

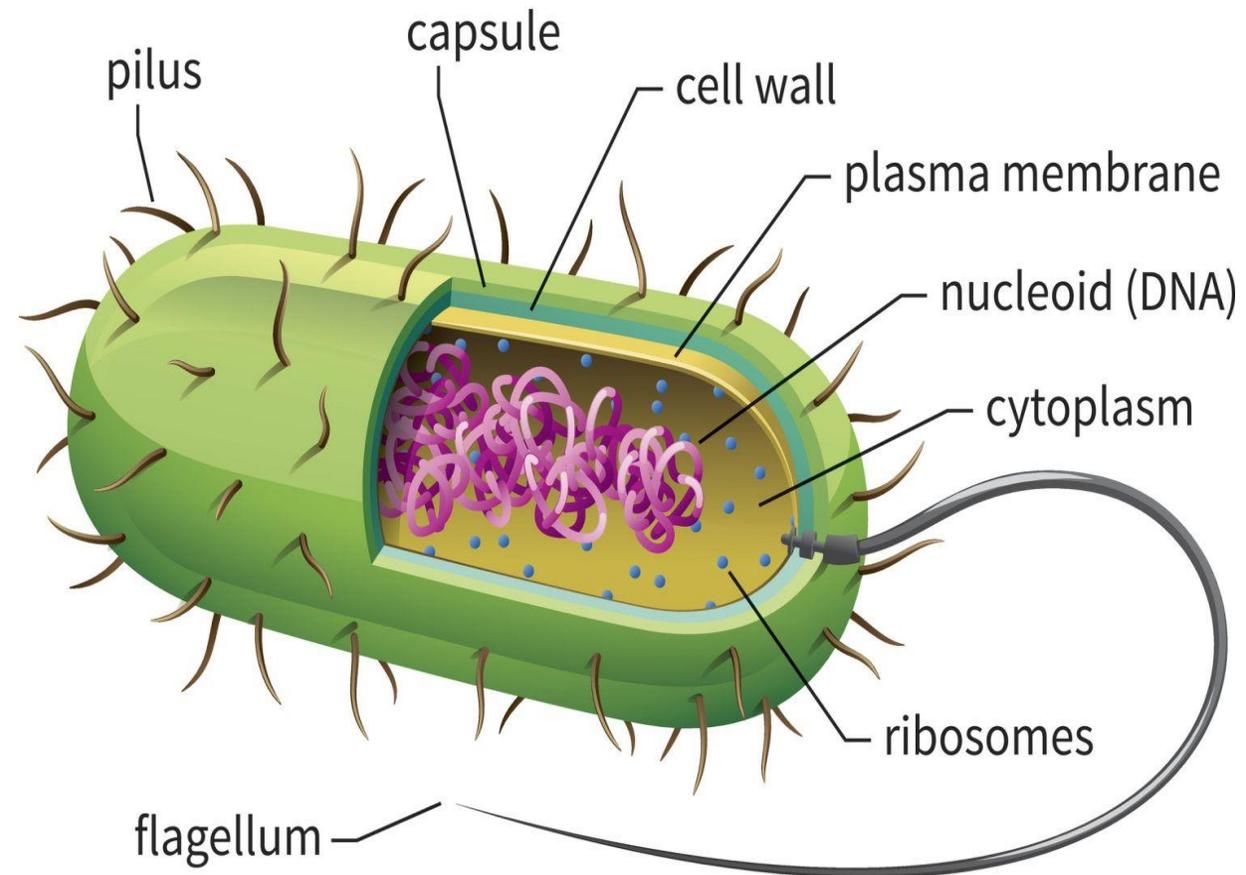
Bacterial structure and classification 1

Dr. Hala Altarawneh



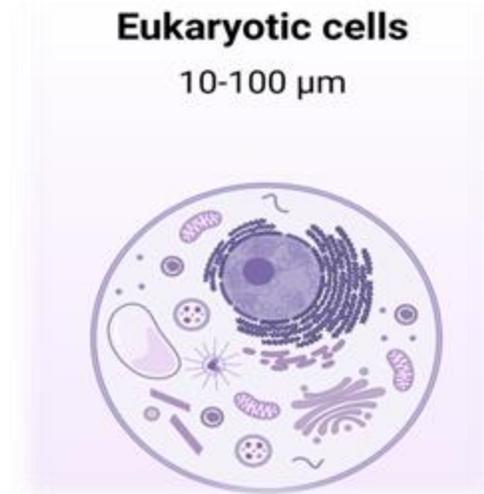
Outline

1. Overview of Bacteria
2. Bacterial Cell Structure:
 - ✓ Internal structures
 - ✓ The cell envelope
 - ✓ External structures



Bacteria: An Overview

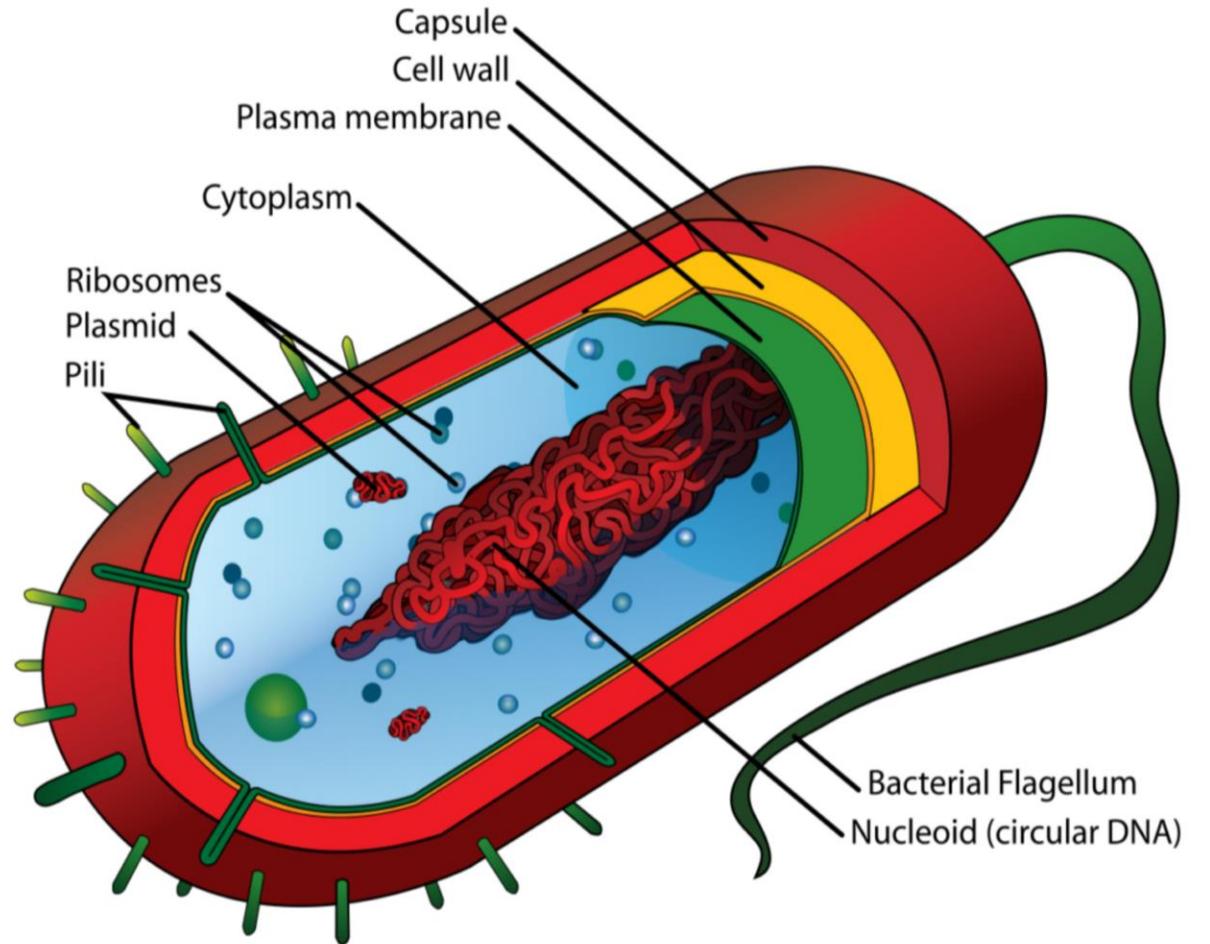
- Bacteria are unicellular prokaryotic organisms i.e. they lack a nucleus and membrane-bound organelles.
- Found everywhere in soil, water, air, and inside the human body.
- Size: Typically, 0.2–5 μm (much smaller than human cells)
- Most bacteria are harmless or beneficial
 - Only **~1-2% are pathogenic** to humans



