Department of biology

2025-2026

((MICROBIOLOGY))

Stage (2)

LEC- ((4))

Bacterial cell structure

By

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STRUCTURE OF BACTERIA

- Smaller and simpler in structure than eukaryotic cells, with no recognizable organelles.
- The small size, simple design, and broad metabolic capabilities of bacteria allow them to grow and divide very rapidly and to inhabit and flourish in almost any environment.
- They were first seen under a microscope by Anton van Leeuwenhoek in 1676.
- As microscopes have improved, scientists have come to understand bacterial cell structure better.

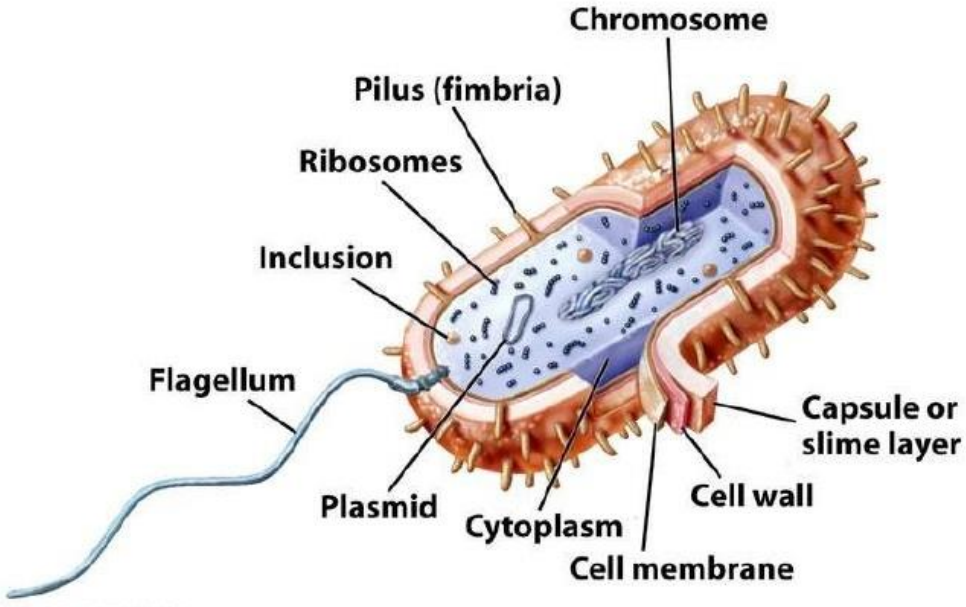

Figure 4-3 Microbiology, 6/e
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Bacterial cell structure

- organized into 3 categories:
- **Internal Structures**: Cytoplasm, nucleoid, bacterial chromosome, plasmid, ribosomes, and storage granules
- **Cell envelope**: cell membrane, peptidoglycan cell wall or an **outer lipid membrane** (only found in Gram-negative cells)
- **External structures** (appendages & coverings): flagella, fimbriae, sex pilus and glycocalyx.

Intracellular structures

- **Cytoplasm**
- **Chromosome**
- **Plasmid**
- **Ribosomes**
- **Inclusion bodies**

The nucleoid

- The genetic material of prokaryotes lacks a surrounding nuclear membrane.
- The nucleoid or bacterial chromosome comprises a closed circle of double stranded DNA, many times the length of the cell and highly folded and compacted.
- The DNA may be associated with certain bacterial proteins.

- Some bacteria contain additional DNA in the form of small, self-replicating extrachromosomal elements called plasmids. These do not carry any genes essential for growth and reproduction, and thus the cell may survive without them.
- Not all bacteria conform to the model of a single circular chromosome; some have been shown to possess two with genes shared between them, while examples of linear chromosomes are also known.

