

Prokaryotic Cells

Tishk International University,
Education Faculty, Biology Dept,
Cell Biology, 1st Semester/W2

Outline

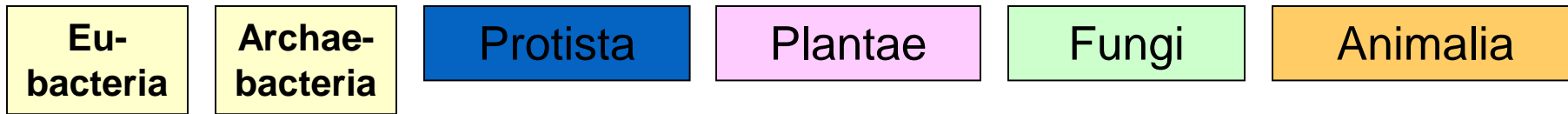
- Classification of organisms
- Prokaryotic cells
- Eukaryotic cells
- Difference between pro and eukaryotic cells

Classification

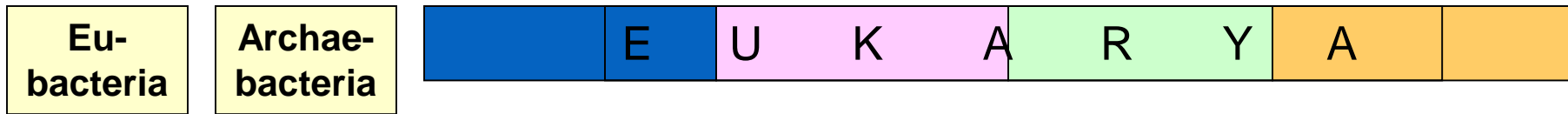
Five kingdom system:



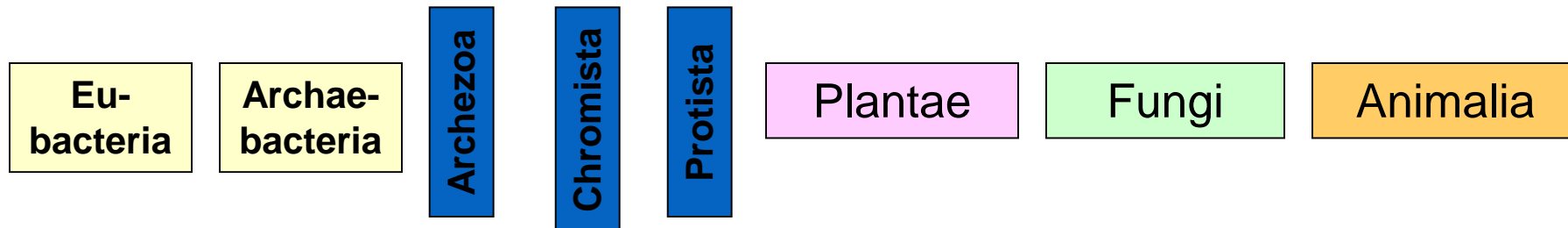
Six kingdom system:



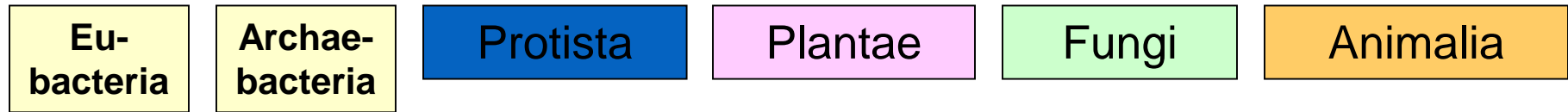
Three domain system:






Eight kingdom system:



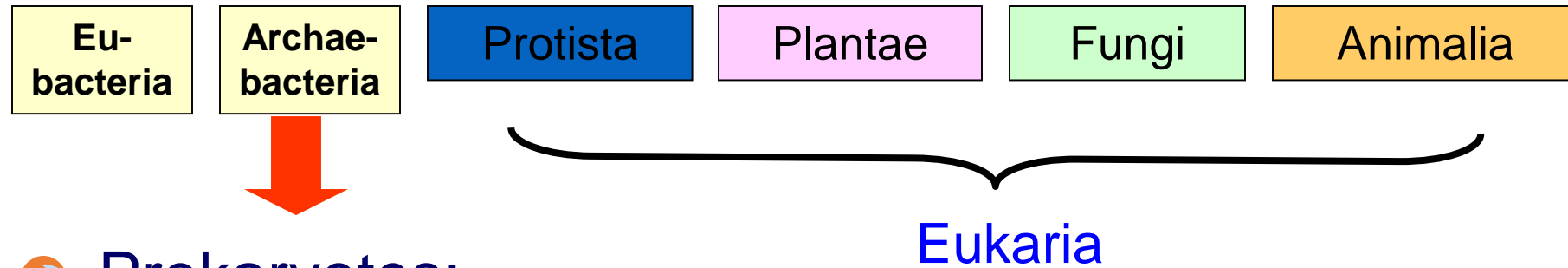
Kingdom Eubacteria



Prokaryotes:

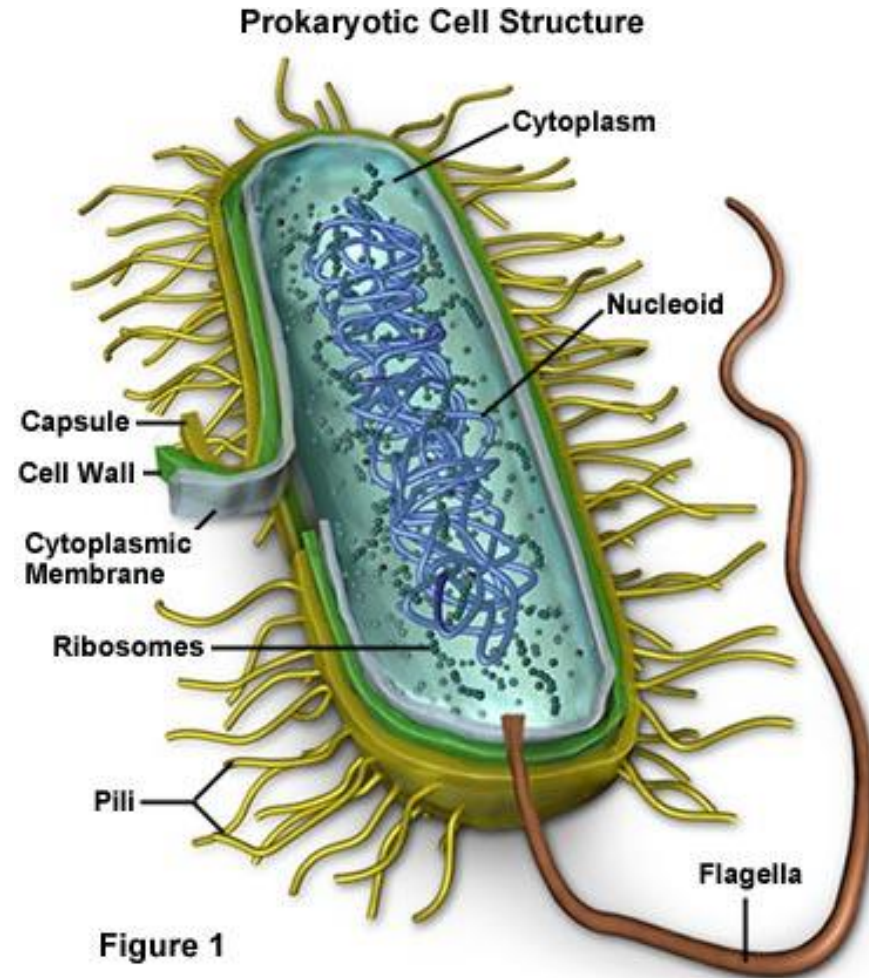
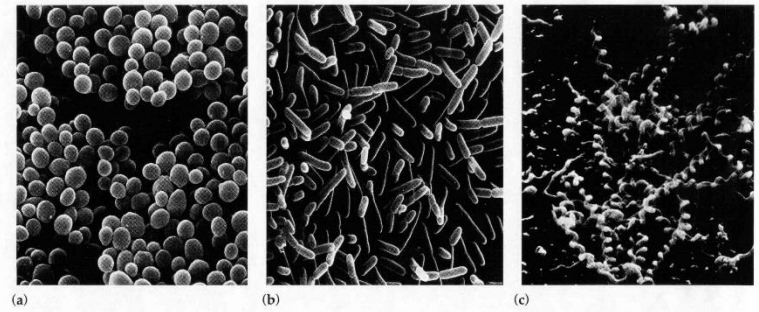
- No true nucleus
- No membrane-bound organelles
-  Cell Wall composed of peptidoglycan
-  Reproduce asexually by budding and fission
-  Very small (1 - 10 μm)