Bacterial Structures

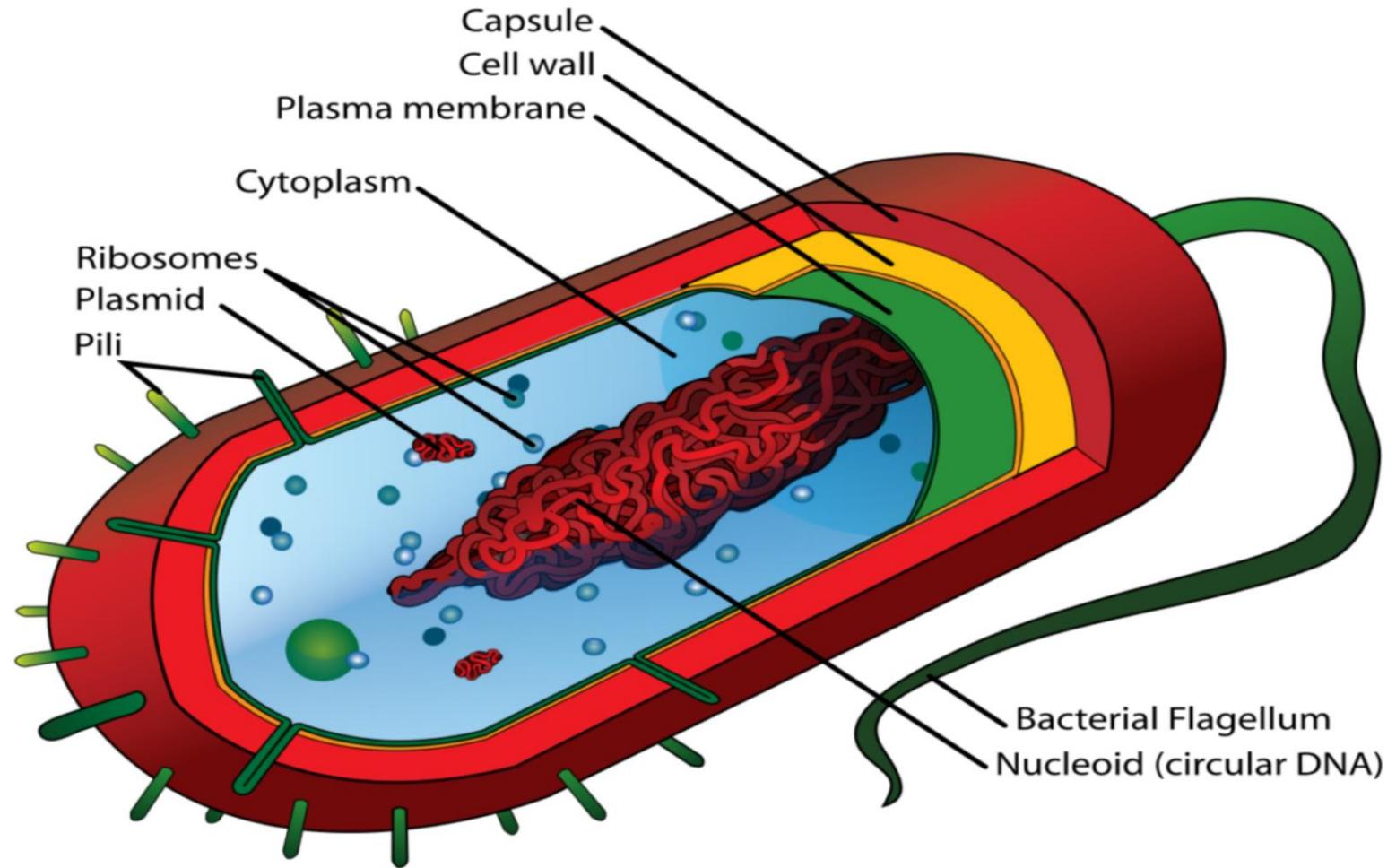
Bacterial structures can be grouped into:

- Internal structures
- The cell envelope
- External structures



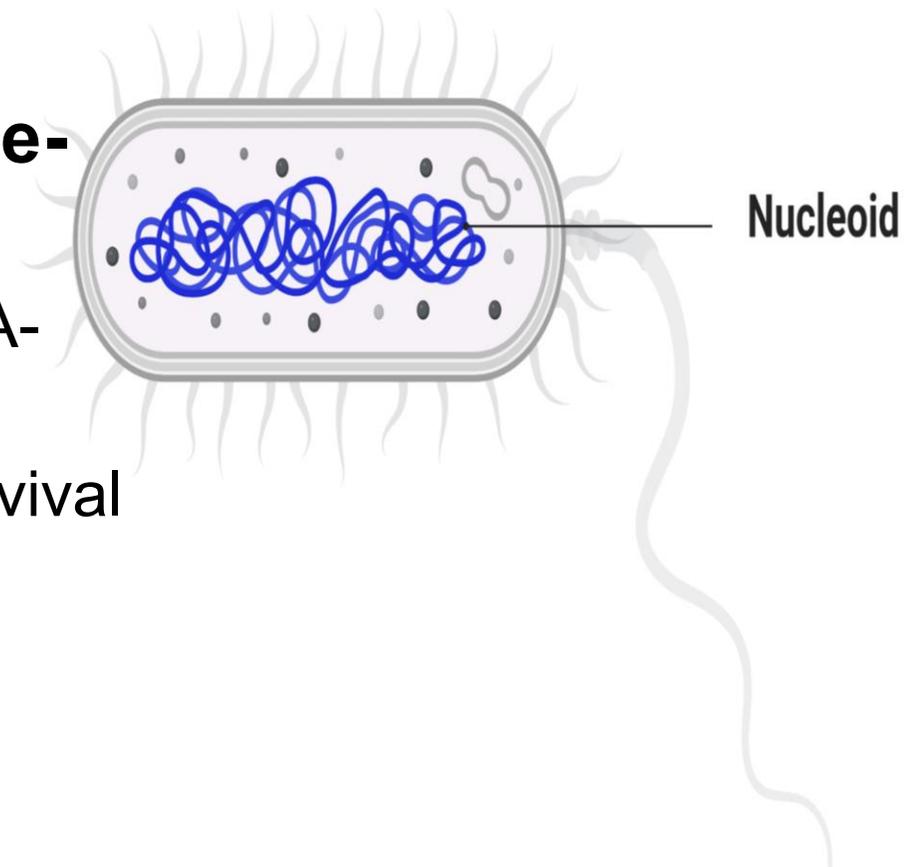
Bacterial Structures- Internal Structures