Cytoplasm

- Portion of the cell that lies within the PM
- substances within the plasma membrane, excluding the genetic material.
- Gel-like matrix composed of mostly water(4/5 th), enzymes, nutrients, wastes, and gases.
- Contains cell structures - ribosomes, chromosome, and plasmids , as well as the components necessary for bacterial metabolism.
- It is relatively featureless by electron microscope - although small granules can be seen.
- carries out very important functions for the cell - **growth, metabolism, and replication .**

Constituents

- Proteins including enzymes
- Vitamins
- Ions
- Nucleic acids and their precursors
- Amino acids and their precursors
- Sugars, carbohydrates and their derivatives
- Fatty acids and their derivatives

Ribosomes

- They are composed of a complex of protein and RNA, and are the site of protein synthesis in the cell. They are measured in Svedberg units (S).
- Although they carry out a similar function, the ribosomes of prokaryotic cells are smaller and lighter than their eukaryotic counterparts.
- All ribosomes comprise two unequal subunits; each subunit contains its own RNA and a number of proteins.

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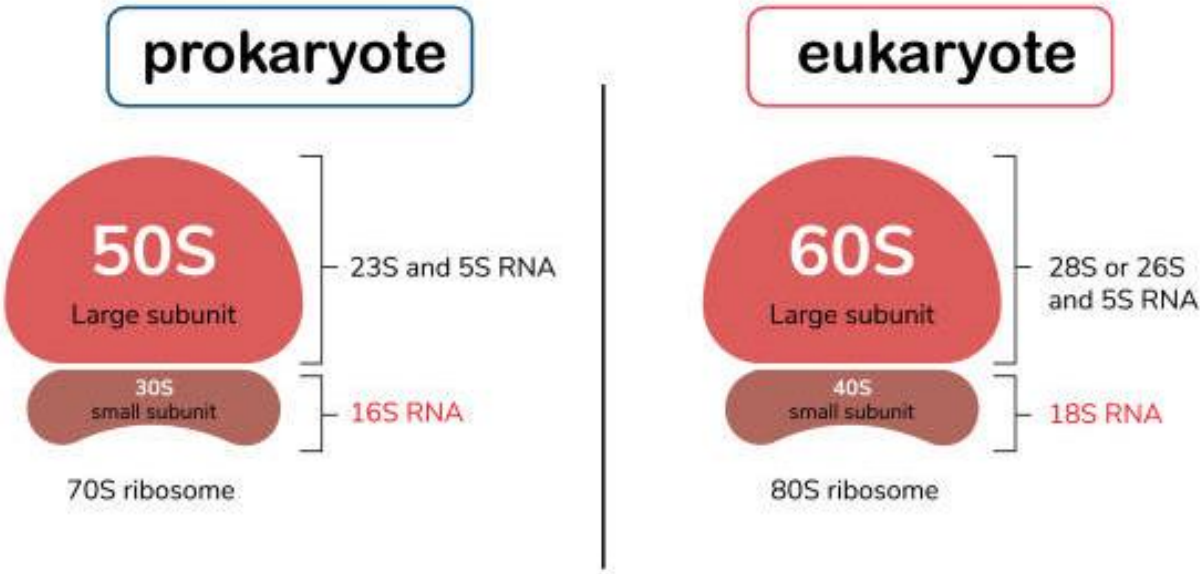
ribosomal RNA (rRNA) subunit