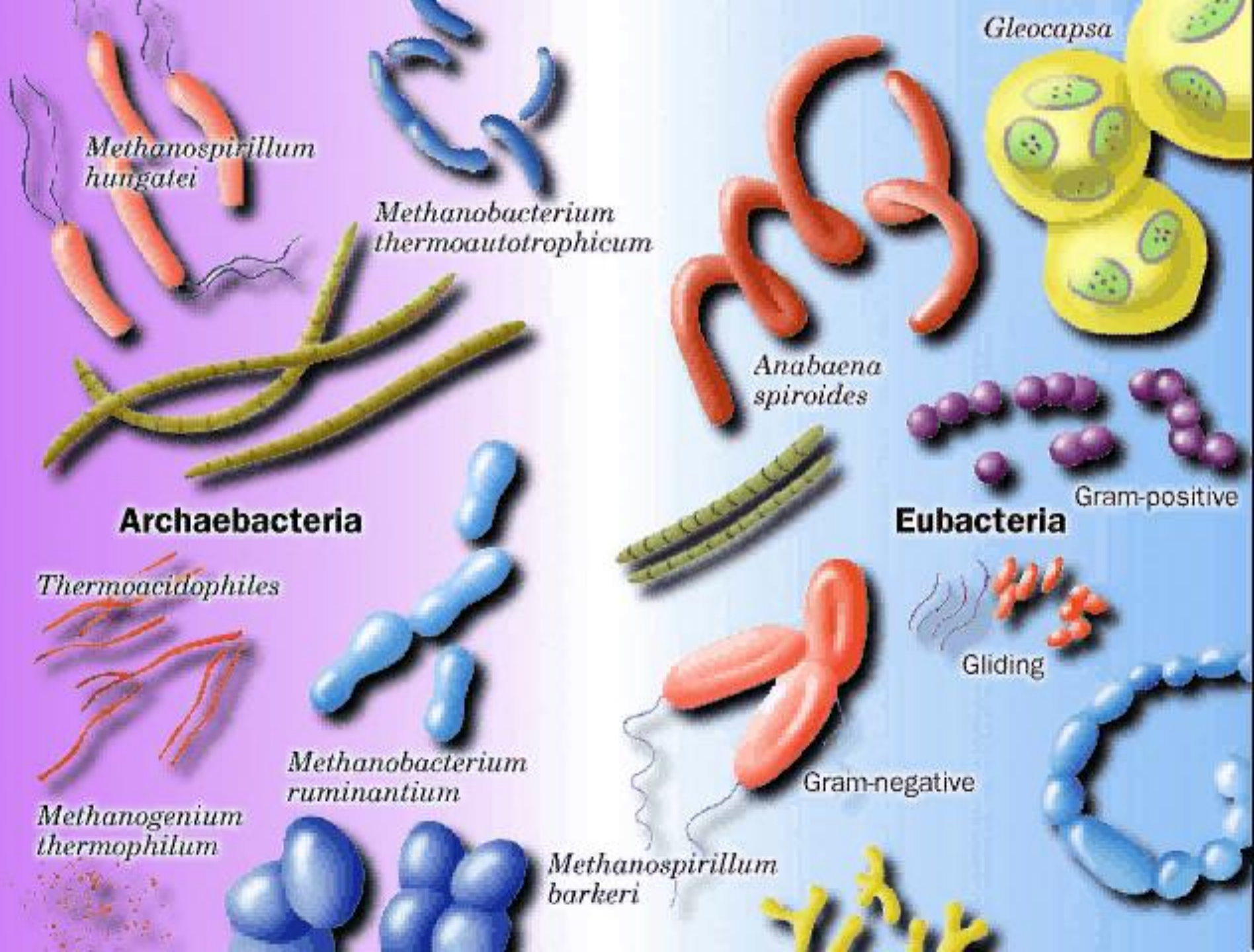
Kingdom Archaeobacteria



- Prokaryotes:
 - No true nucleus
 - No membrane-bound organelles like mitochondria or chloroplasts
- NO peptidoglycan in cell wall
- Reproduce asexually by budding and fission
- Very small (1 - 10 μm)
- “Extreme” environments (high temperatures)

Prokaryotic Cells





Methanospirillum hungatei

Methanobacterium thermoautotrophicum

Gleocapsa

Anabaena spiroides

Archaebacteria

Eubacteria

Thermoacidophiles

Gram-positive

Methanogenium thermophilum

Methanobacterium ruminantium

Gliding

Gram-negative

Methanospirillum barkeri

Eukaryotes



- Eukaryotes:
 - True nucleus
 - Membrane-bound organelles
- Cell size generally 10 - 100 μm
- At least 4 lineages:
- Protista, Plantae, Fungi, Animalia

