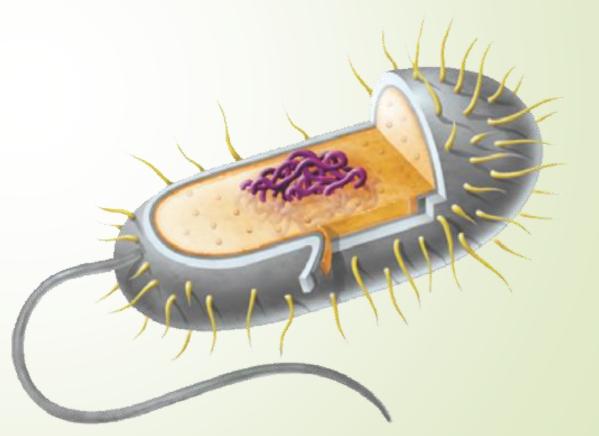
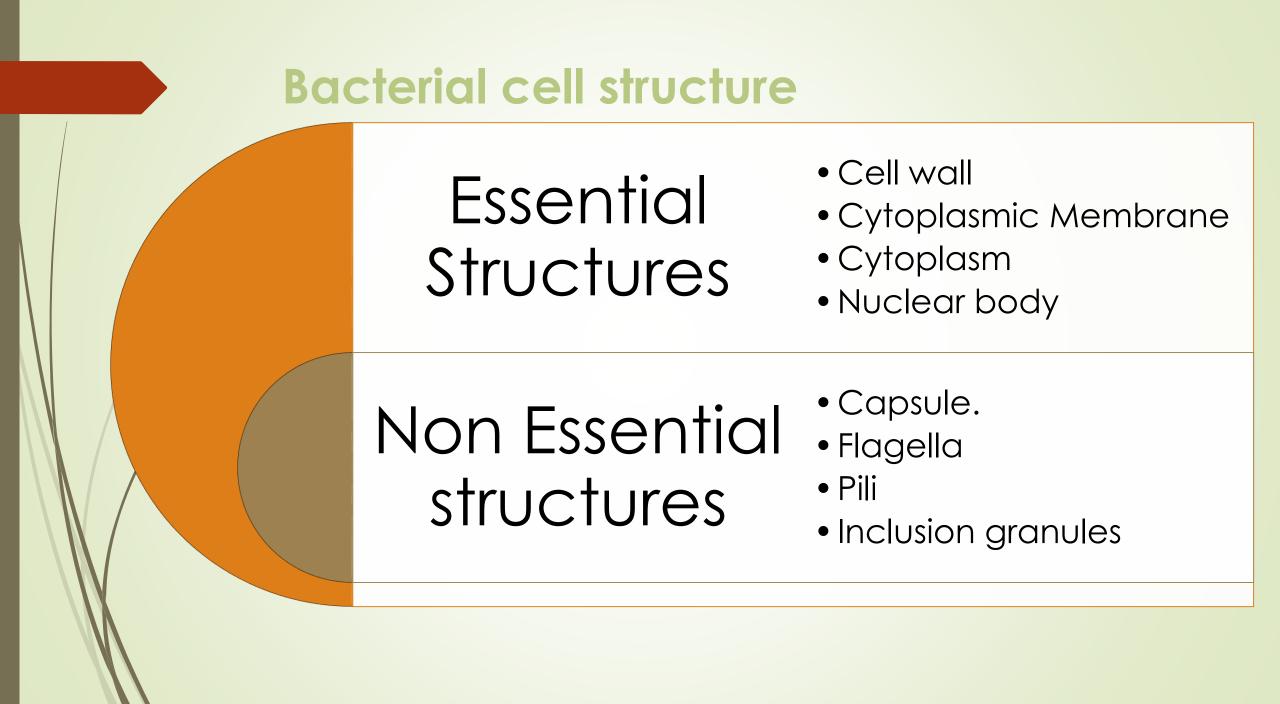


Lecture (3) Bacterial cell structure



Objectives

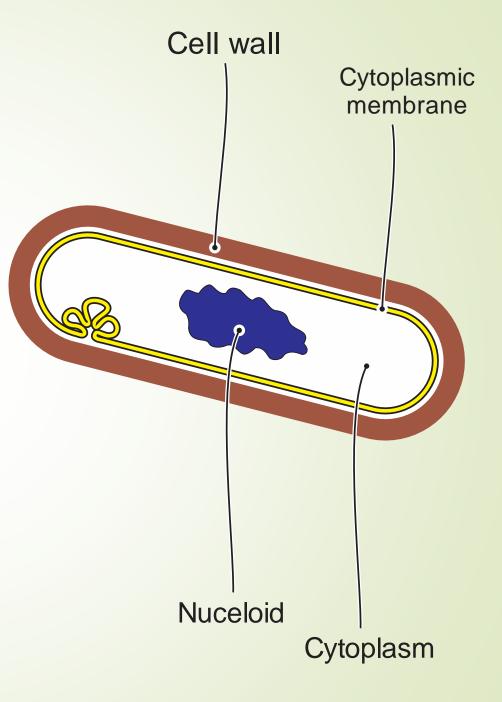
- Enumerate Essential and non-essential bacterial cell components
- Describe the common anatomical structures found in bacteria and explain their function [flagella, pili, glycocalyx, capsule, endospores, cytoplasm, inclusions, chromosome, plasmids, cell membrane, and cell wall].
- Compare gram positive and gram negative bacterial structure
- Explain the medical implications of spore formation.