- Nucleoid
- Plasmids
- Ribosomes
- Cytosol



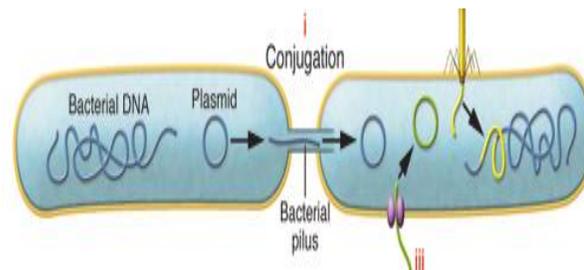
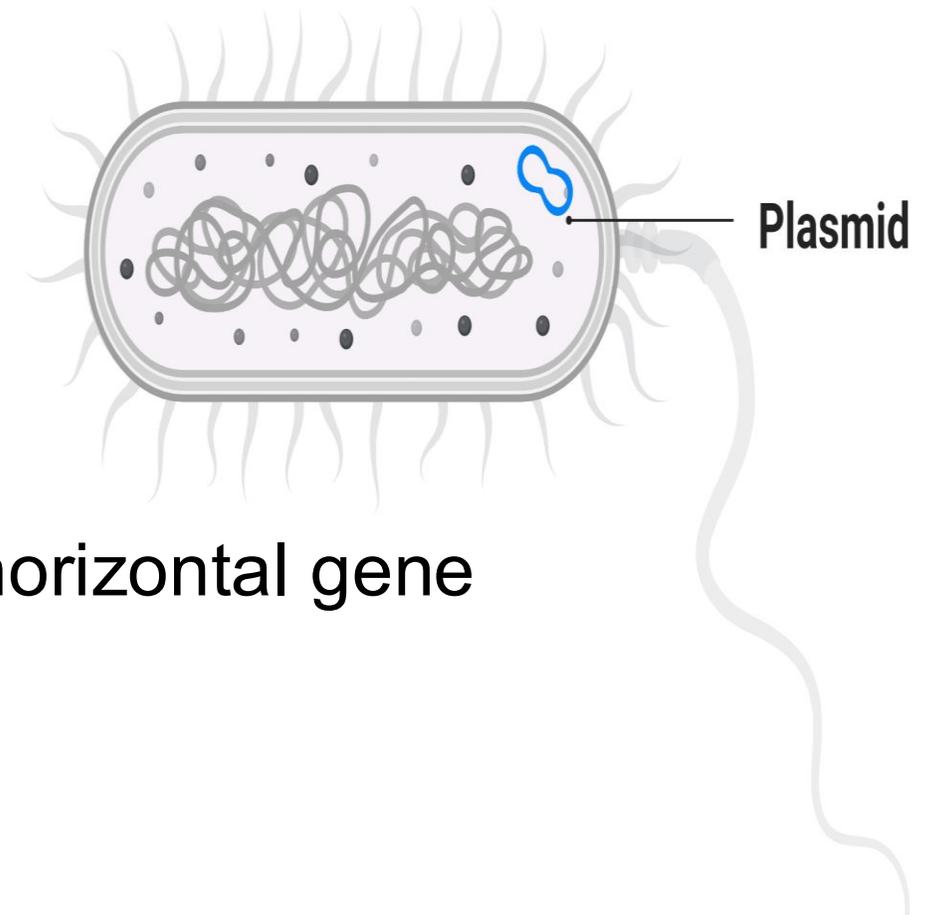
Bacterial Structures: Internal Structures- Nucleoid

- Region in the cytoplasm where bacterial chromosome is located
- Contains mostly a **single, circular double-stranded DNA molecule**
 - DNA is compacted by **supercoiling** and DNA-binding proteins
 - **Carries all essential genes** for bacterial survival and reproduction
 - **Not surrounded by a membrane** (unlike a eukaryotic nucleus)



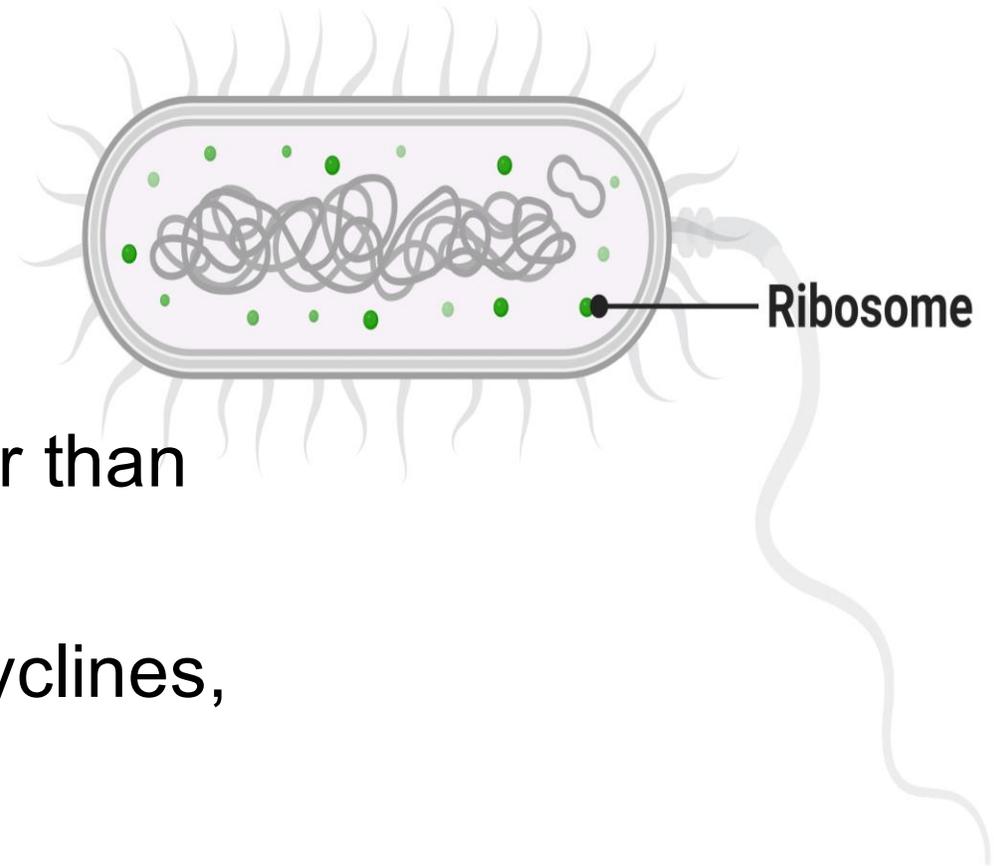
Bacterial Structures: Internal Structures- Plasmids

- Small, circular, double-stranded DNA molecules
- Independent of chromosomal DNA
- **Carry non-essential genes**, often for:
 - Antibiotic resistance
 - Virulence factors
 - Toxin production
- Can be transferred between bacteria (horizontal gene transfer)



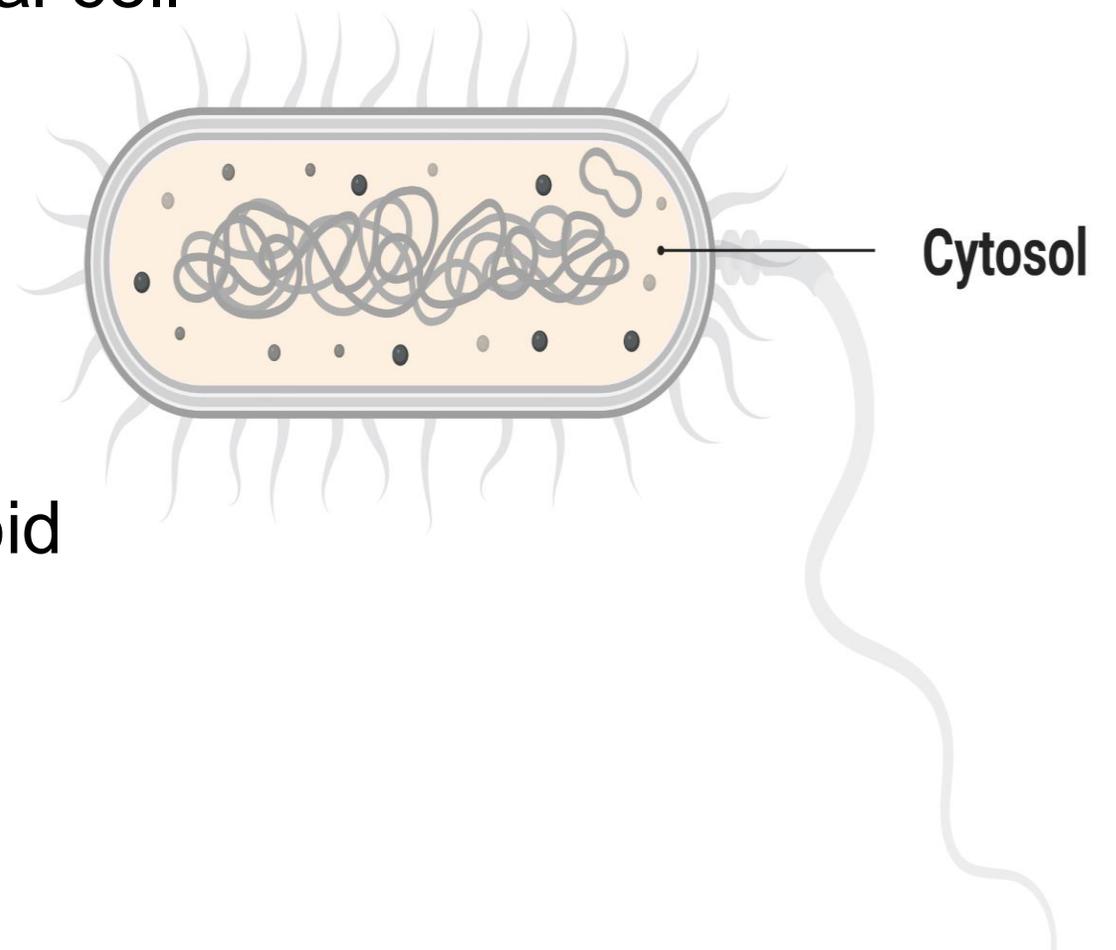
Bacterial Structures: Internal Structures- Ribosomes