Cells

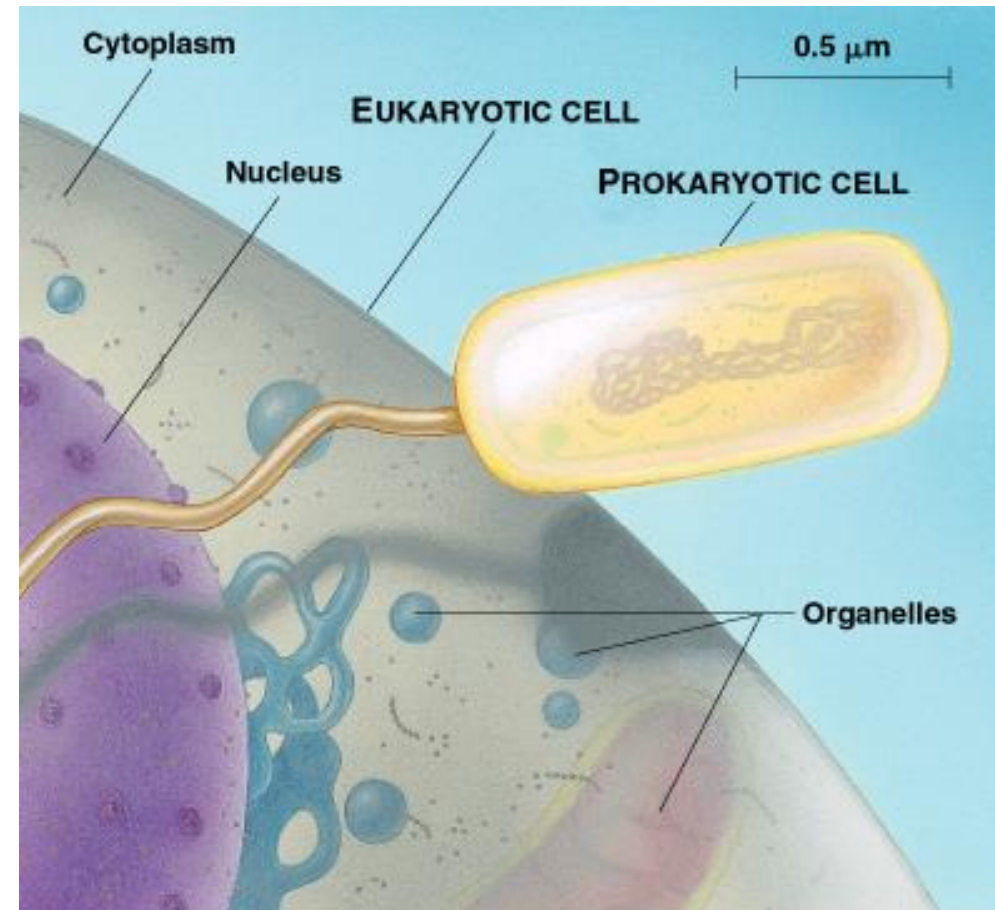
Two fundamental types:

Prokaryotic

- No Nucleus
- No organelles
- Small 100nm-5um

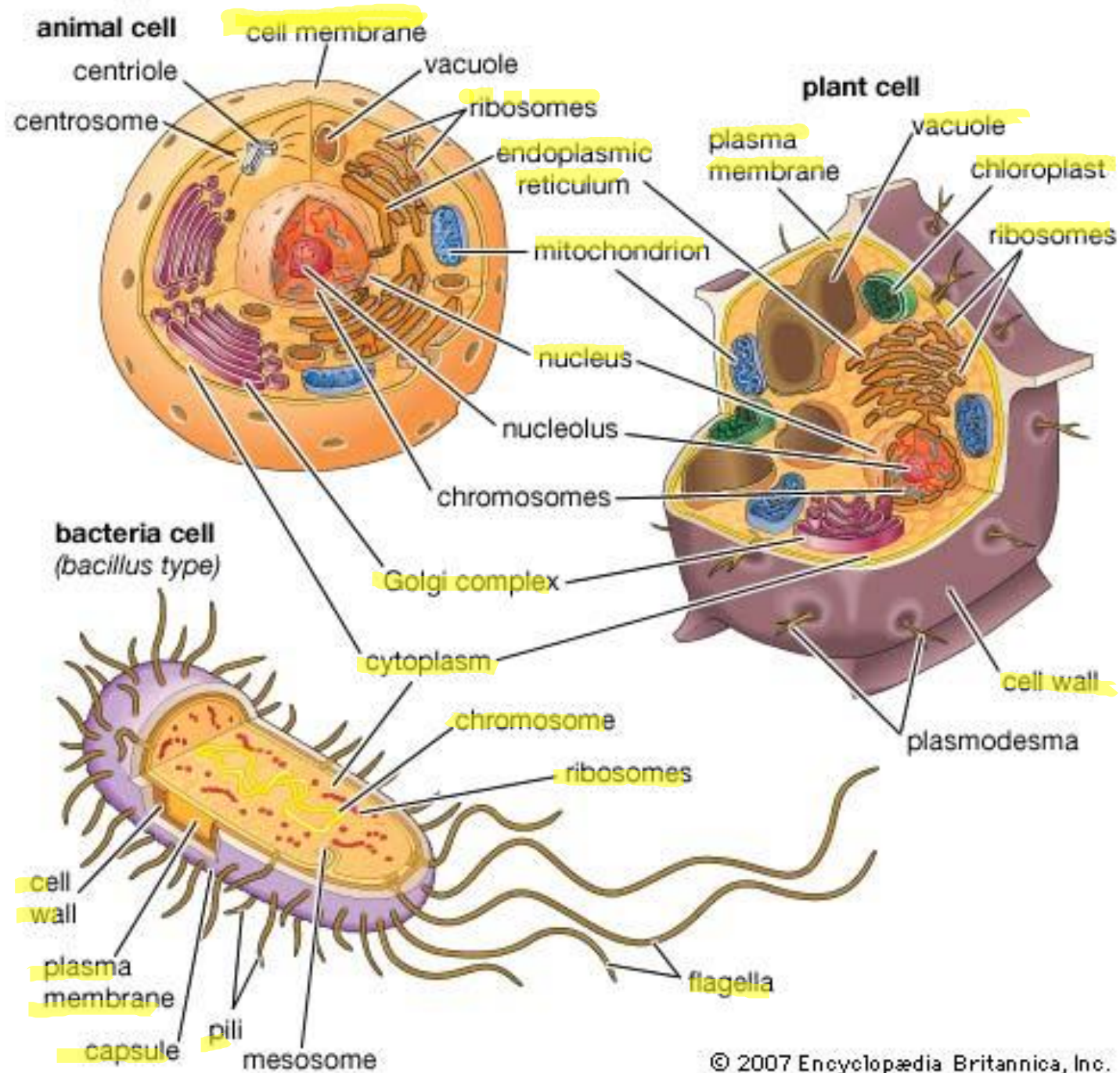
Eukaryotic

- True Nucleus
- Membrane bound organelles
- 10-100um
- Some are larger



Characteristics	Prokaryotic Cells	Eukaryotic Cells
Cell wall	Complex composition in layers, typically contains peptidoglycan	Composition is simple, peptidoglycan not found
Plasma membrane	No carbohydrates or sterols	Contains carbohydrates and sterols
Glycocalyx	Present as capsule or slime layer	Present in cells that lack cellwall
Cell organelles	None. Only some inclusion bodies are present	ER, golgi body, lysosomes, mitochondria, lysosomes
Nucleus	Not well defined, without any nuclear membrane or nucleoli	Well defined nucleus present, with nuclear membrane and nucleus
Chromosome	Single circular chromosome present as nuclear material without histones	Multiple linear chromosomes found with histones
Ribosomes	70S	80S
Cell division	Binary fission	Mitosis and meiosis

Some typical cells



Prokaryotic Cells

- **Prokaryotic cells** lack a membrane-bound nucleus. Genetic material is present in the **nucleoid**
- There are four main structures shared by all prokaryotic cells, bacterial or archaean:
 - The plasma membrane
 - Cytoplasm
 - Ribosomes
 - Genetic material (DNA and RNA)
- Some prokaryotic cells also have other structures like the **cell wall**, **pili** (singular "pillus"), and **flagella** (singular "flagellum"). Each of these structures and cellular components plays a critical role in the growth, survival, and reproduction of prokaryotic cells.