Essential structures

Any bacterial cell is composed of the following structures (Essential structures):

- 1. Cell wall.
- 2. Cytoplasmic membrane.
- 3. Cytoplasm.
- 4. Nuclear body.



Non Essential Structures

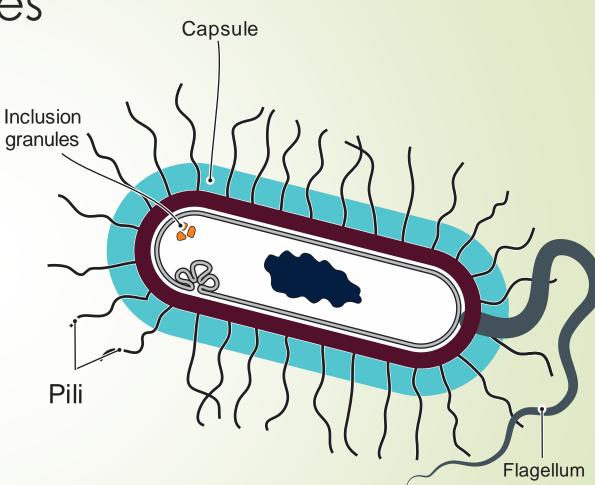
Some (Not all) bacteria may contain one or more of the following structures:

1. Capsule.

2. Flagella (single Flagellum)

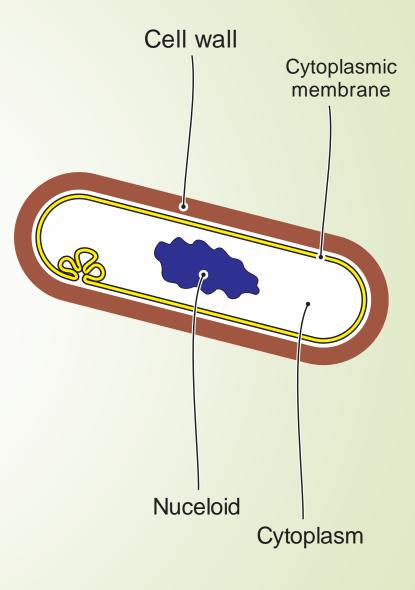
3. Fimbria (pili).

4. Inclusion granules



THE CELL WALL

The cell wall is a **rigid structure** that **surrounds** the bacterial cell just outside of the plasma membrane.



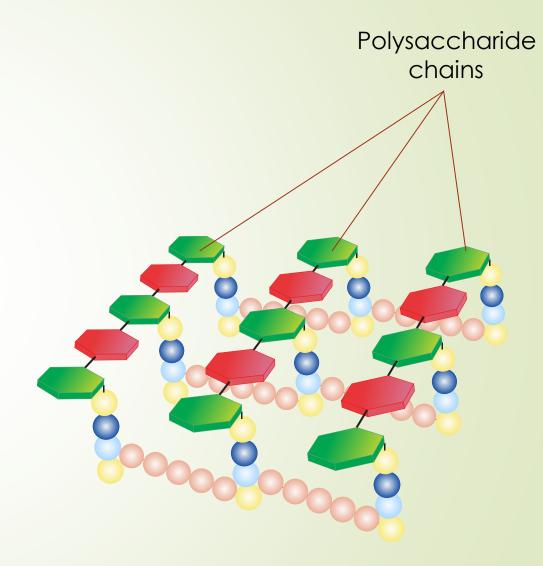


Bacteria are classified according to their cell wall as:

- Gram positive or
- Gram negative.

Peptidoglycan

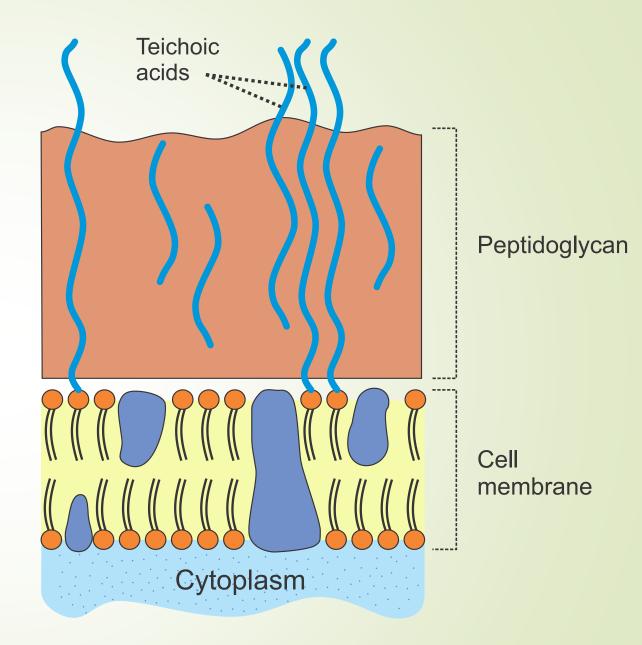
The main structural component of the cell wall.
Peptidoglycan is formed of carbohydrate + protein.
It consists of long polysaccharide chains that are cross-linked by amino acid bridges.



