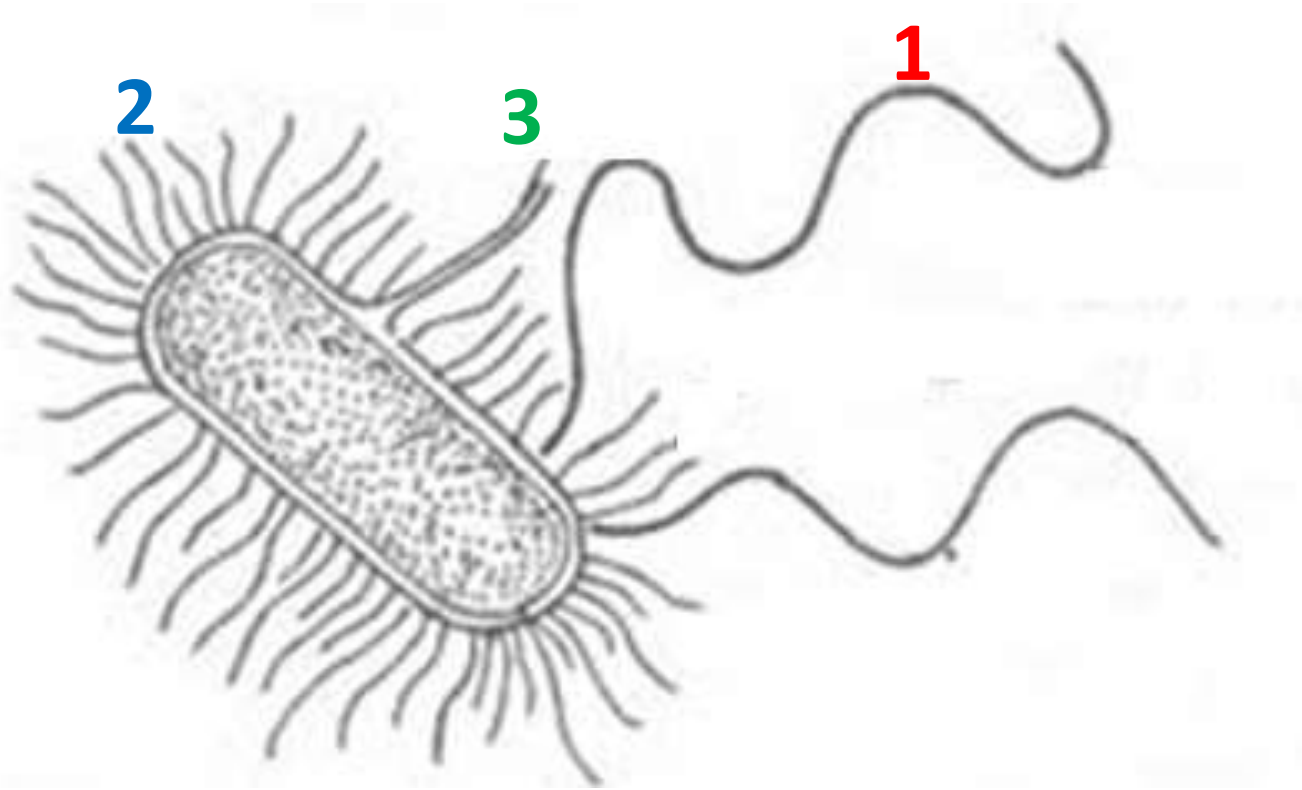

**Gram positive**

# Gram negative bacteria



# Ultrastructure of Bacterial Cell

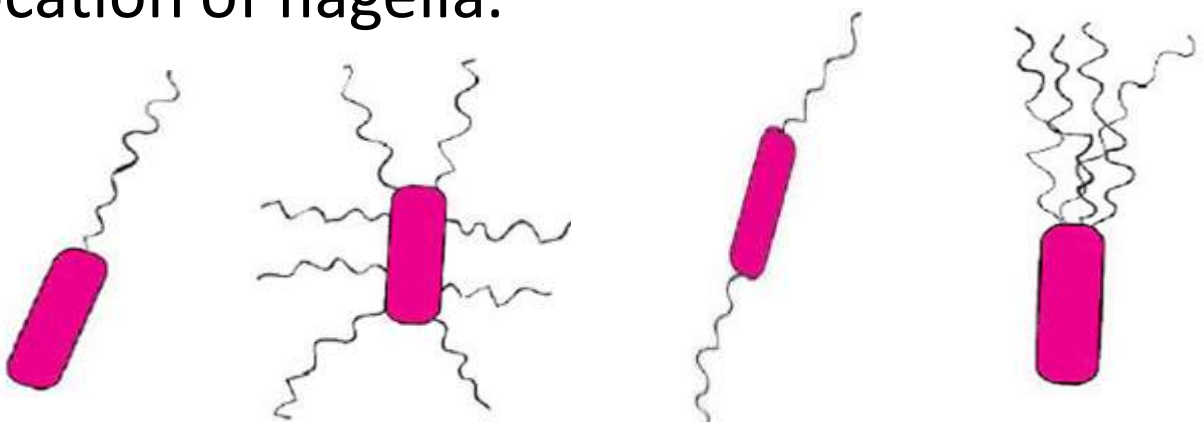
1. Flagella
2. Pili
3. Sex Pili



# 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.



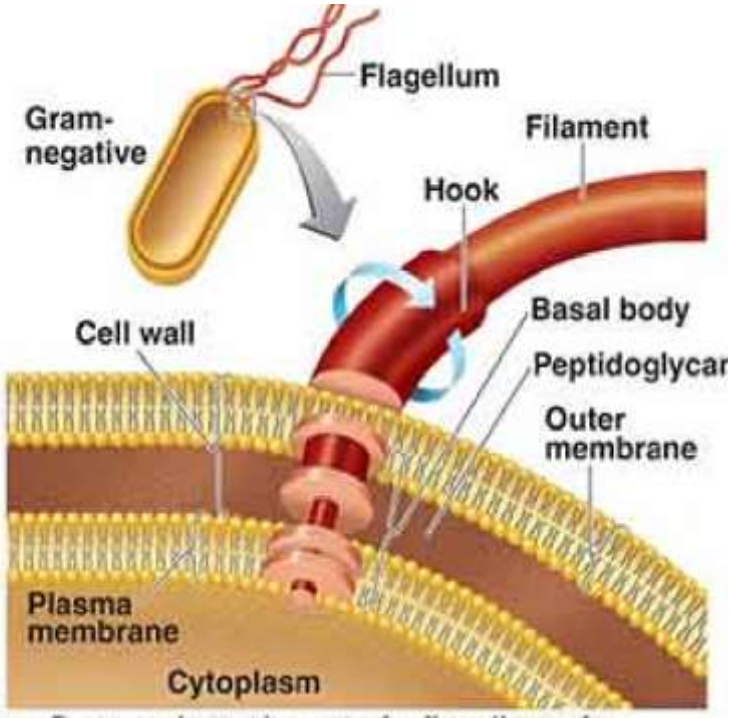
Monotrichous Peritrichous Amphirichous Lophotrichous