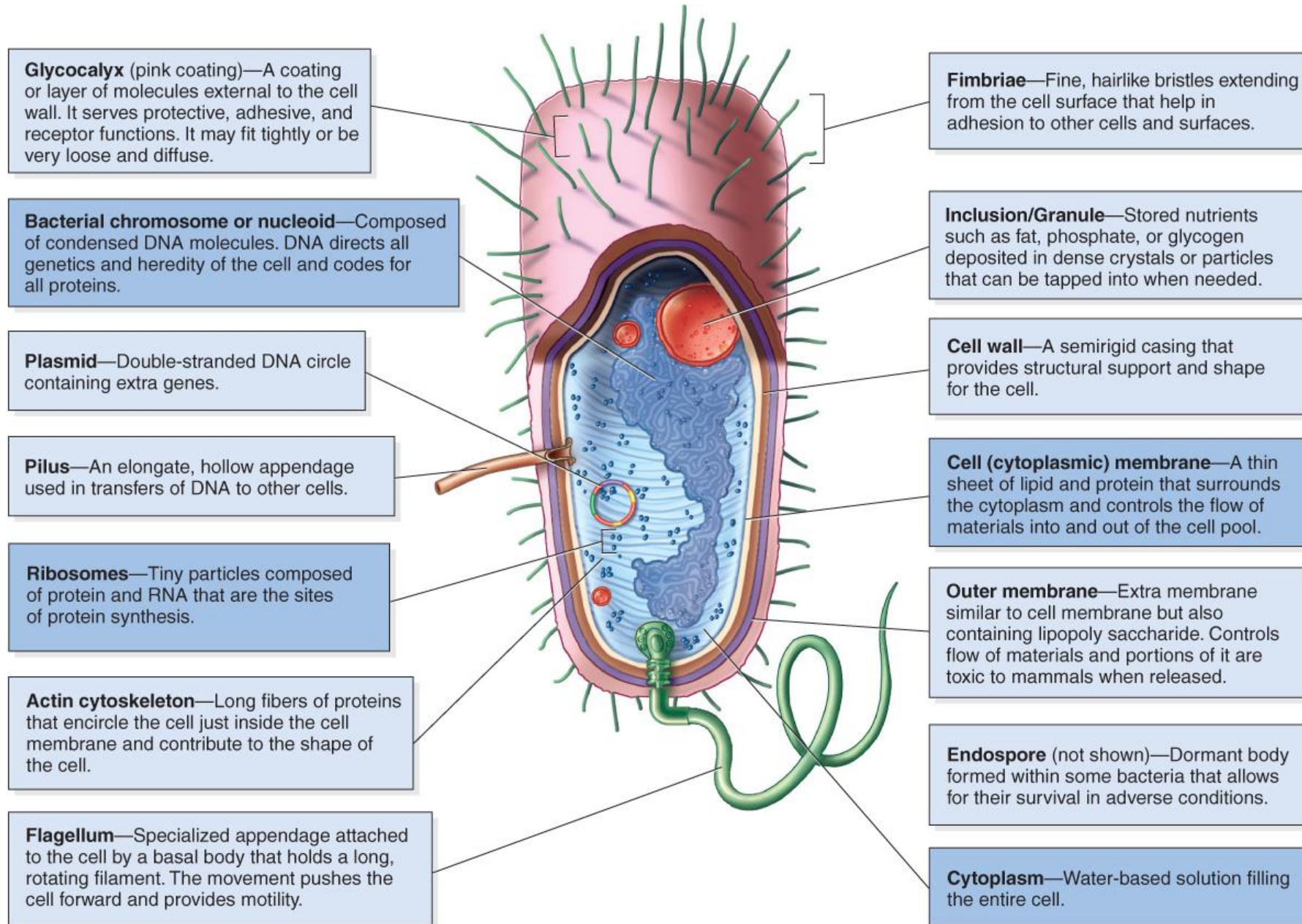


Figure 4.1

Prokaryotes

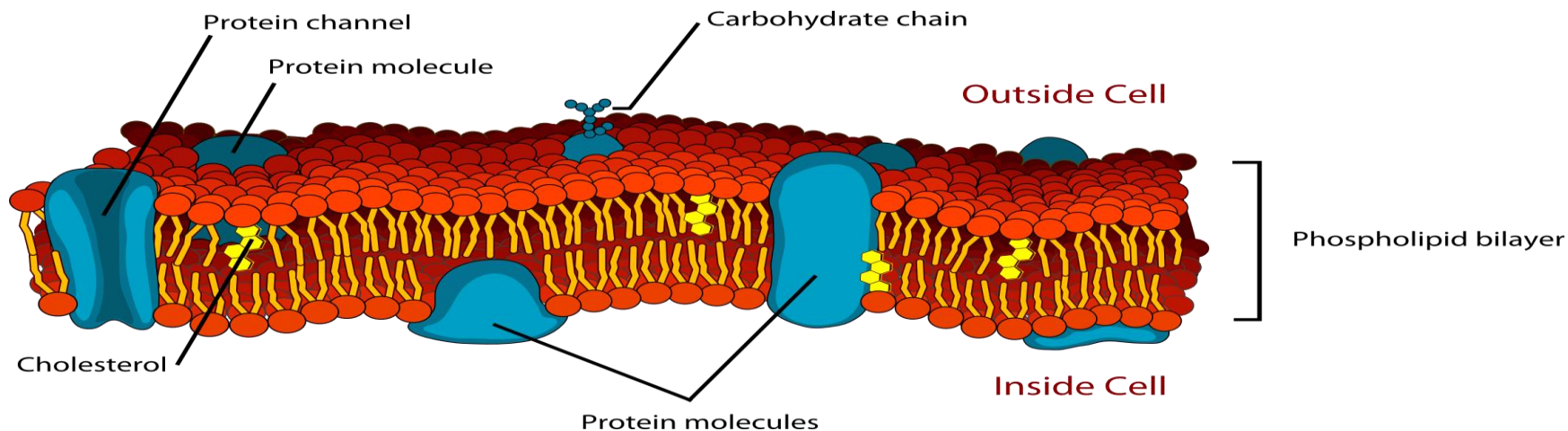
- **Plasma membrane:**

Separates the cell from its environment.

Phospholipid molecules oriented so that hydrophilic phosphate heads directed outward and hydrophobic tails directed inward.

Proteins embedded in two layers of lipids (lipid bilayer).

Proteins allow substances to pass into out of the cell.

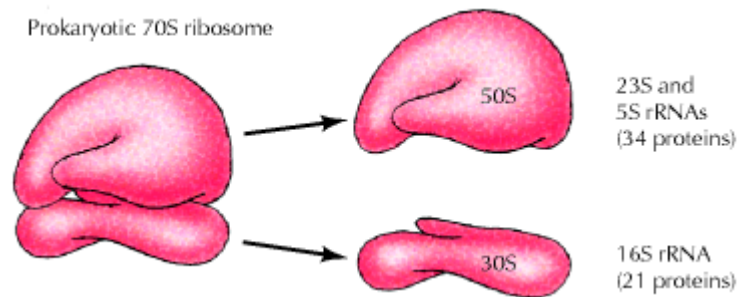


- **Cytoplasm:**

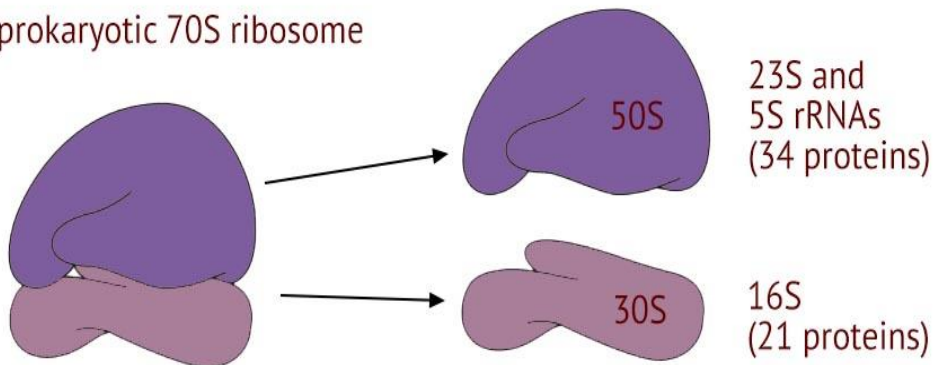
- Also known as proto-plasm.
- Gel-like matrix of water, enzymes, nutrients, wastes, and contains cell structures.
- Location of growth, metabolism, and replication.