Gram positive Cell Wall

In Gram-positive bacteria the peptidoglycan forms a thick layer external to the cell membrane.

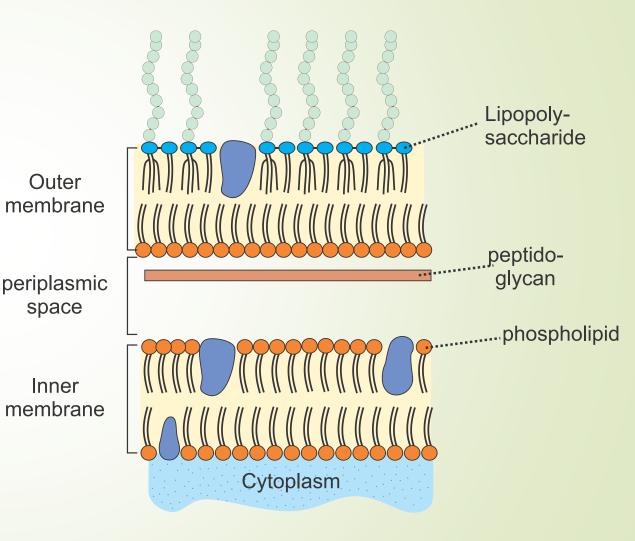
Cell wall of gram positive bacteria also contain Teichoic acid molecules.



Gram negative Cell Wall

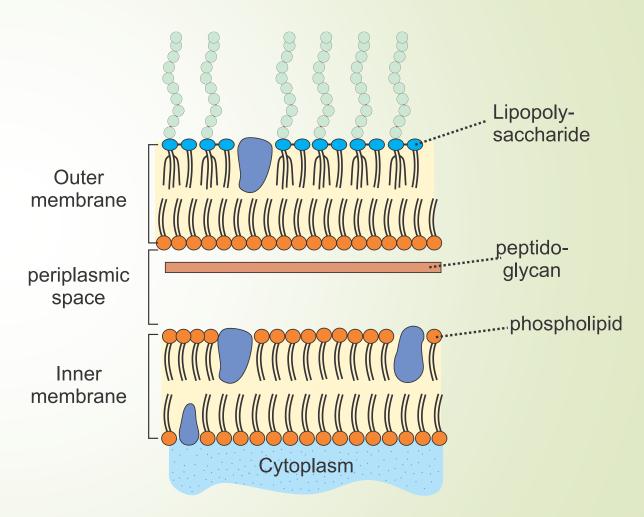
In Gram-negative bacteria, the peptidoglycan layer is thin and is overlaid by an outer membrane.

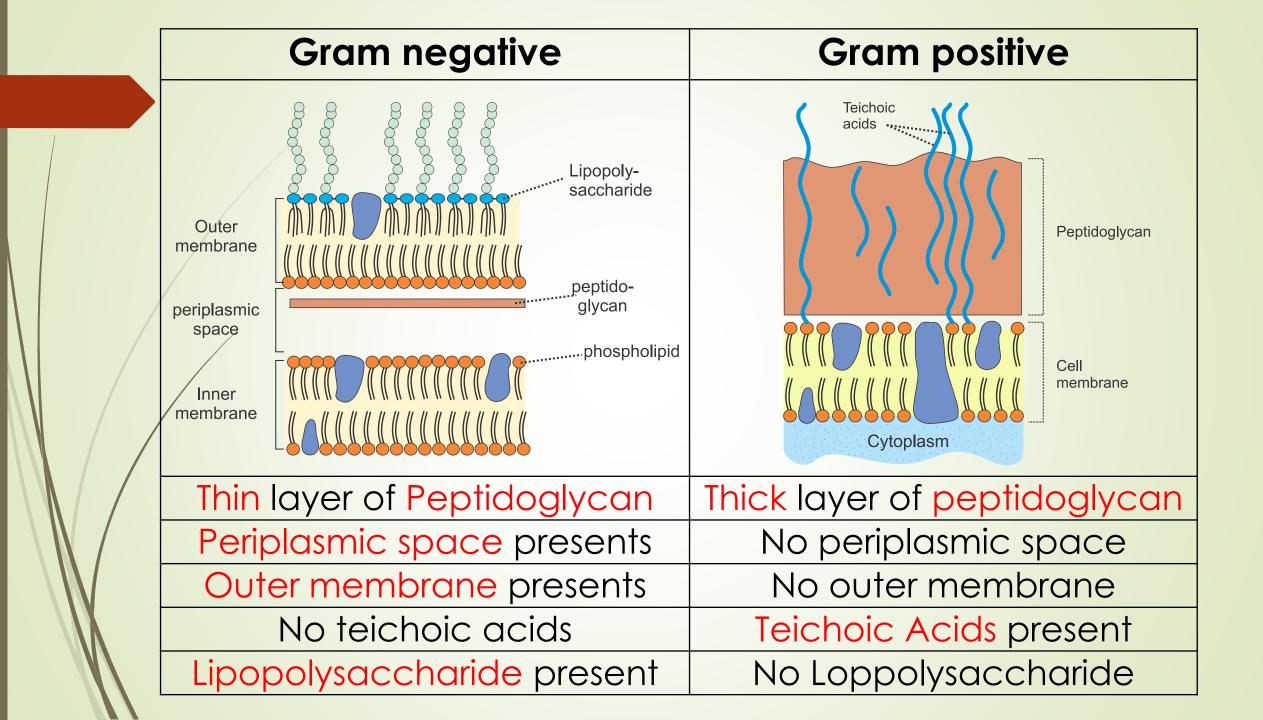
The space between the plasma membrane and the outer membranes, is called the periplasmic space.