- Sites of protein synthesis
- Made of rRNA and proteins
- **Bacterial ribosomes are 70S** (smaller than human 80S ribosomes)
- Target of many antibiotics (e.g., tetracyclines, macrolides)



Bacterial Structures: Internal Structures- Cytosol

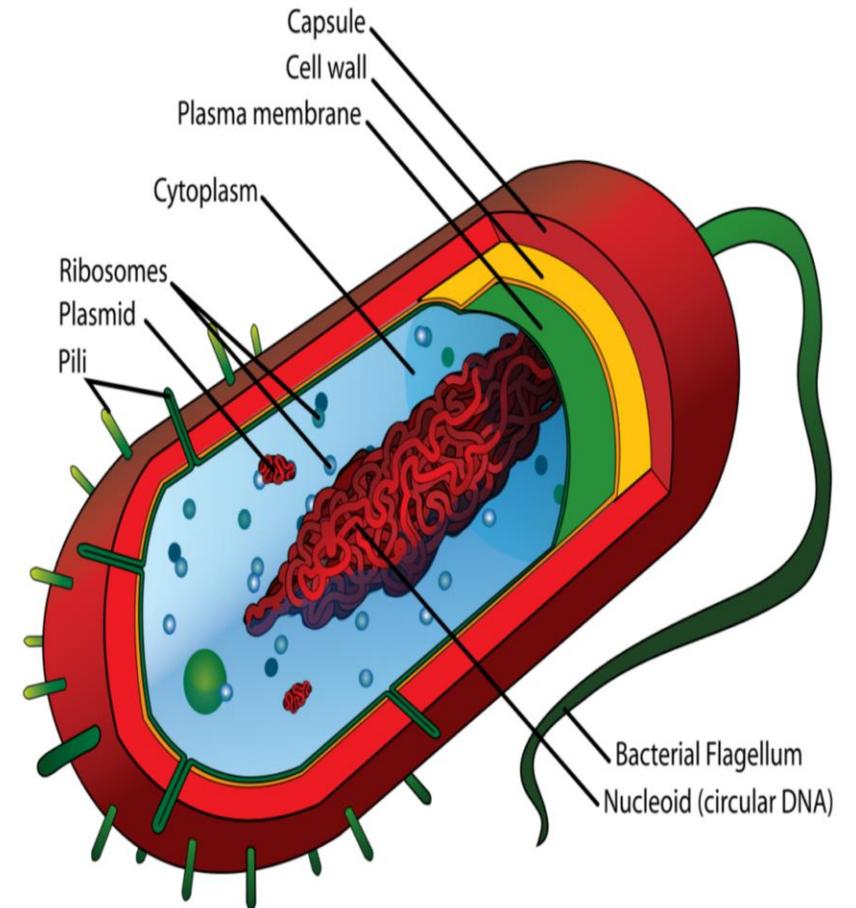
- Gel-like matrix inside the bacterial cell
- Contains:
 - ✓ Enzymes
 - ✓ Nutrients
 - ✓ Ions
 - ✓ Ribosomes, plasmids, nucleoid
- Site of most metabolic activities
- No membrane-bound organelles



Bacterial Structures- Cell Envelope

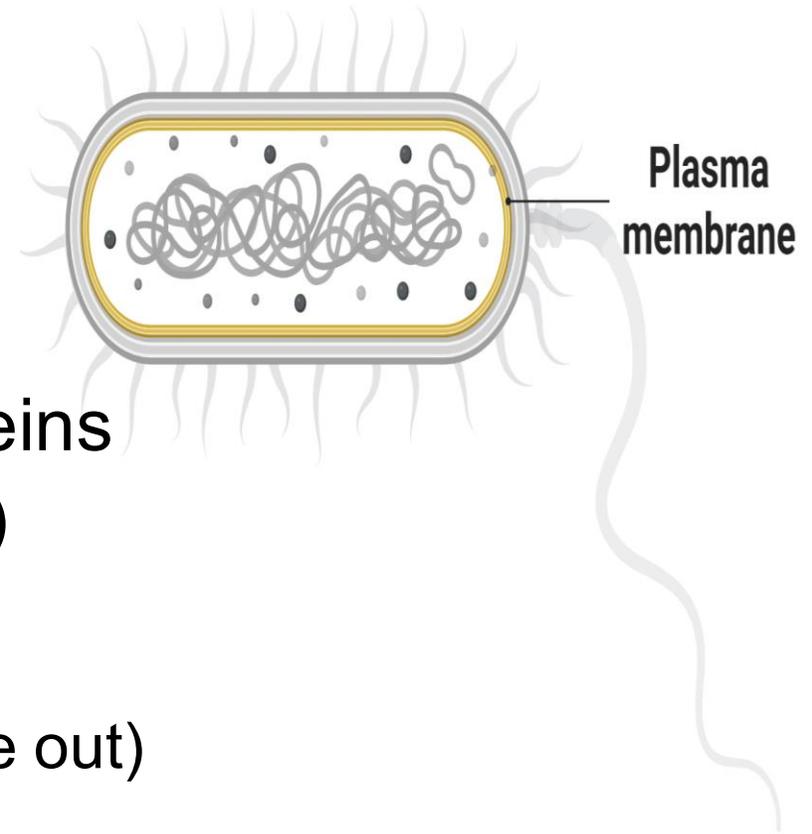
Cell envelope comprises:

- The cytoplasmic (inner) membrane
- The cell wall.
- In Gram-negatives also an outer membrane (with periplasm lies between the two membranes).