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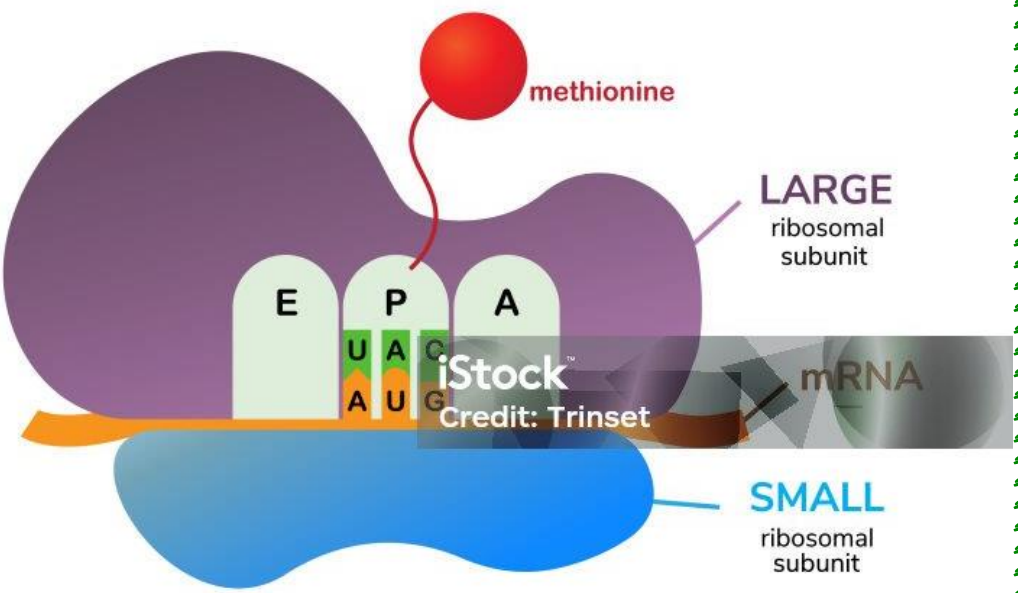
Structure of Ribosome

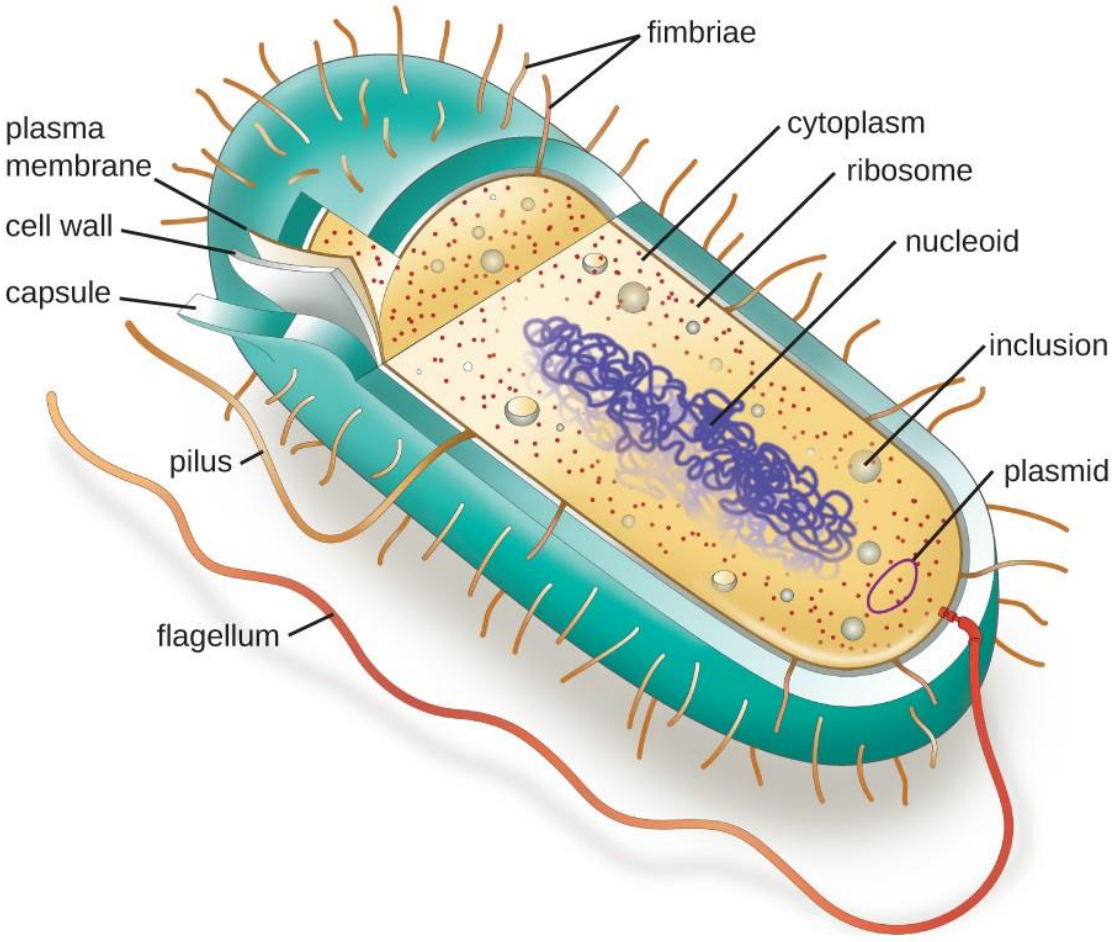
Ribosome
have two component;
LARGE subunit
SMALL sub unit