Gram negative

The Outer membrane contains lipopolysaccharide (LPS).
 LPS is toxic (endotoxin).



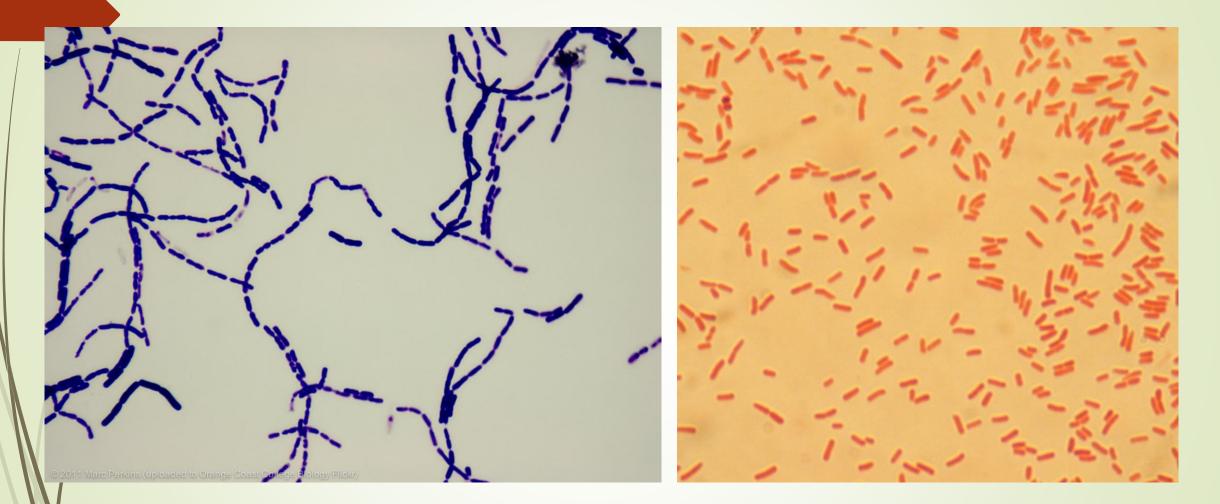


Function of the cell wall

Determines the shape of the bacterial cell.

- Protection of bacterial cell against osmotic lysis.
- Responsible for staining properties of bacteria.

Cell wall determines the staining properties of the bacterial cell



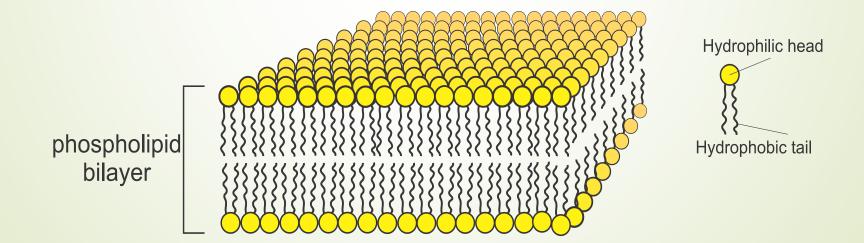
Gram Positive Bacteria (Blue)

Gram Negative Bacteria (Pink)

CYTOPLASMIC MEMBRANE

Surrounds the cytoplasm

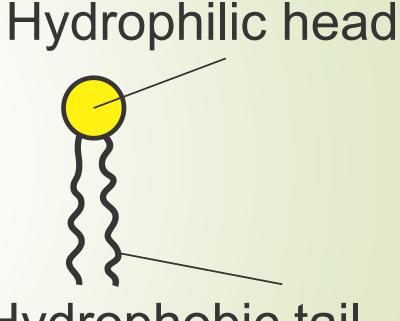
The cytoplasmic membrane is a bilayer of phospholipids