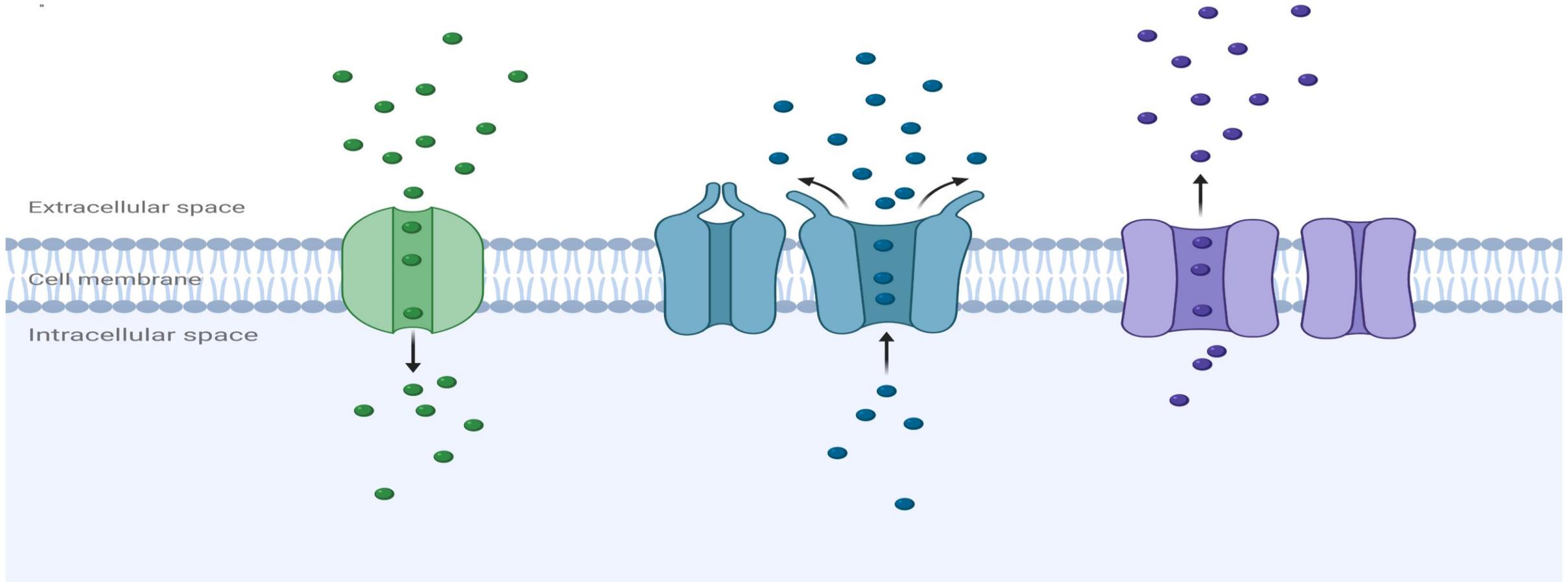


Bacterial Structures: Internal Structures- Cytoplasmic Membrane

- Location: Lies just beneath the cell wall
- Structure:
 - Phospholipid bilayer with embedded proteins
 - No sterols (unlike eukaryotic membranes)
- Functions:
 - ✓ Controls selective transport (nutrients in, waste out)
 - ✓ Site of respiration & ATP production
 - ✓ Hosts enzymes for cell wall synthesis
 - ✓ Involved in DNA replication and segregation

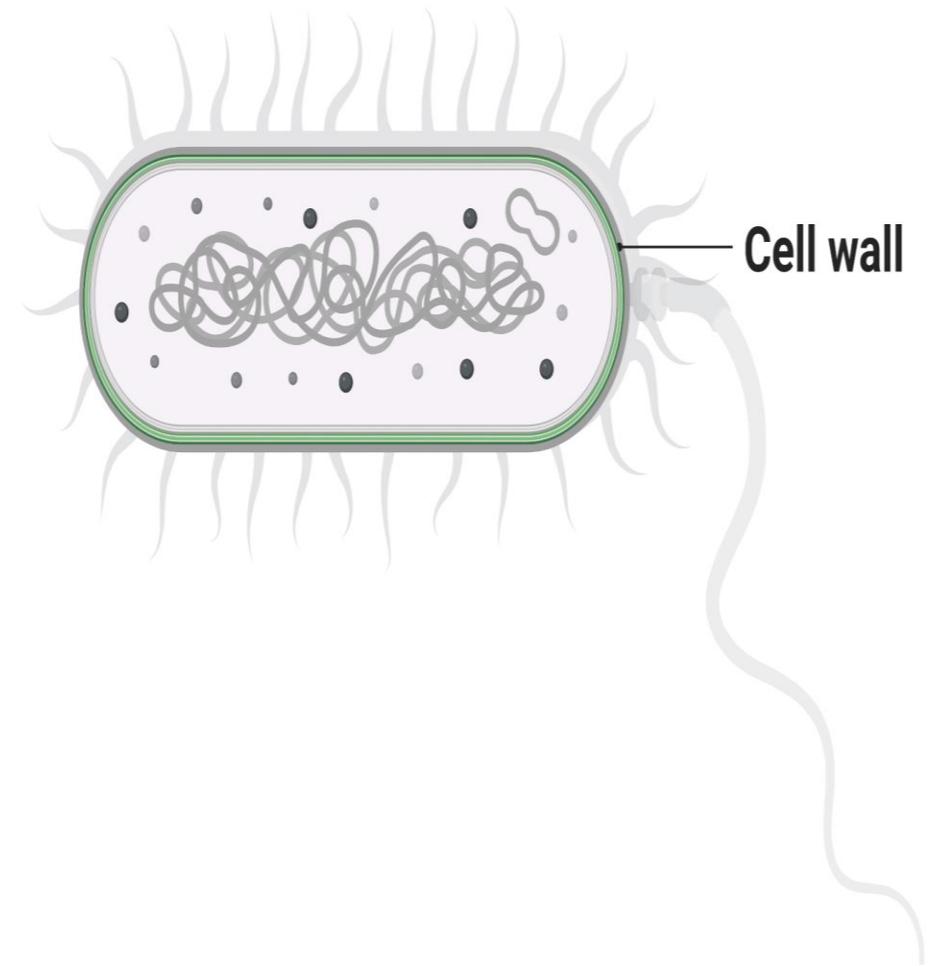


Bacterial Structures: Internal Structures- Cytoplasmic Membrane



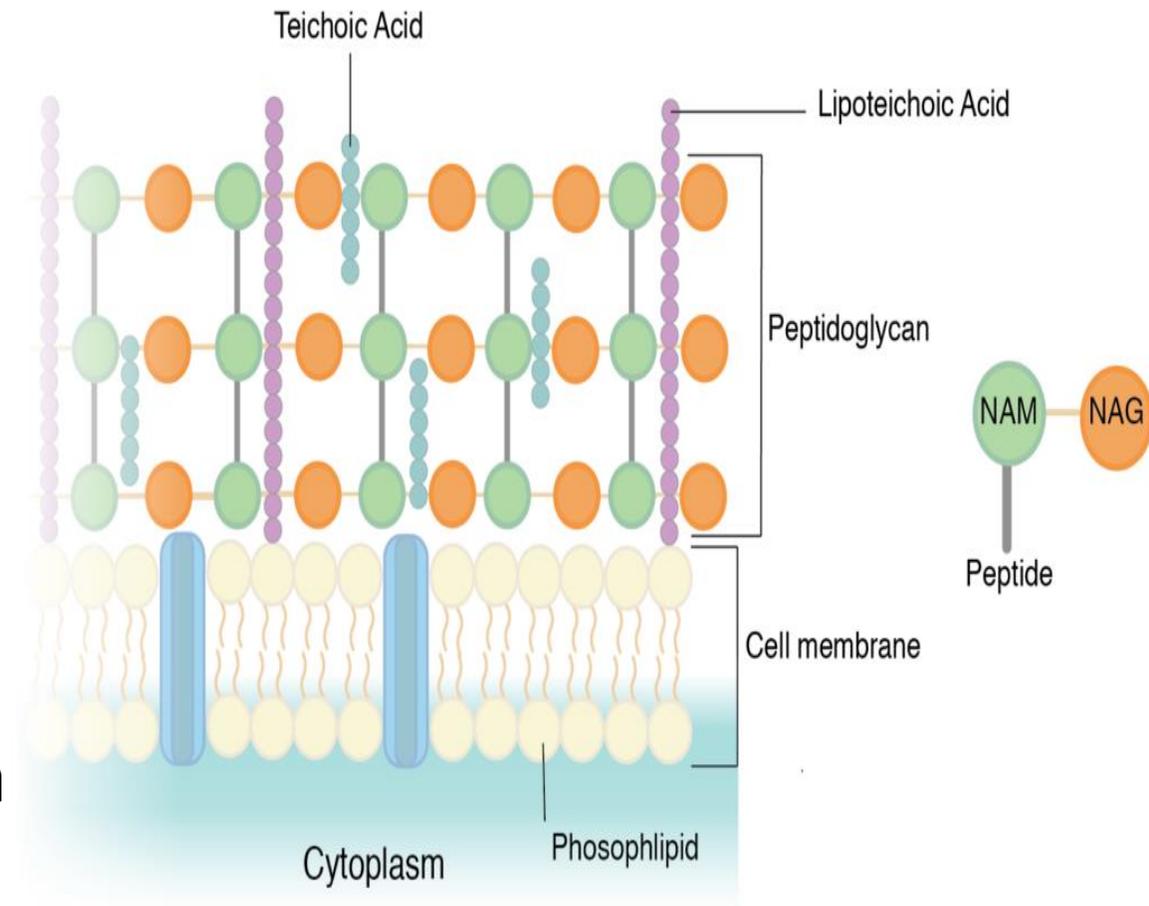
Bacterial Structures: Internal Structures- Cell Wall