tRNA binding sites;
E: Exit
P: Peptidyl-tRNA
A: Aminoacyl-tRNA



Inclusion bodies

- **Inclusion bodies:** Bacteria can have within their cytoplasm a variety of small bodies collectively referred to as inclusion bodies.
- Some are called **granules** and other are called **vesicles**.
- **Inclusions** are considered to be nonliving components of the cell that do not possess metabolic activity and are not bounded by membranes.
- The most common inclusions are **glycogen, lipid droplets, crystals, and pigments.**



Inclusion bodies – Granules

- **Granules:** Densely compacted substances without a membrane covering.
- Nutrients and reserves may be stored in the cytoplasm in the form of glycogen, lipids, polyphosphate, or in some cases, sulfur or nitrogen for later use.
- Each granule contains specific substances, such as glycogen (glucose polymer) and polyphosphate (phosphate polymer, supplies energy to metabolic processes).
- Sulfur bacteria contains reserve granules of sulfur.
- These granules are depleted in starvation.

Inclusion bodies-vesicles

- Some aquatic photosynthetic bacteria and cyano bacteria have rigid gas-filled vacuoles and it helps in floating at a certain level - allowing them to move up or down into water layers with different light intensities and nutrient levels.
- Some magnetotactic bacterium, eg. Aquaspirillium magnetotacticum , stores Magnetitite (Ferric oxide). The presence of such magnetic inclusions enables these bacteria to responds to magnetic fields.