Phospholipid

Phospholipids are composed of two parts:

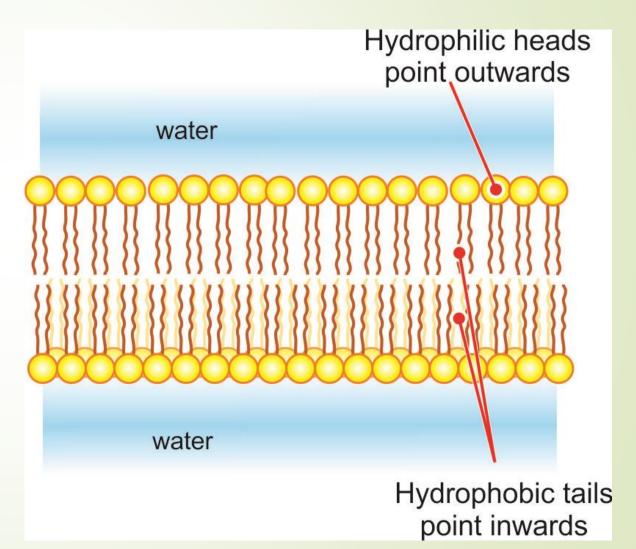
- Hydrophilic head ("waterloving").
- Hydrophobic tails ("waterfearing").



Hydrophobic tail

The Hydrophilic heads points outwards (facing the aqueous medium on both sides of the bilayer).

The hydrophobic Tails points inwards.



Functions of cell membrane

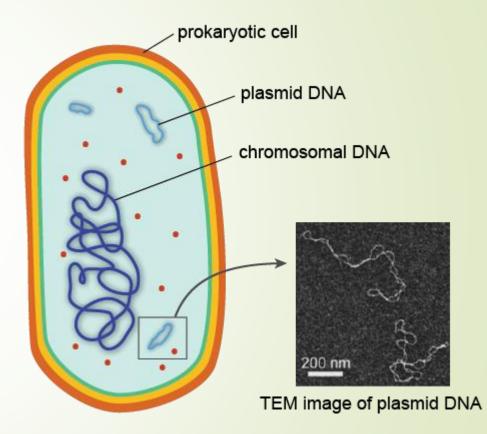
- Selective permeability = selectively allows particular ions and molecules to pass through the membrane, while preventing the movement of others.
- Active transport (using energy) of ions and molecules to the inside of cells.
- **Excretion** e.g. hydrolytic exoenzymes

Cytoplasm

- A homogeneous soft gel mass inside the cell.
- The cytoplasm of prokaryotes has no membrane bound organelles.
- It contains:
 - Nuclear body.
 - Plasmids.
 - Ribosomes.
 - Enzymes.
 - Storage granules

THE NUCLEAR BODY

- Consists of single circular DNA molecule coiled to form a mass.
- It carries all essential genetic information of the cell.
- There is no nuclear membrane and no nucleolus.



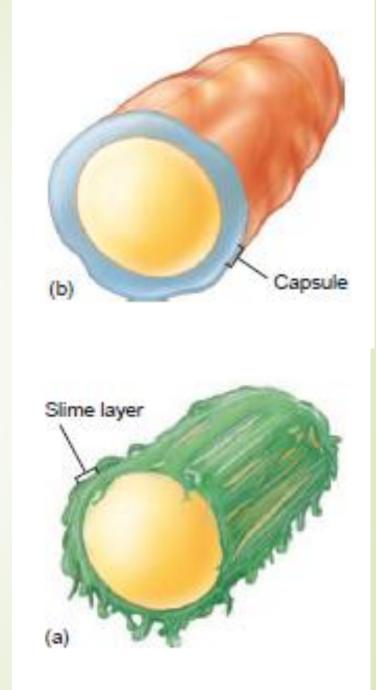
Plasmids

- Plasmids: are small extrachromosomal pieces of circular DNA.
- Plasmids carry non-essential genes such as antibiotic resistance genes.
- Some Plasmids can be transmitted from one bacterium to another.



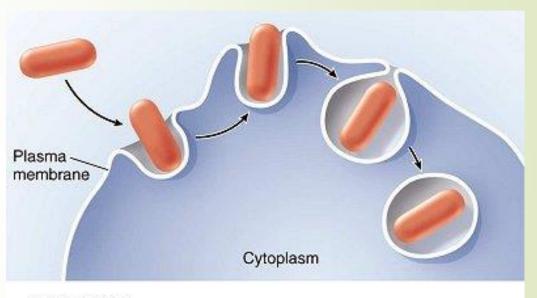
Capsule and slime layer

- Capsule is a <u>well-defined</u> gelatinous protective outer covering surrounding and <u>firmly</u> attached to bacterial cell wall.
- Slime layer : A slime layer is a zone of diffuse, unorganized material, loosely associated with the cell wall and can be easily removed.