- Rigid outer layer surrounding the cytoplasmic membrane
- Gives shape and protects against osmotic lysis



Bacterial Structures: Internal Structures- Cell Wall

- Composition:
 - Made of peptidoglycan (**unique to bacteria**)
 - Provides rigidity via sugar chains cross-linked by peptides
- Two major types:
 - Gram-positive: thick peptidoglycan
 - Gram-negative: thin peptidoglycan + outer membrane

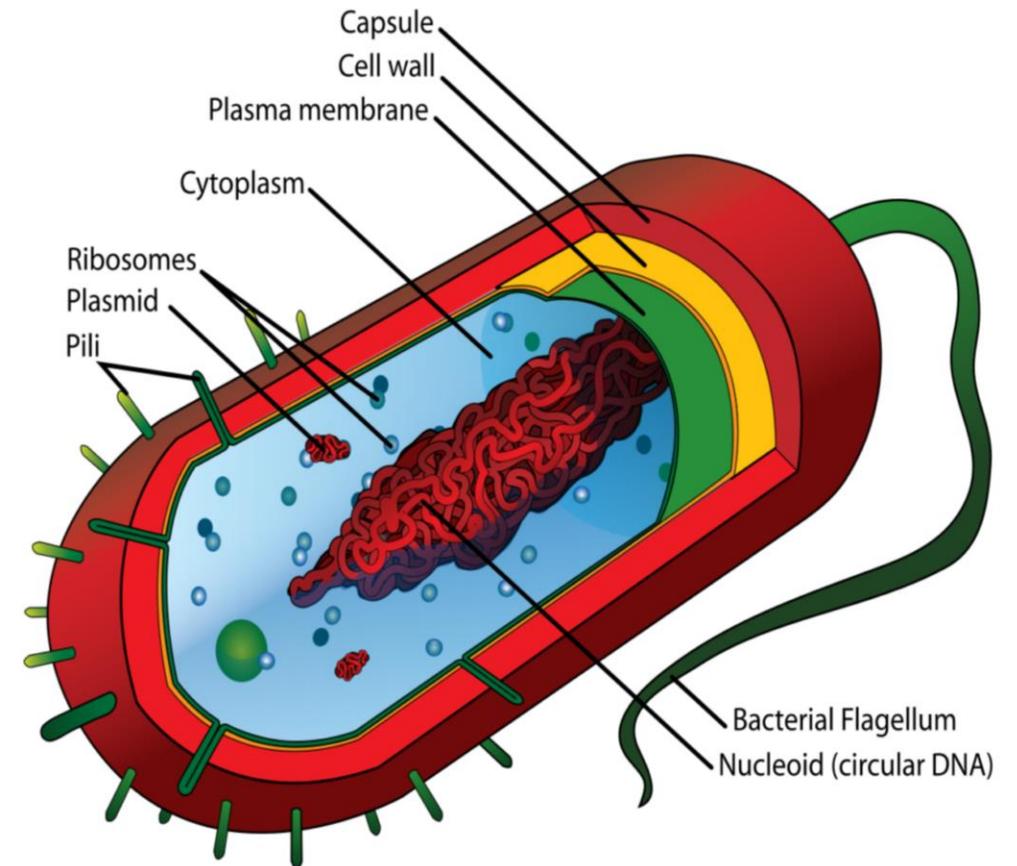


Gram Positive Bacteria Cell Wall

Bacterial Structure- External Structures

Extracellular Structures include:

- Capsule/slime layer
- Flagella
- Pili (fimbriae)
- Endospores



Bacterial Structure: External Structures- Capsule

- Outer coating made of polysaccharides (some polypeptides)
- Capsule: thick, well-organized
- Functions:
 - ✓ Protects against phagocytosis (immune evasion)
 - ✓ Promotes biofilm formation
 - ✓ Enhances virulence (as in *Streptococcus pneumoniae*)

Bacterial Structure: External Structures- Flagella

- Long, whip-like filaments anchored in the membrane
- **Function:** Motility — allows bacteria to swim toward nutrients or away from threats
- **Clinical note:** *Helicobacter pylori* uses flagella to colonize gastric mucosa

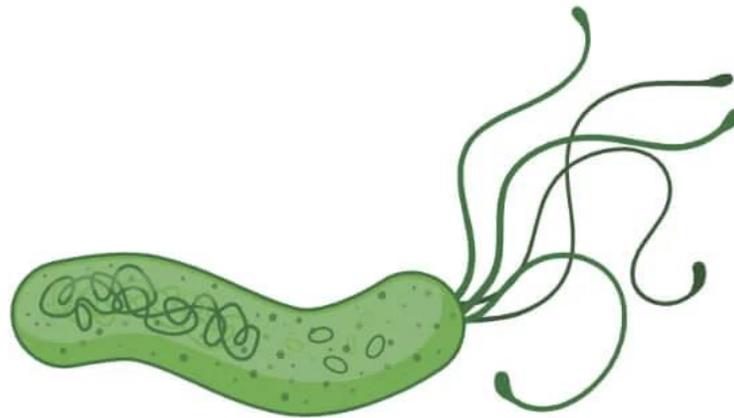
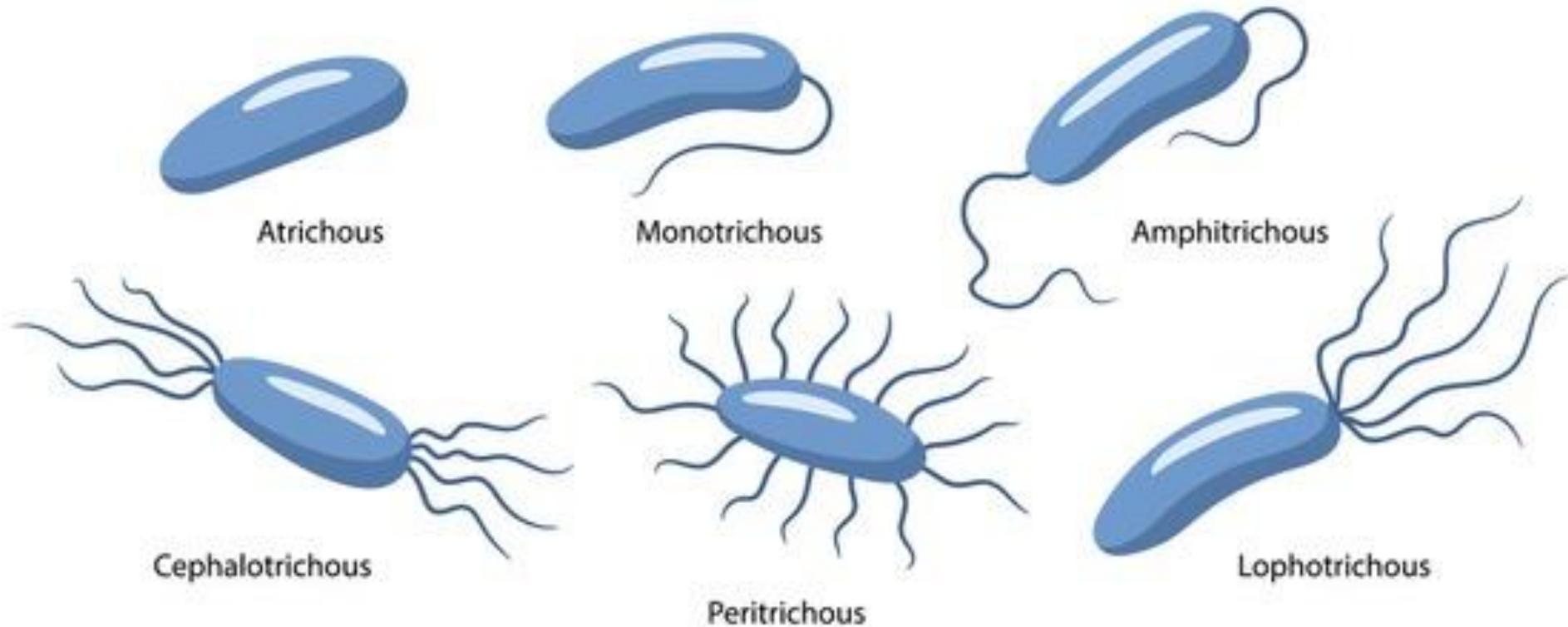


