

Microbiology

Bacterial cell structure

Faculty of Medicine

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Objectives

- Understanding Prokaryotic cells structure and function
- Understanding Eukaryotic cells anatomy and function
- Differentiates Prokaryotic from Eukaryotic cells

Introduction

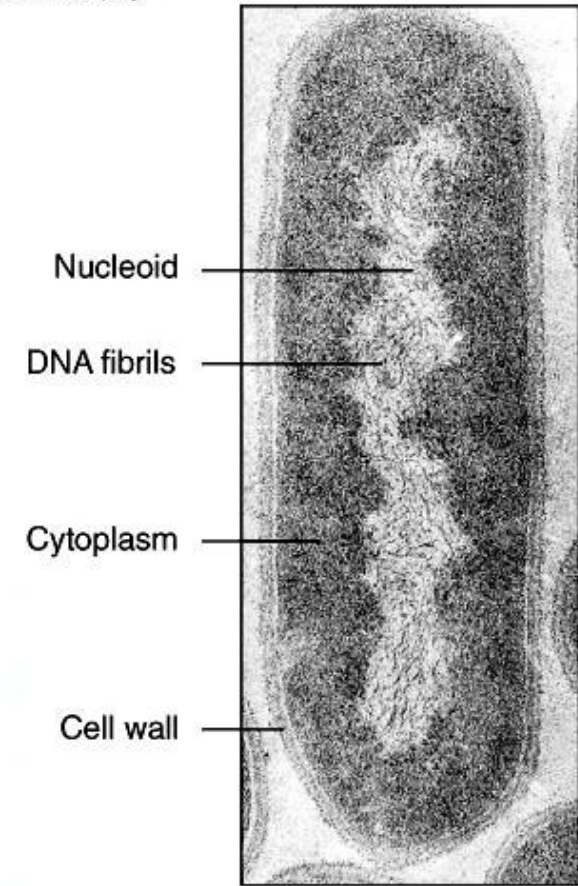
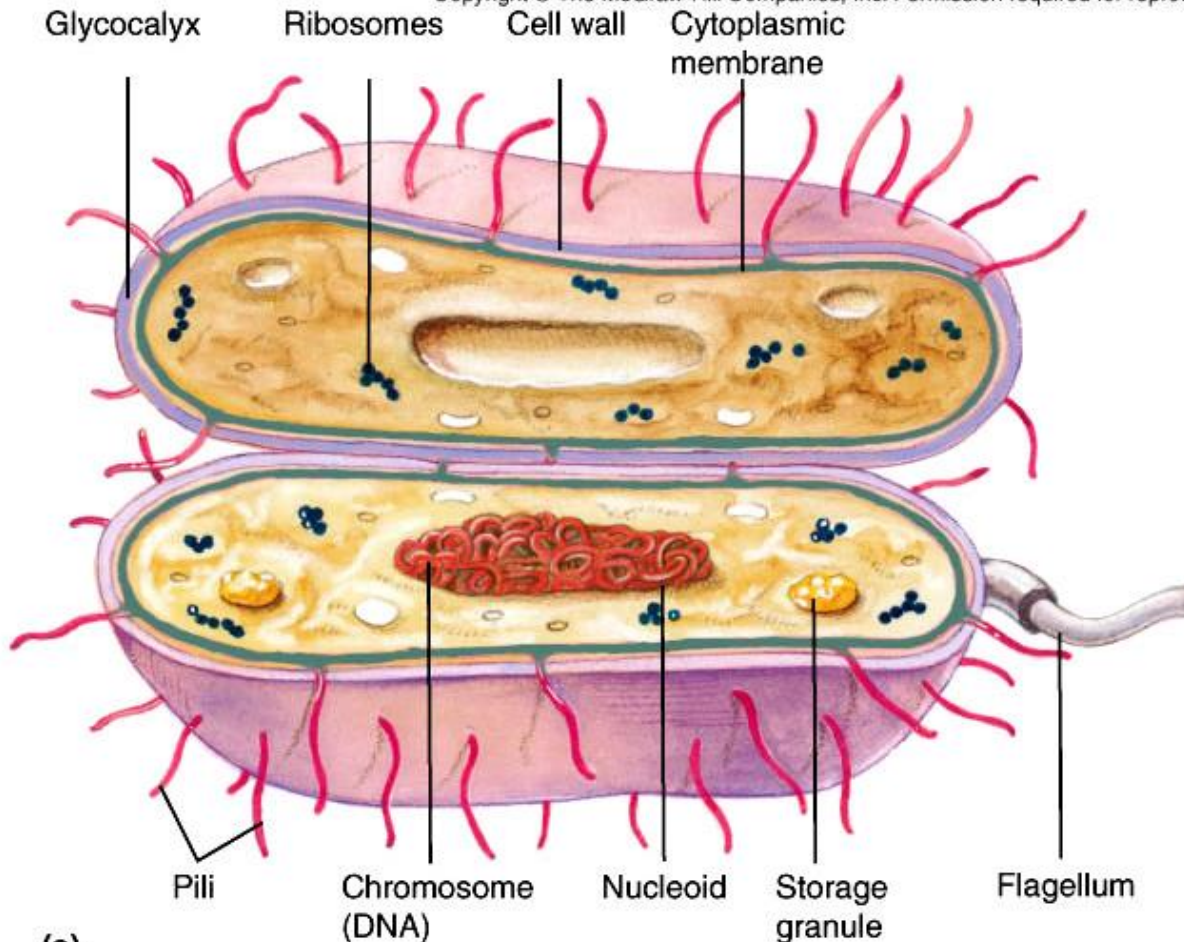
- Prokaryote comes from the Greek words for prenucleus
- Eukaryote comes from the Greek words for true nucleus
- Prokaryotic cell is simpler than eukaryotic cells at every level except the cell envelope which is more complex