Function

 Protection of bacteria against phagocytosis.
 Protect cells from drying.
 Help bacteria in adherence to surfaces.



Phagocytosis

Flagella (single Flagellum)

 Flagella are long helical appendages composed of repeating protein subunits (flagellin)



Flagella (single Flagellum)

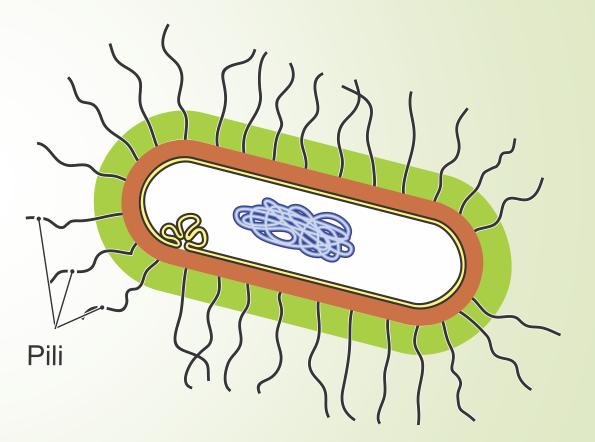
Flagella are responsible for **motility**.



Pili (single → pilus)

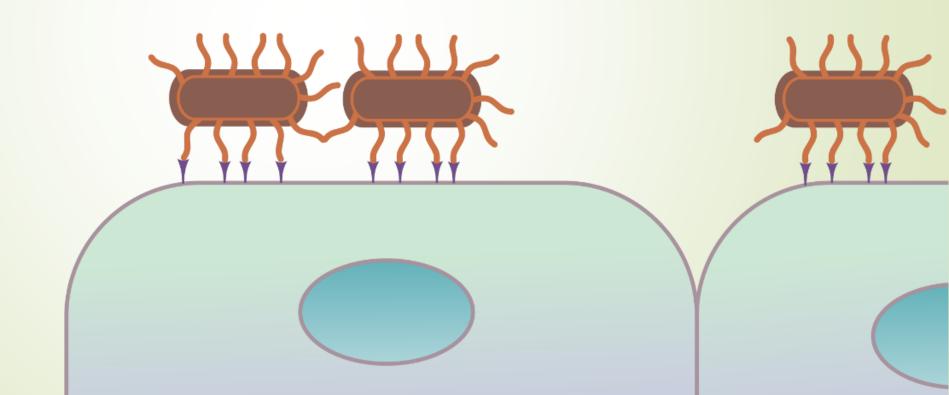
Pili are short **hair-like** surface appendages.

Pili exist in two classes:
Ordinary pili
Sex pili



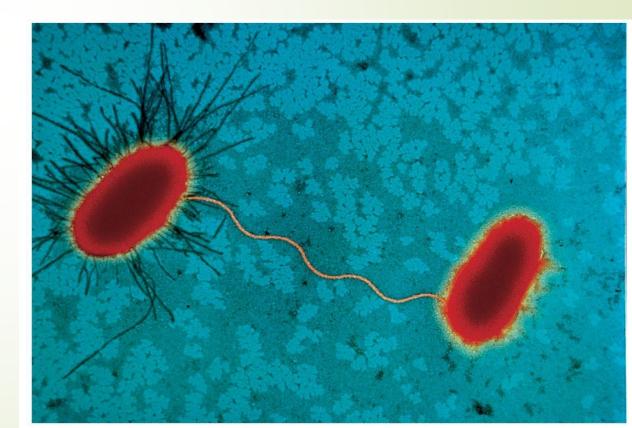
Pili (single → pilus)

Ordinary pili are involved in bacterial adherence.



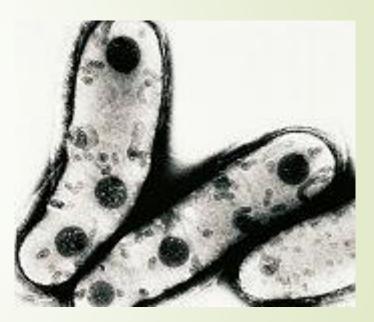
Pili (single \rightarrow pilus)

Sex pili, involved in transfer of genetic material (conjugation).



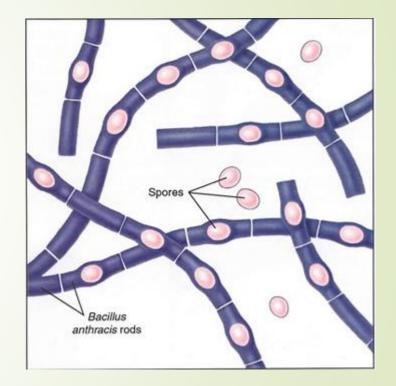
INCLUSION GRANULES

- Function: Storage of energy or structural building blocks.
- Site: In cytoplasm.
- Example: Volutin granules in diphtheria bacilli (reservoir of inorganic phosphate).