- **Ribosomes:**

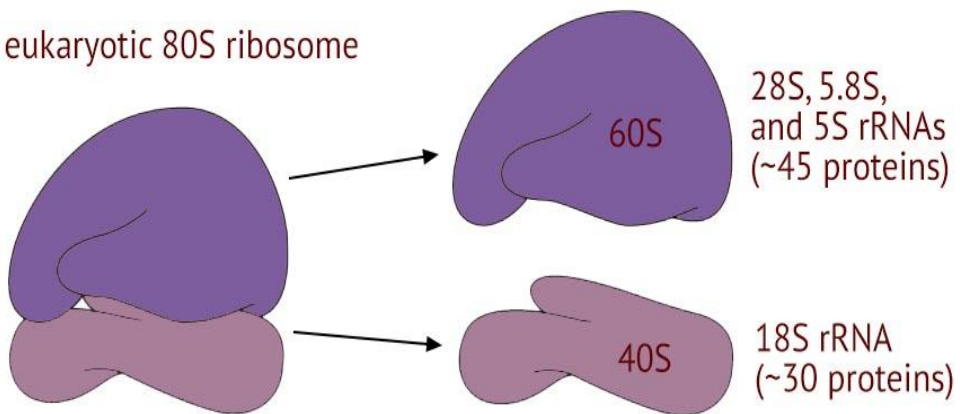
- Ribosomes are the principle structure in a prokaryotic cell after the nucleoid.
- They are composed of a complex of protein and RNA, and are the site of protein synthesis in the cell.
- The prokaryotic ribosomes are **70S**, comprised of sub units 50S and 30S.



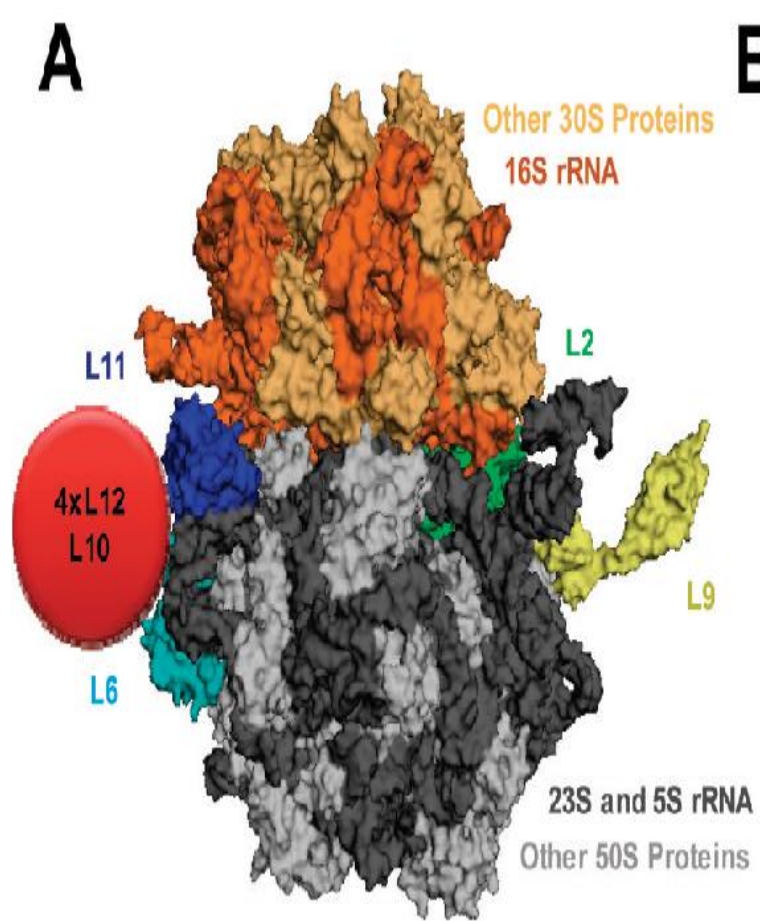
prokaryotic 70S ribosome



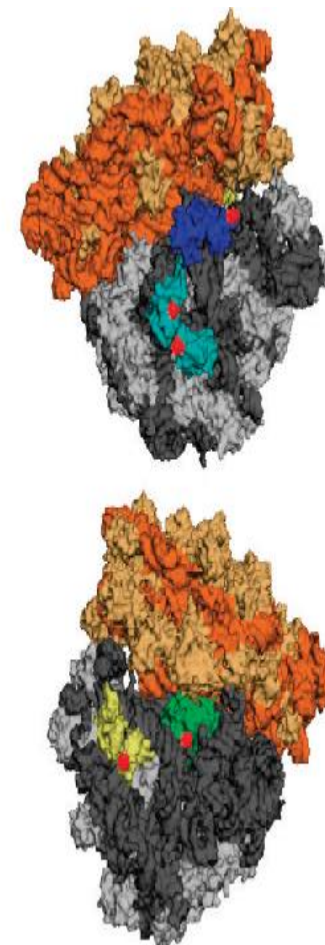
eukaryotic 80S ribosome



A



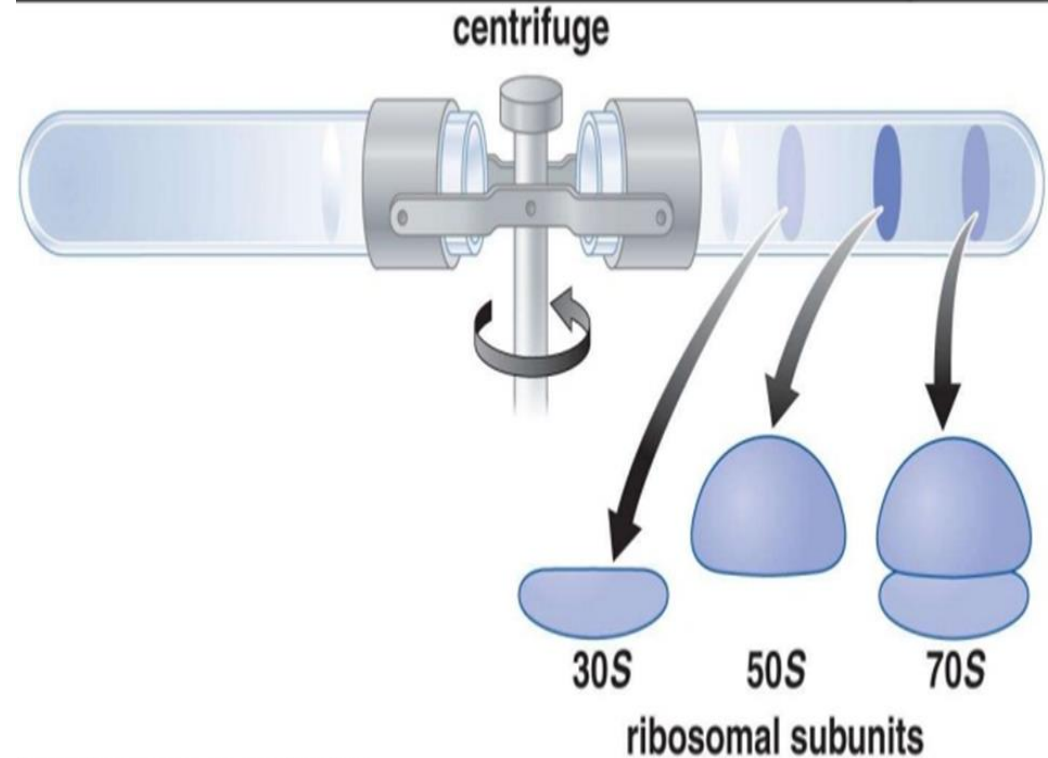
B



Svedberg (S);

- It is the centrifugal unit depending on the density of the object (and in the case of cell organelles) determining that how quickly sink to the depth when centrifuged.