Figure: *Helicobacter pylori* flagella

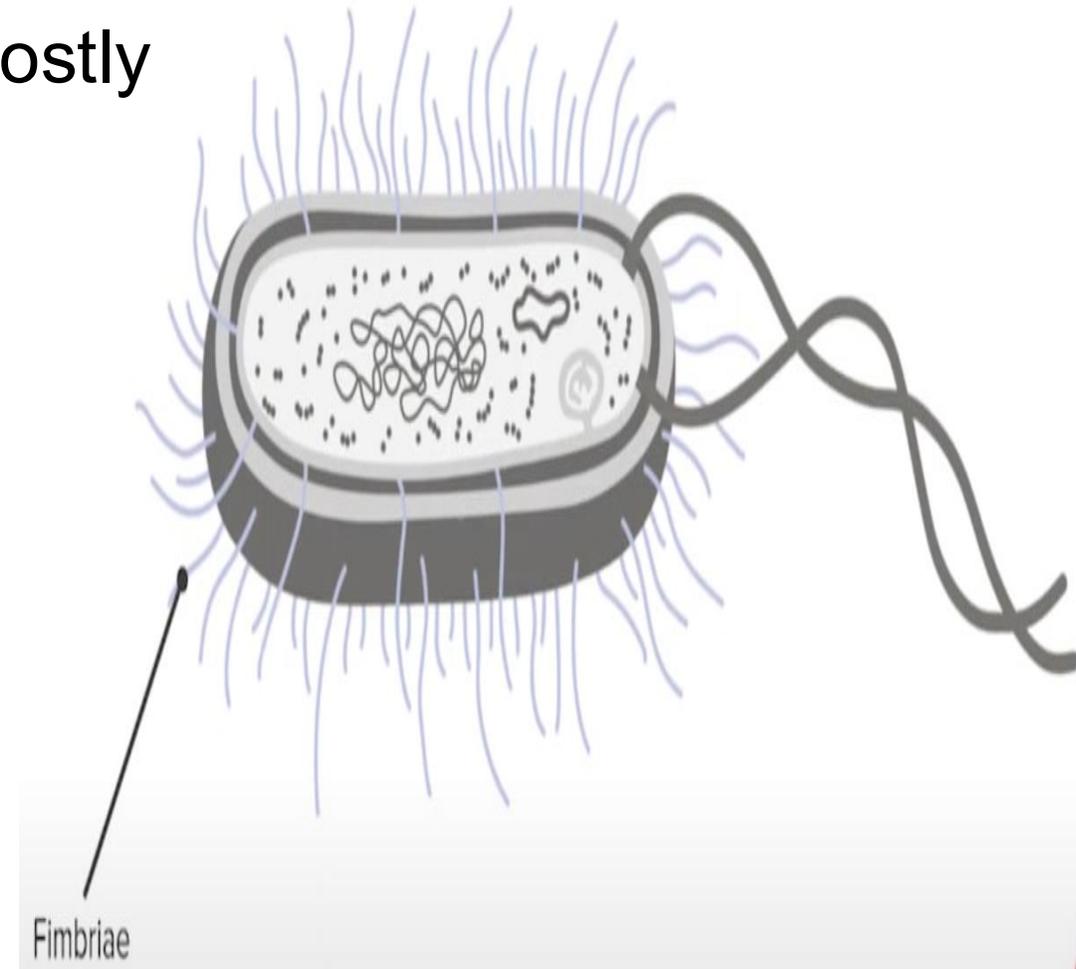
Bacterial Structure: External Structures- Flagella

Arrangement of bacterial flagelars



Bacterial Structure: External Structures- Common Pili (Fimbriae)

- **Short, thin, hair-like projections** (mostly Gram-negative bacteria)
- Composed of **pilin protein subunits**
- Usually **hundreds per cell**



Bacterial Structure: External Structures- Common Pili (Fimbriae)

◆ Main Functions:

- ✓ Adhesion to host cells, tissues, or medical devices
- ✓ Initiate colonizes and biofilm

◆ Clinical Relevance:

- Essential for pathogenesis (first step of infection)
- Examples: Uropathogenic *E. coli* – causes UTIs by attaching to bladder wall

Bacterial Structure: External Structures- Sex Pili

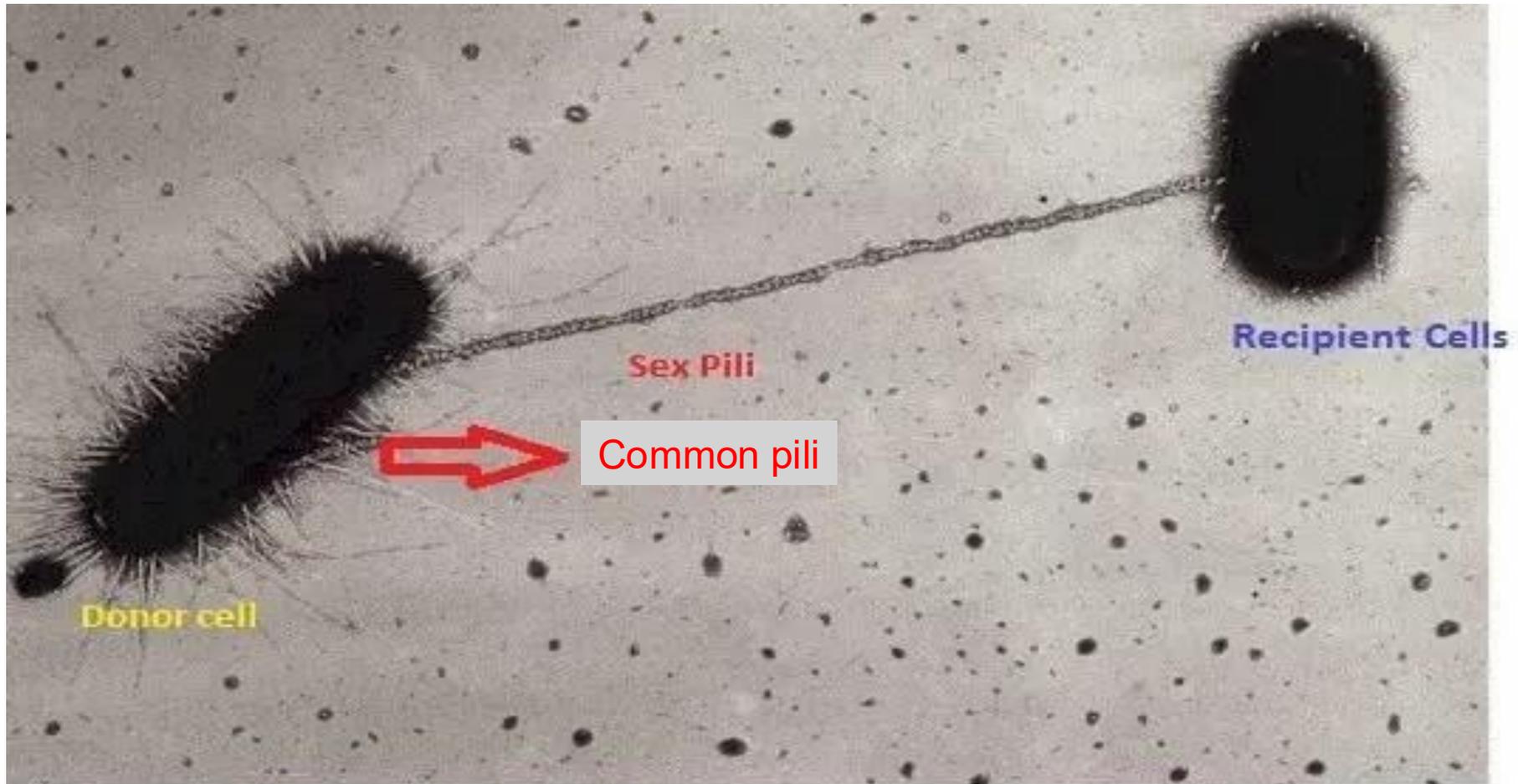
- **Longer, thicker, fewer** compared to common pili
- Encoded by genes on F plasmid (fertility plasmid)
- ◆ **Main Function:**
 - ✓ Mediate **bacterial conjugation**
 - ✓ Connects donor (F^+) and recipient (F^-) cells
 - ✓ Forms a **conjugation bridge** to transfer plasmid DNA



Clinical Relevance:

- Major driver of **horizontal gene transfer (HGT)**
- Promotes spread of **antibiotic resistance genes**

Bacterial Structure: External Structures- Sex Pili



Bacterial Structure: Endospores

- Under stressful conditions (e.g., nutrient depletion, heat, or dehydration), some Gram-positive bacteria can transform **from an active, growing (vegetative) cell into a highly resistant, dormant structure** called an **endospore**.