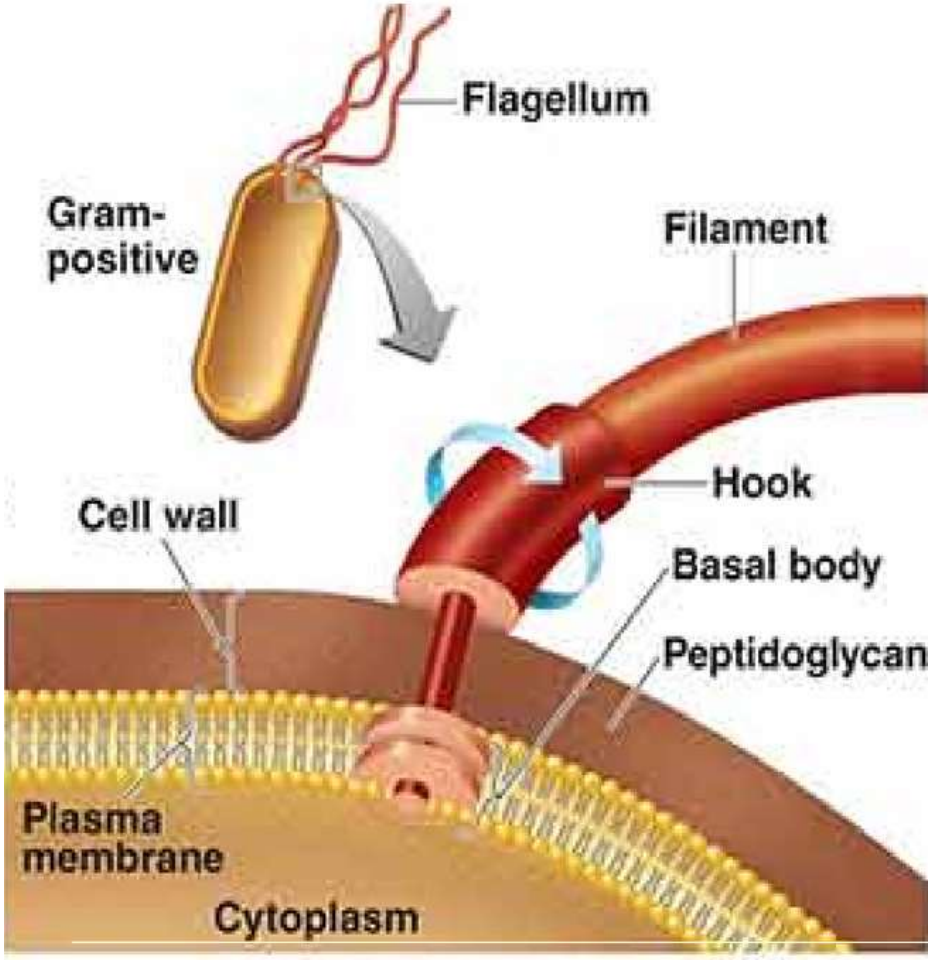
# Ultrastructure of Bacterial Cell

## Ultrastructure of flagellum

Each bacterial flagellum is structurally differentiated into three parts

- basal body.
- Hook .
- Main filament or shaft.