Microcompartments

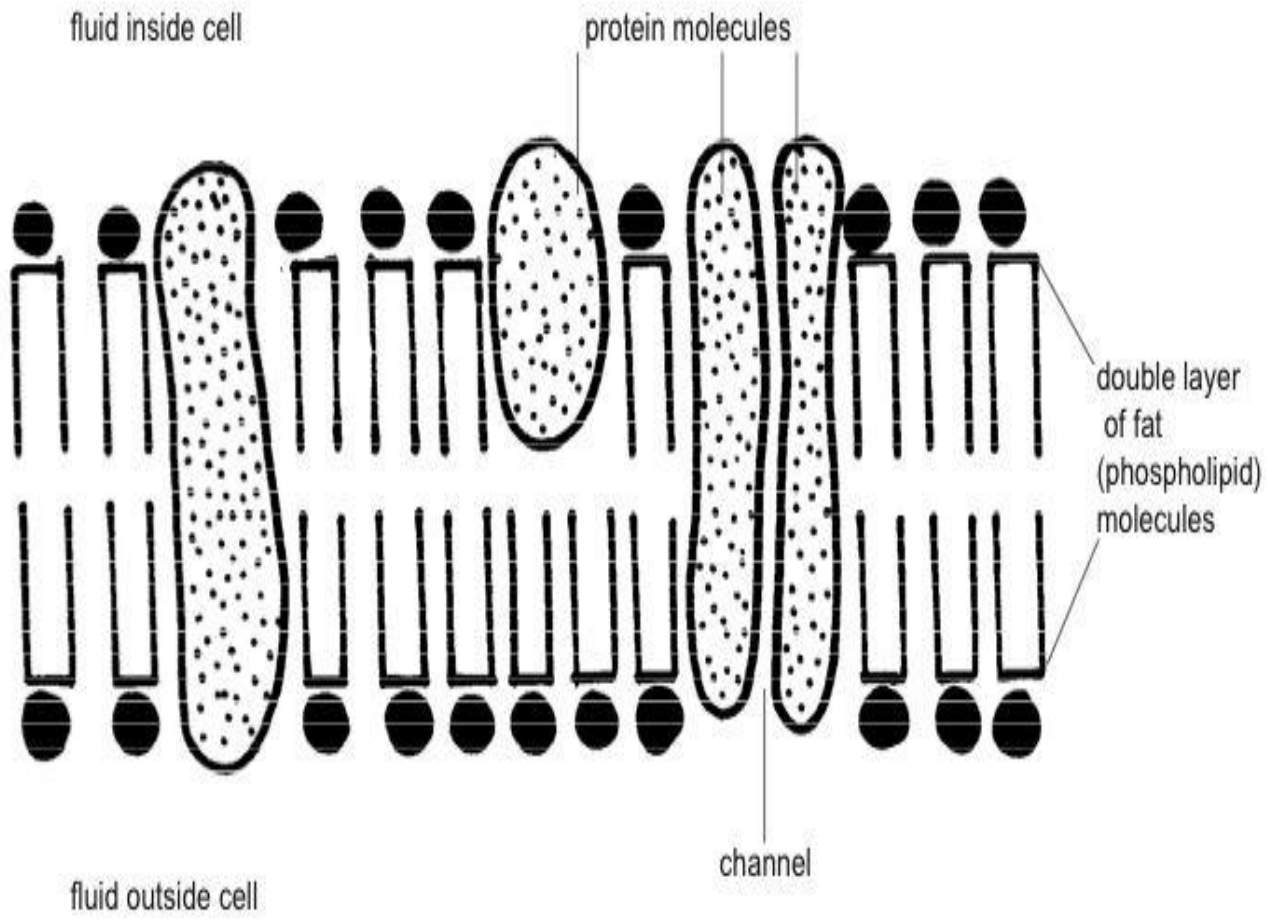
- Microcompartments are widespread, membrane-bound organelles that are made of a protein shell that surrounds and encloses various enzymes.
- **Carboxysomes** are protein-enclosed bacterial microcompartments that contain enzymes involved in carbon fixation.
- **Magnetosomes** are bacterial microcompartments, present in magnetotactic bacteria, that contain magnetic crystals.