Ribosomal subunits:



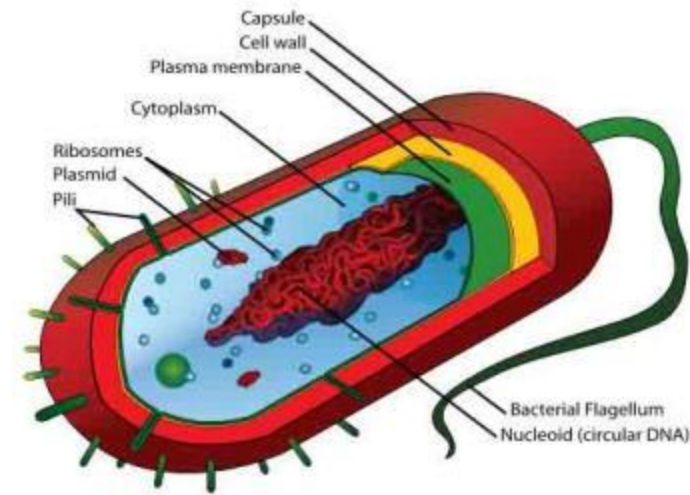
- **Nucleoid/Genetic material:**

- The cytoplasm also contains a region called the nucleoid, which is where the DNA of the cell is located.
- The prokaryotic cell consists of a chromosome that isn't contained within a nuclear membrane or envelope.
- The nucleoid or bacterial chromosome comprises a closed circle of double stranded DNA, many times the length of the cell and is highly folded and compacted.

Prokaryote Genetics

Nucleoid

- Region of cytoplasm where prokaryote's **genome (DNA)** is located.
- Usually a singular, circular chromosome.



Plasmid

- Small extra piece of chromosome/genetic material.
- 5 - 100 genes
- Not critical to everyday functions.
- Can provide genetic information to promote:

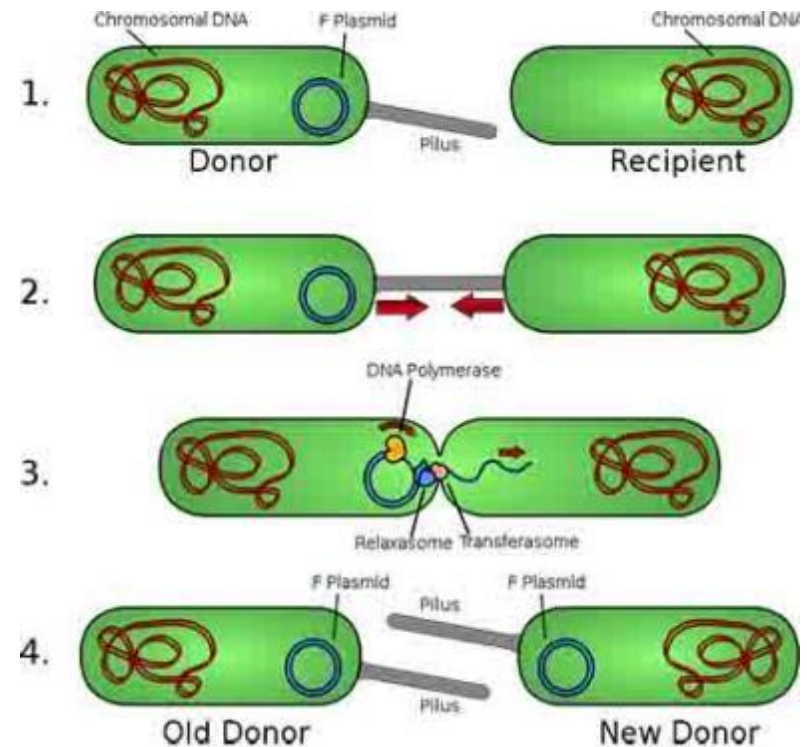
- Antibiotic resistance

- Virulence factors

(molecules produced by pathogen that specifically influence host's function to allow the pathogen to develop)

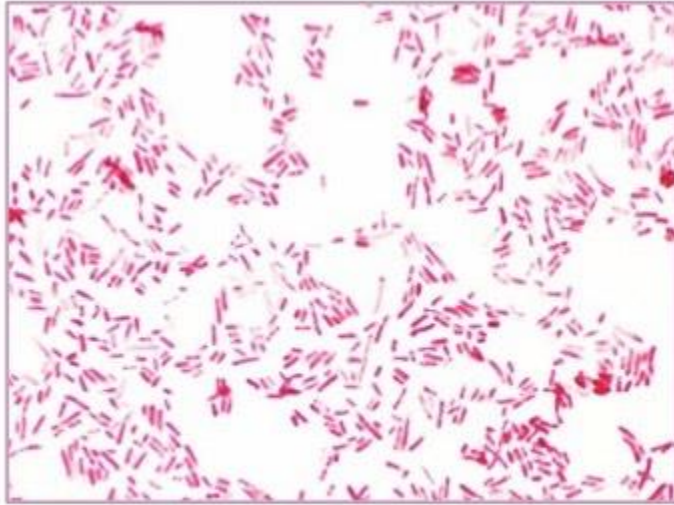
- Promote **conjugation**

(transfer of genetic material between bacteria through cell-to-cell contact)

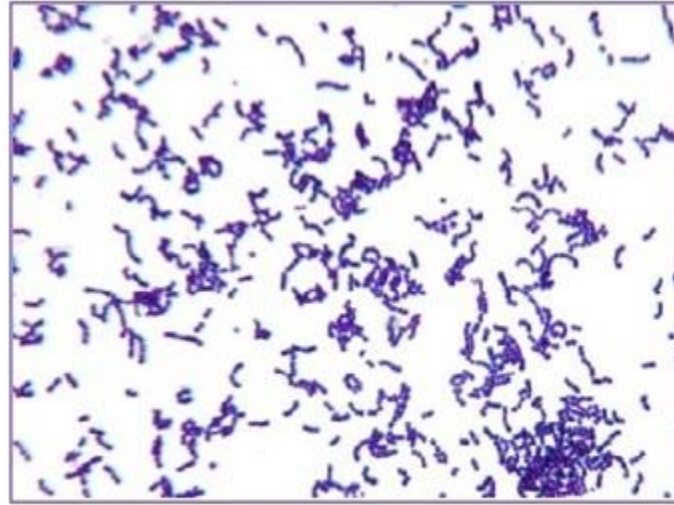


- **Cell wall:**

- The prokaryotic cell's cell wall is present outside the plasma membrane.
- It provides rigidity to the cell shape and structure and protects the cell from its environment.
- Bacterial cell wall is primarily composed of **peptidoglycan** and on the basis of cell wall composition the bacteria classified into **gram-positive** and **gram negative** organisms.