 Not a form of reproduction — this is purely a **survival mechanism**

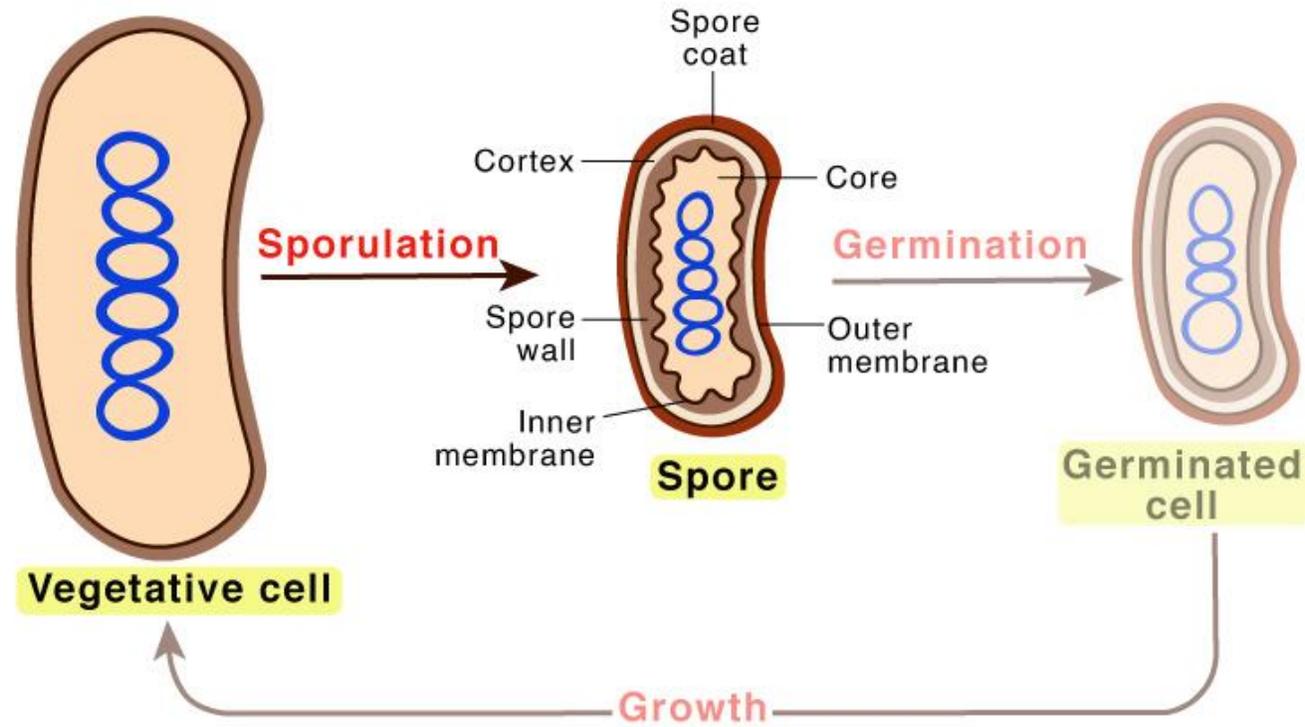
Why So Important?

- Endospores can survive:
 - ✓ Extreme heat
 - ✓ Drying
 - ✓ Radiation
 - ✓ Chemicals, disinfectants
- Remain viable for **decades in harsh environments**

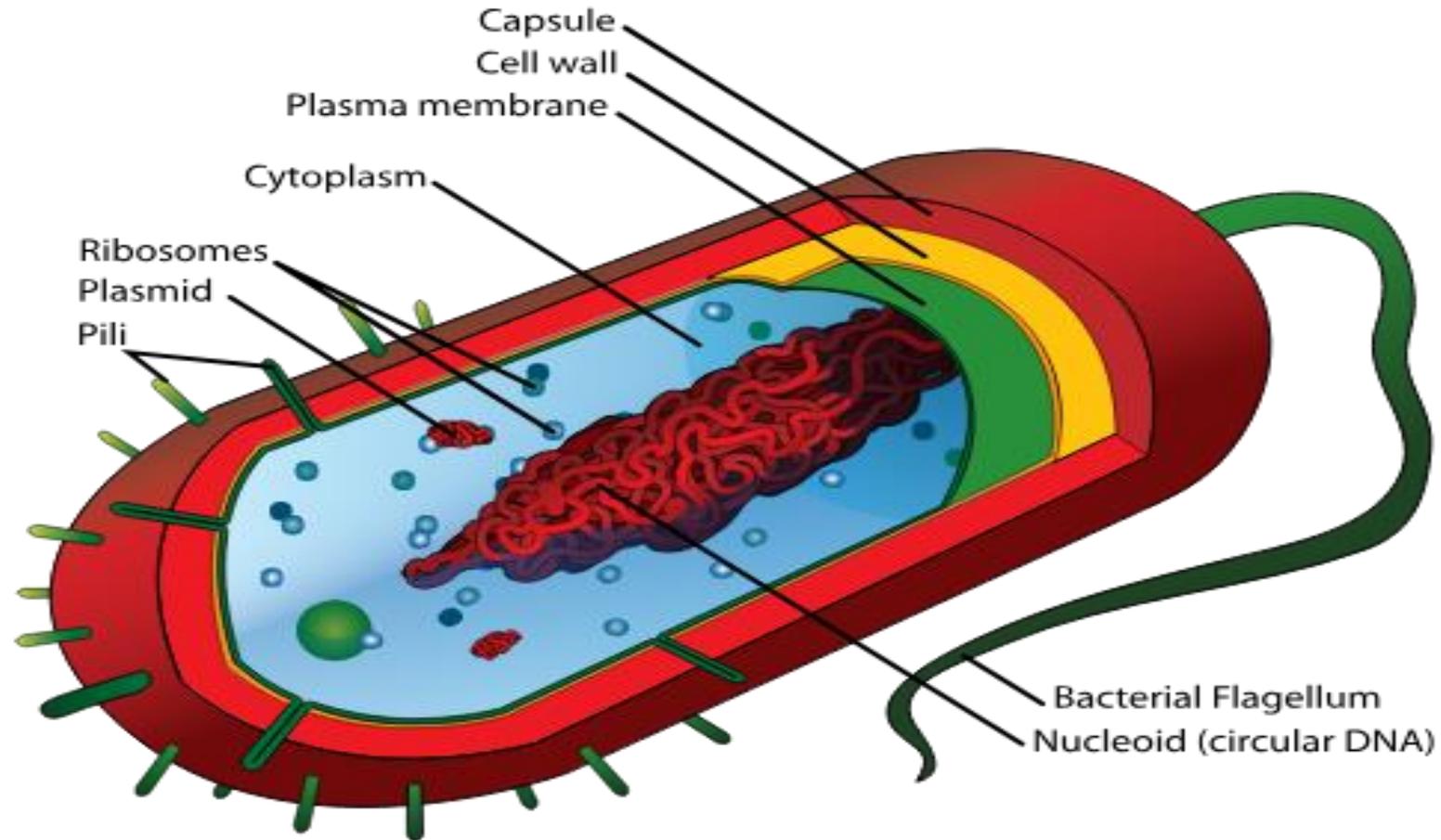
Bacterial Structure: Endospores

Sporulation

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Summary:



THANK YOU

ANY QUESTIONS?