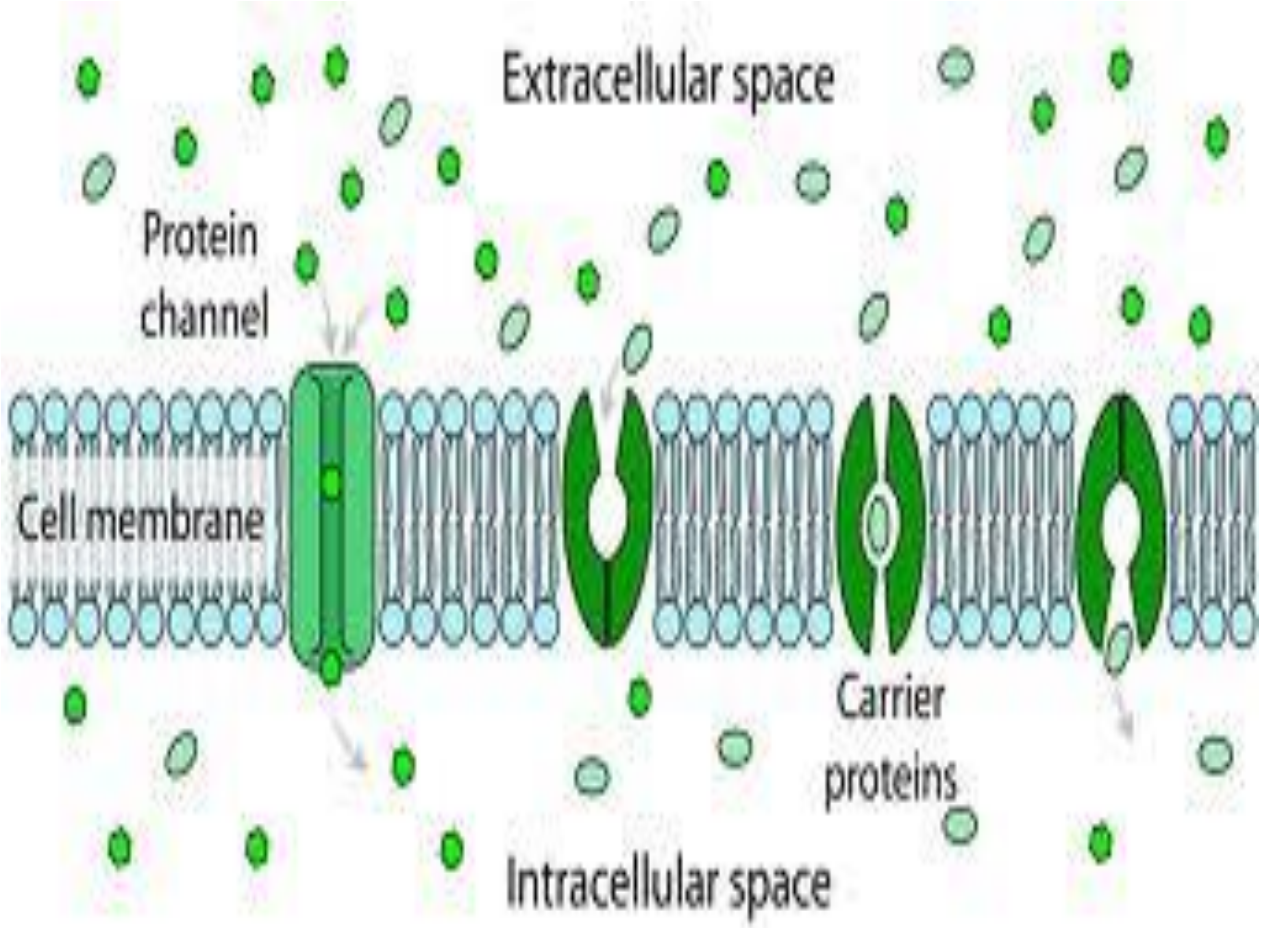
Cell Envelope

- Plasma Membrane
- Periplasmic Space
- Cell Wall
- Outer membrane

Plasma Membrane

- Phospholipid bilayer surrounding the cytoplasm and regulates the flow of substances in and out of the cell.
- Consists of both lipids and proteins.
- Protects the cell from its surroundings.
- Selectively permeable to ions and organic molecules and controls the movement of substances in and out.
- numerous proteins moving within or upon this layer are primarily responsible for transport of ions, nutrients and waste across the membrane.


fluid inside cell
protein molecules
double layer of fat (phospholipid) molecules
channel
fluid outside cell


Extracellular space
Protein channel
Cell membrane
Carrier proteins
Intracellular space