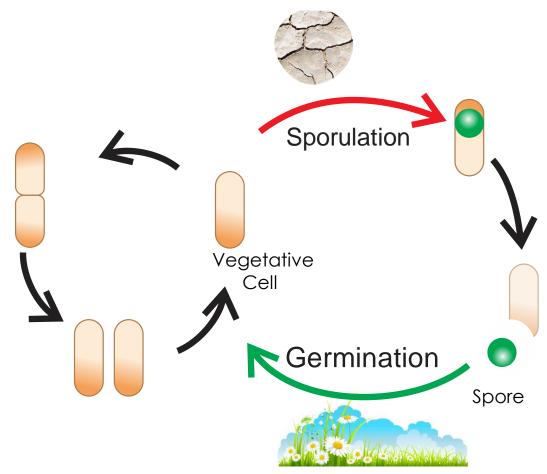
Spores

- Spores are highly resistant resting forms of some bacteria.
- Spores are formed on exposure to <u>unfavorable</u> <u>conditions</u> e.g. dryness, heat and depletion of nutrients.



Sporulation / Germination

- Sporulation (sporogenesis): the process of formation of spores from vegetative cells.
- Germination: opposite to sporulation i.e. formation of vegetative cells from spores in favorable conditions.



Medical Importance of spores

- The medical importance of spores lies in their <u>extraordinary resistance to</u> <u>killing by heat</u> and <u>chemicals</u>.
- As a result of their resistance to heat, <u>sterilization</u> cannot be achieved by ordinary methods such as boiling.
- Steam heating under pressure (autoclaving) at 121°C, usually for 30 minutes, is required to ensure the sterility of products for medical use.



Quizzes



1. The bacterial structure responsible for <u>motility</u> is:

- A. The nuclear body.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. Pili.



2. The bacterial structure responsible for <u>adhesion</u> (attachment) to surfaces:

- A. The nuclear body.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. Pili.



3. The bacterial structure responsible for selective permeability:

- A. The nuclear body.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. Pili.



4. Short hair like surface appendages of bacteria are called:

- A. Capsule.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. Pili.



5. The bacterial structure responsible for cell shape and staining properties is:

- A. The cell wall.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. Pili.



6. Highly resistant resting from of Bacteria is called

- A. Inclusion granule
- B. Nucleoid
- C. Flagellum
- D. Spore



7. Staining properties of the bacterial cells is determined by ____?

- A. The cell wall.
- B. The cytoplasmic membrane.
- C. The flagellum.
- D. The capsule.



8. The toxic part of the bacterial cell wall is:

- A. Peptidoglycan
- B. Phospholipid
- C. Lipopolysaccharide



9. The bacterial structure responsible for protecting bacteria against phagocytosis is:

- A. Flagellum
- B. Cell membrane
- C. Capsule
- D. Pilli.

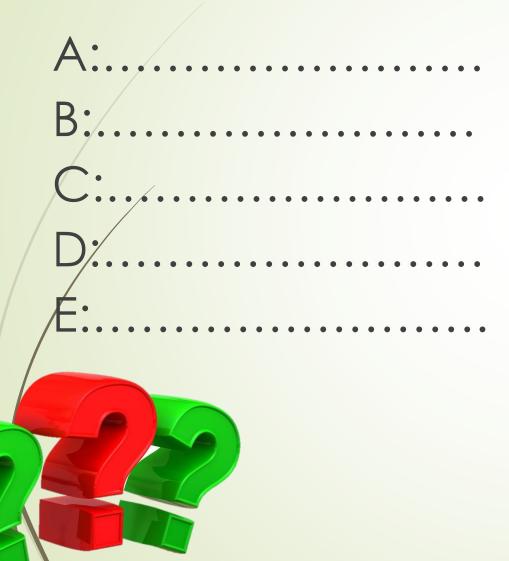


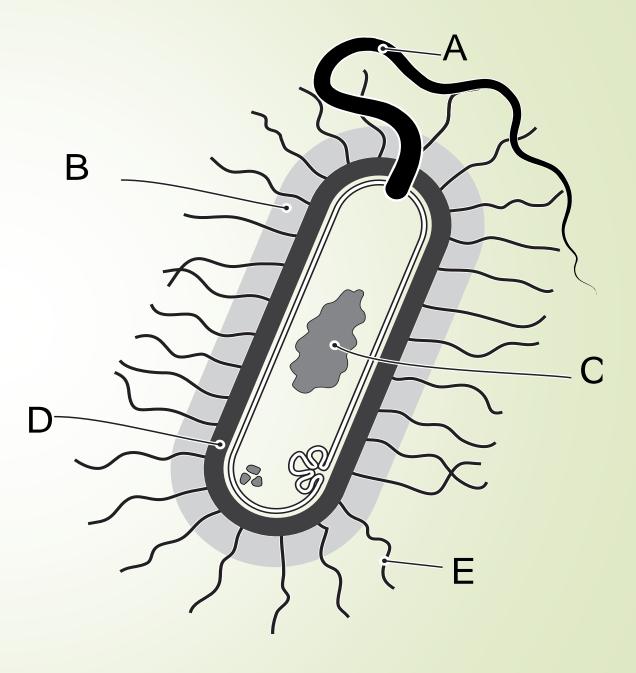
10. The cell wall of Gram Positive bacteria:

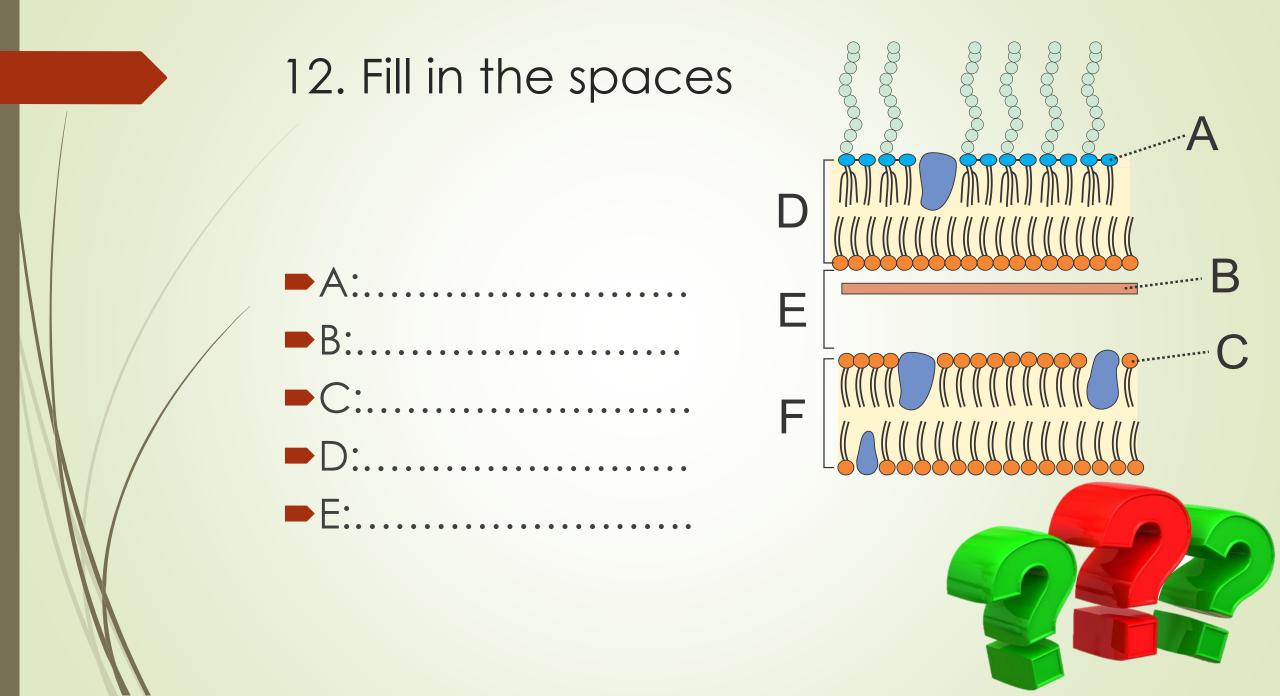
- A. Contains a periplasmic space
 - 3. Contains a thick layer of peptidoglycan
- C. Contains an outer membrane
- D. Contains Lipopolysaccharide



11. Fill in the spaces

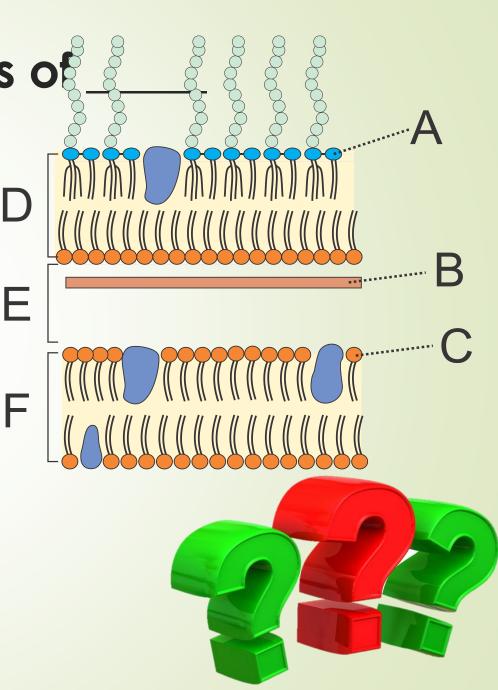






13. This cell wall diagram is of Bacteria

A. Gram positive.B. Gram negative.



14. True or False:

- A. The toxic part of the cell wall is the peptidoglycan.
- B. The toxic part of the cell wall is Lipopolysaccharide.
- C. Plasmids carries essential genetic information of the cell.
 D. Plasmids carries non-essential genes such as antibiotic resistance. genes.
- É. Selective permeability is a function of bacterial cell wall.
- F. Selective permeability is a function of bacterial cell membrane.