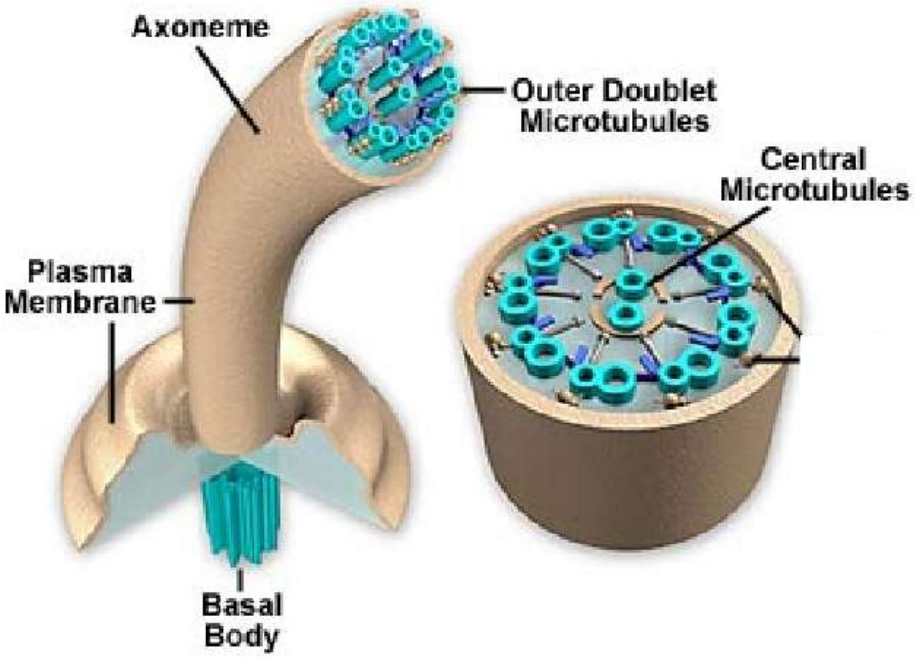


# Ultrastructure of Bacterial Cell

## Ultrastructure of flagellum

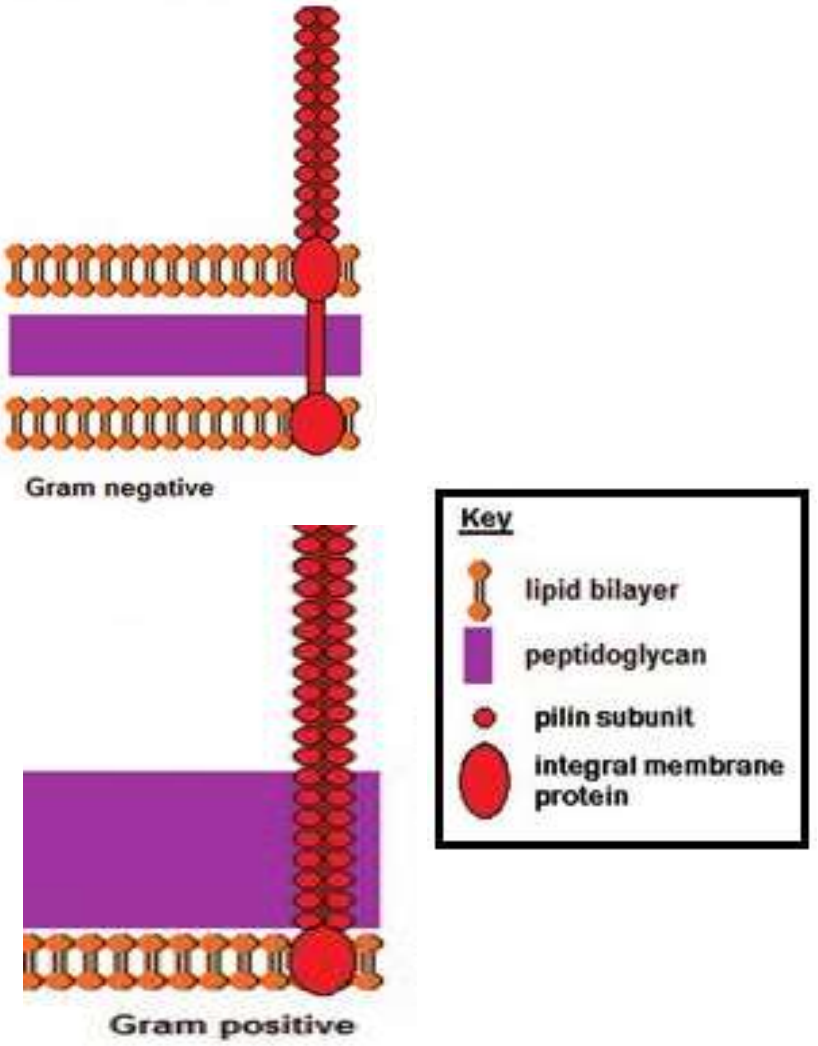
- Flagella are membrane bound cylinders about 0.2 µm in diameter.
- The strands called axoneme.
- The axoneme consists of 9 pairs of microtubule doublets arranged in a circle around 2 central tubules.
- This is called 9+2 pattern of microtubules.




Ultrastructure of Cilia and Flagella

# Pili

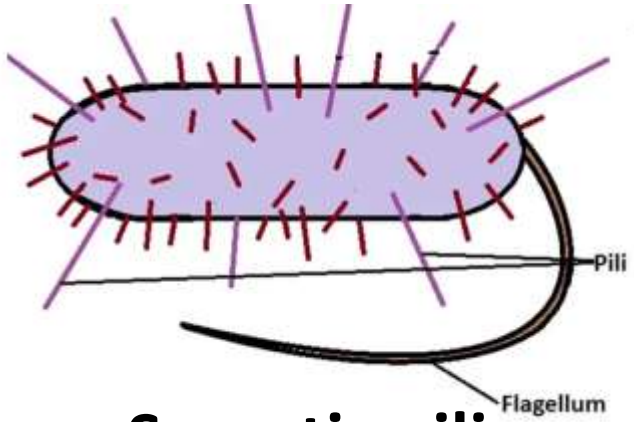
- These are hair like appendages present on the bacterial cell surface