Gram-Negative Bacteria



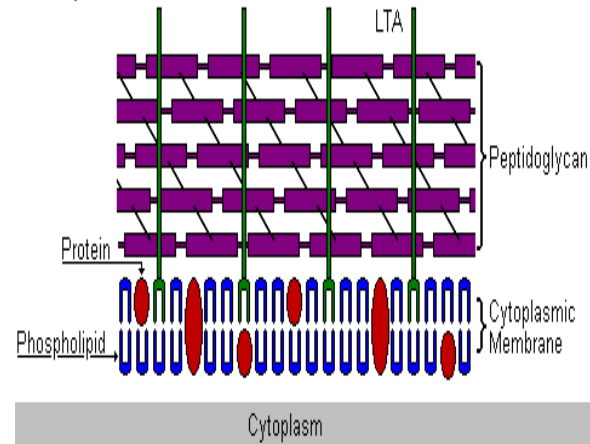
Gram-Positive Bacteria

Prokaryotes - Cell Wall

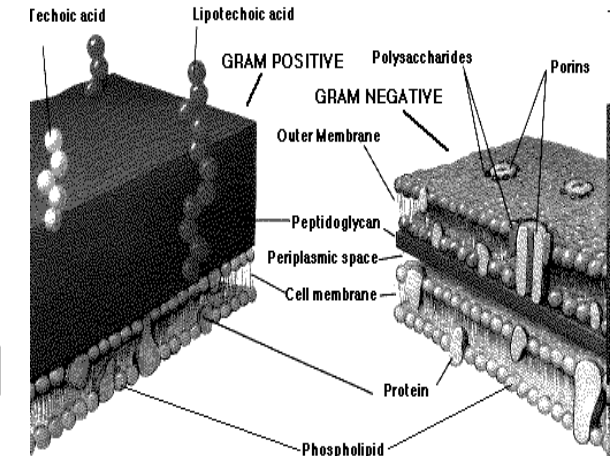
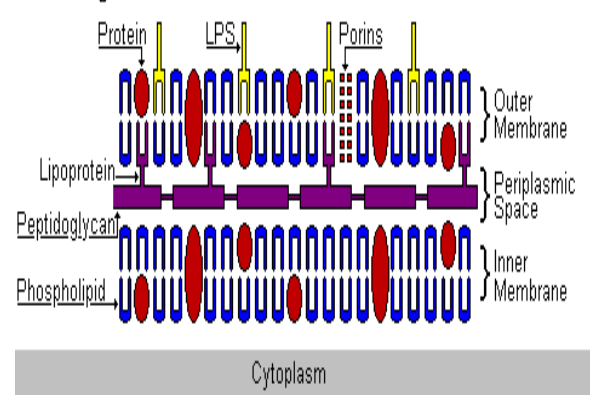
Gram-Positive & Gram-Negative

- **Gram-positive**
- Peptidoglycan makes up as much as 90% of the thick, compact cell wall.
- **Gram-negative**
- More chemically complex and thinner.
- Peptidoglycan only 5 – 20% of the cell wall.
- Peptidoglycan not outermost layer, between the plasma membrane and the outer membrane.
- Outer membrane is similar to the plasma membrane, but is less permeable and composed of lipopolysaccharides (LPS).
- LPS is a harmful substance classified as an endotoxin,
- The space between the cell wall and the plasma membrane is called the **periplasm**.

Gram-positive Cell Wall



Gram-negative Cell Wall





Prokaryotes - **Glycocalyx**

Some bacteria have an additional layer outside of the cell wall called the **glycocalyx**.

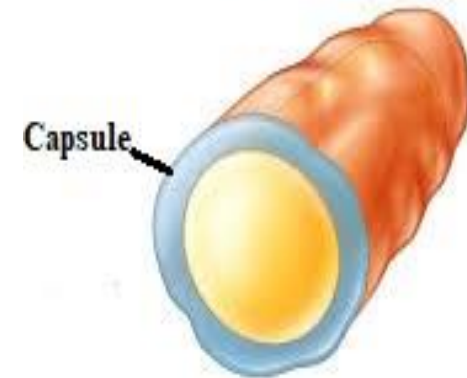
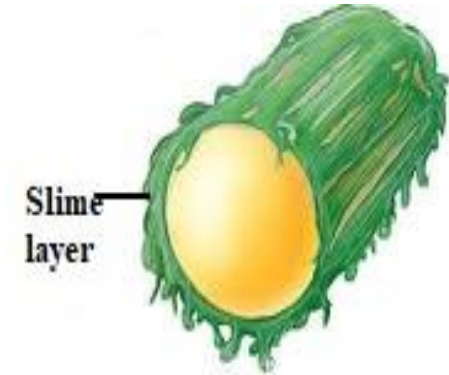
This additional layer can come in one of two forms:

1. **Slime Layer**

the slime layer is considered as a form of [glycocalyx](#).

A glycocalyx is considered a slime layer when the glycoprotein molecules are loosely associated with the cell wall. Bacteria that are covered with this loose shield are protected from dehydration and loss of nutrients.

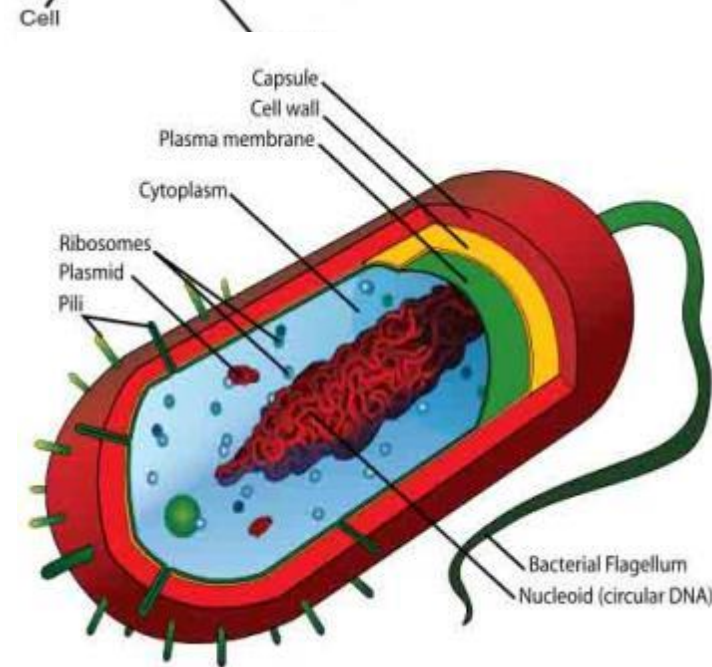
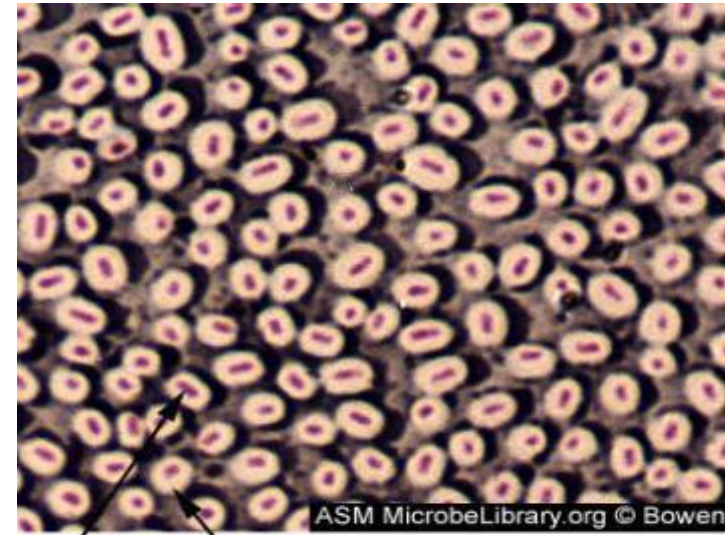
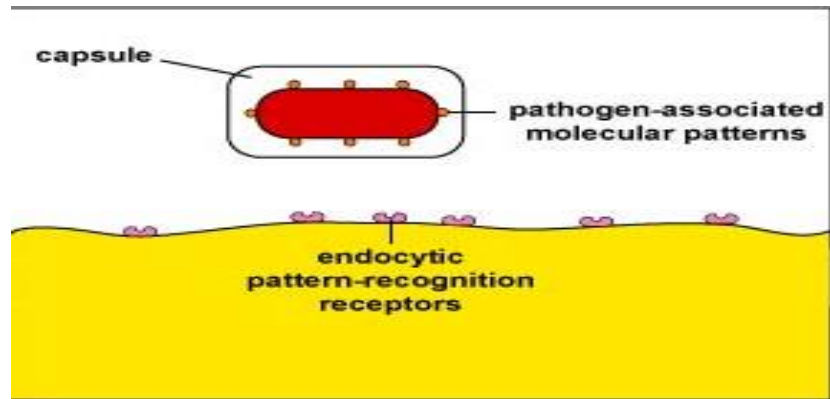
- Slime layer causes bacteria to adhere to solid surfaces and helps prevent the cell from drying out.