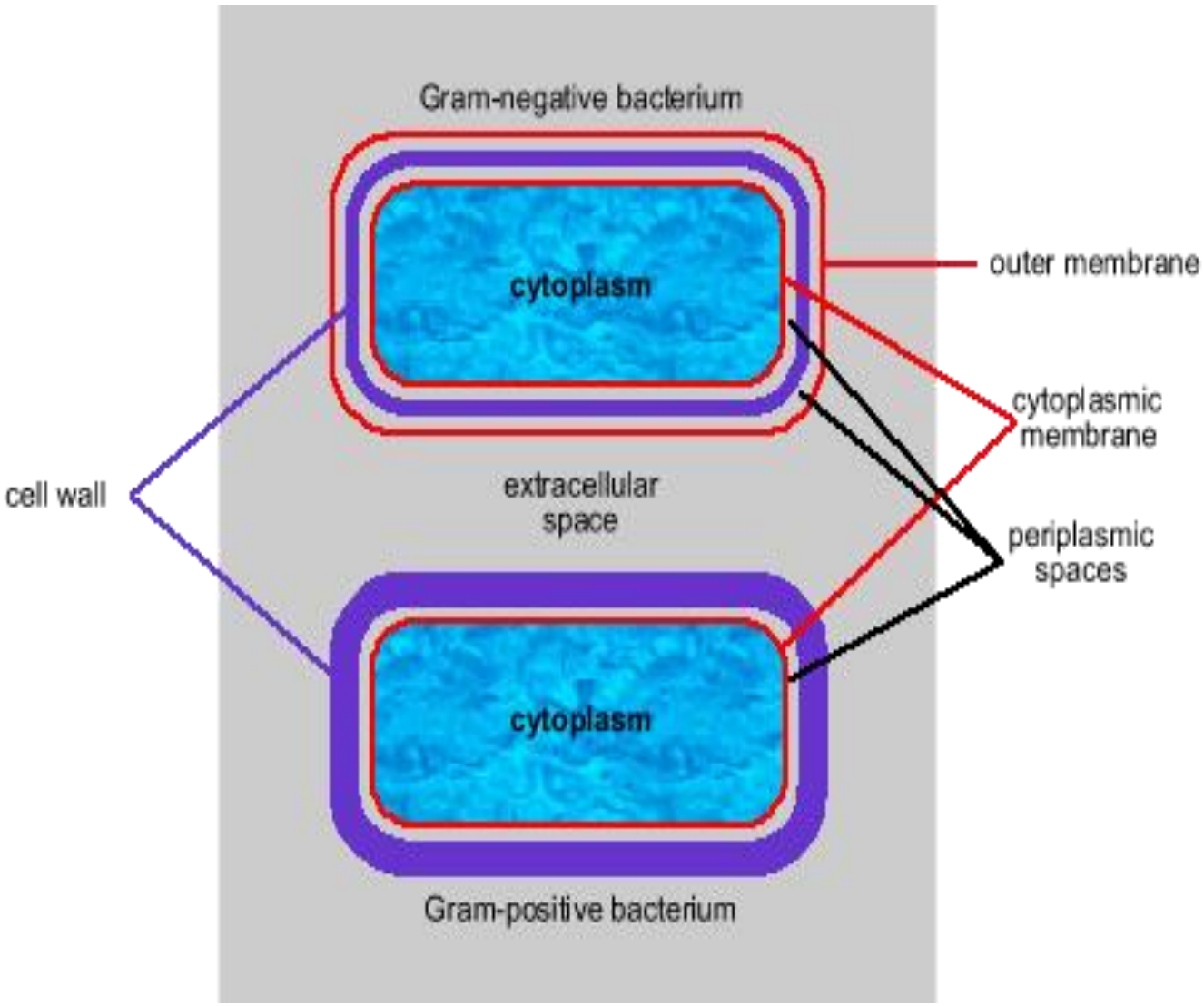
Periplasmic space

- **Gram-negative bacteria** : space between the cytoplasmic membrane and the cell wall and space found between cell wall and the outer membrane
- Periplasm may constitute up to 40% of the total cell volume in G-ve species.
- **Gram-positive bacteria** : space between the cytoplasmic membrane and the cell wall.

The periplasm is filled with water and proteins and is reminiscent of the cytoplasm.

Periplasmic Space

- However periplasm contains proteins and other molecules distinct from those in the cytoplasm because the membrane prevents the free exchange between these two compartments.
- Periplasmic proteins have various functions in cellular processes including: transport, degradation, and motility.
- Periplasm controls molecular traffic entering and leaving the cell.


Gram-negative bacterium
cytoplasm
outer membrane
cytoplasmic membrane
cell wall
extracellular space
periplasmic spaces
cytoplasm
Gram-positive bacterium