- Found on most of gram negative bacteria, but can be found in Gram-positive.
- They are smaller than flagella, have no role in the motility of bacteria.
- A single bacterial cells bears about 100-500 pili which are arranged peritrichously.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



# Pili

## Somatic pili:

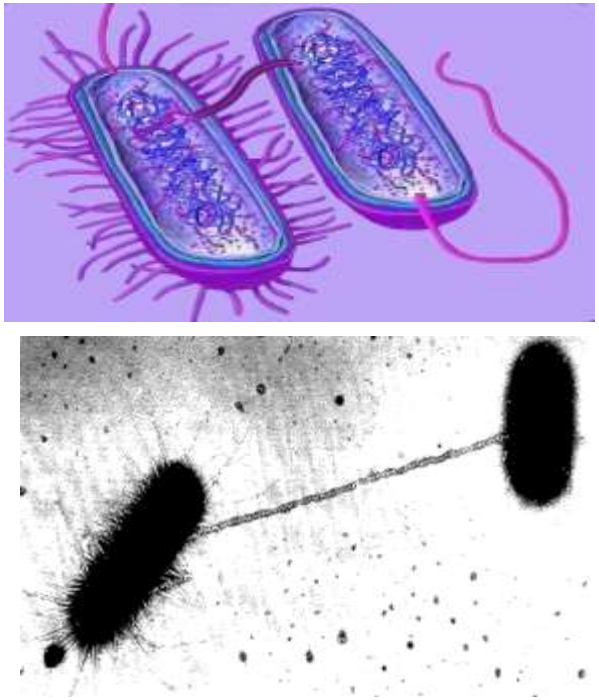
- Each bacterial cell bears about 100 somatic pili.
- Function: is to help the bacterium for attachment to a substratum.




**Somatic pili**

## Sex 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.



**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.