Prokaryotes - Glycocalyx

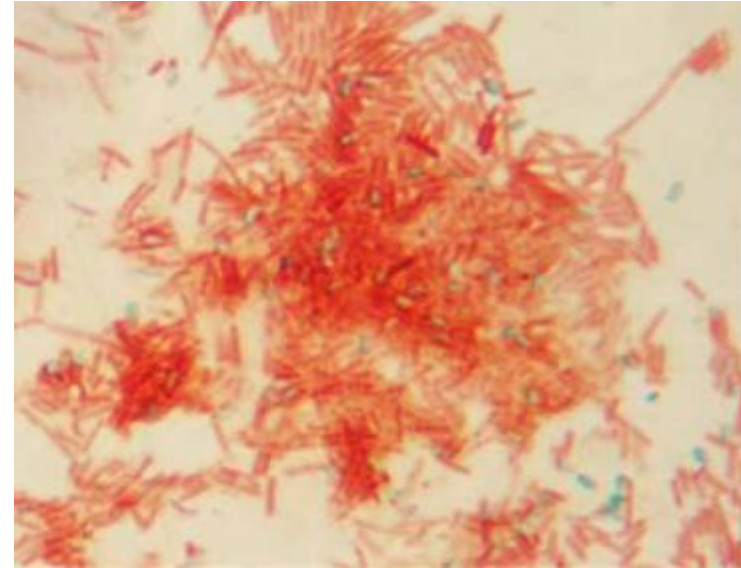
2. Capsule

- Polysaccharides firmly attached to the cell wall.
- Capsules adhere to solid surfaces and to nutrients in the environment.
- Adhesive power of capsules is a major factor in the initiation of some bacterial diseases.
- Capsule also protect bacteria from being phagocytized by cells of the hosts immune system.



Prokaryotes - Endospores

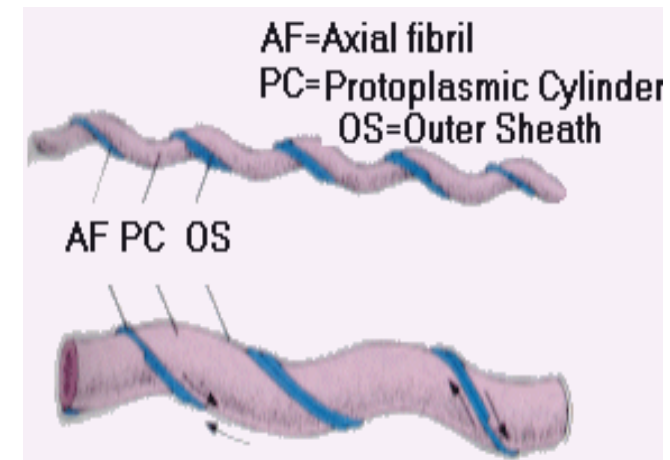
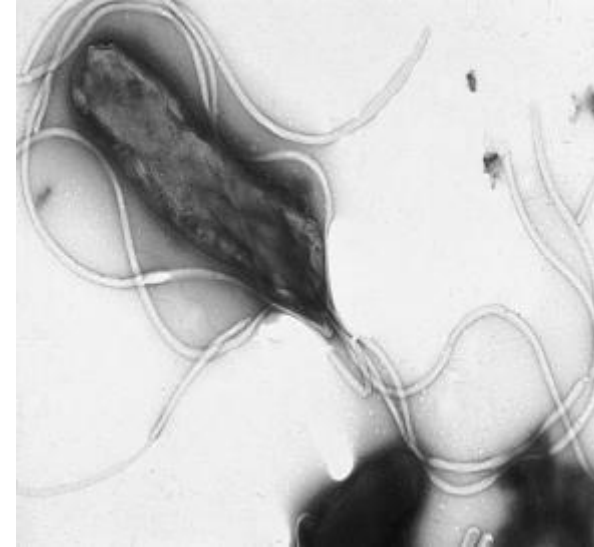
- Dormant, tough, non-reproductive structure produced by small number of bacteria.
- Resistant to radiation, desiccation (drying up), lysozyme, temperature, starvation, and chemical disinfectants.
- Endospores are commonly found in soil and water, where they may survive for very long periods of time.



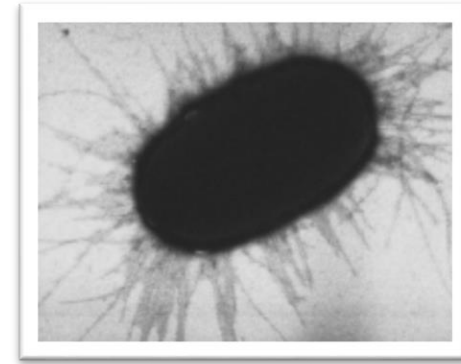
An endospore stained bacterial smear of *Bacillus subtilis* showing **endospores** as green and **vegetative cells** as red.

Prokaryotes - Surface Appendages

- Some prokaryotes have distinct appendages that allow them to move about or adhere to solid surfaces.
- Consist of delicate stands of proteins.
- **flagella:** Long, thin extensions that allow some bacteria to move about freely in aqueous environments.
(singular: flagellum)
- **axial filament (endoflagella):** Wind around bacteria, causing movement in waves.



Prokaryotes - Surface Appendages



- **fimbriae**: Most Gram-negative bacteria have these short, fine appendages surrounding the cell. Gram+ bacteria don't have.

No role in motility. Help bacteria adhere to solid surfaces. Major factor in virulence.

(singular: fimbria)

- **pili**: Tubes that are longer than fimbriae, usually shorter than flagella.

Use for movement, like grappling hooks, and also use conjugation pili to transfer plasmids. (singular = pilus)