Prokaryotic Cells

Typical Prokaryotic Cell

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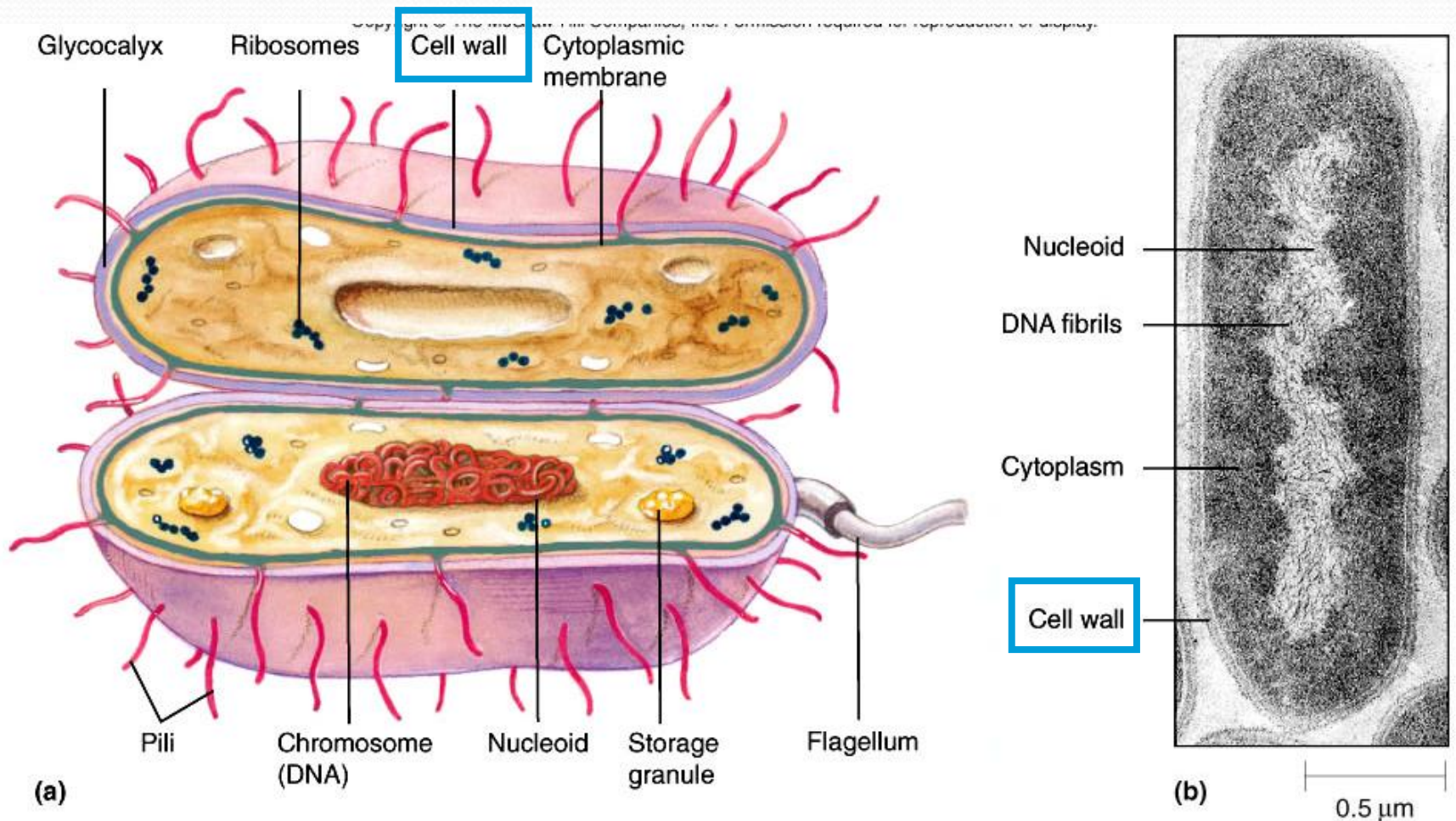


(a)

(b)

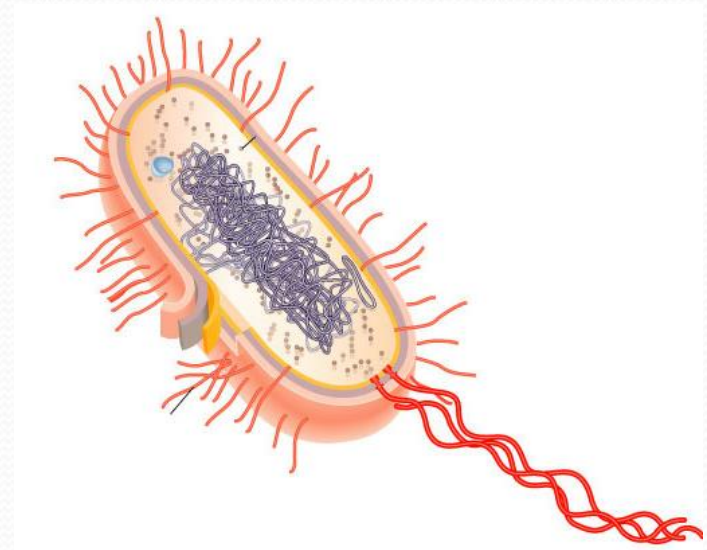
0.5 μm

The Prokaryotic Cell Wall



Cell Wall Functions

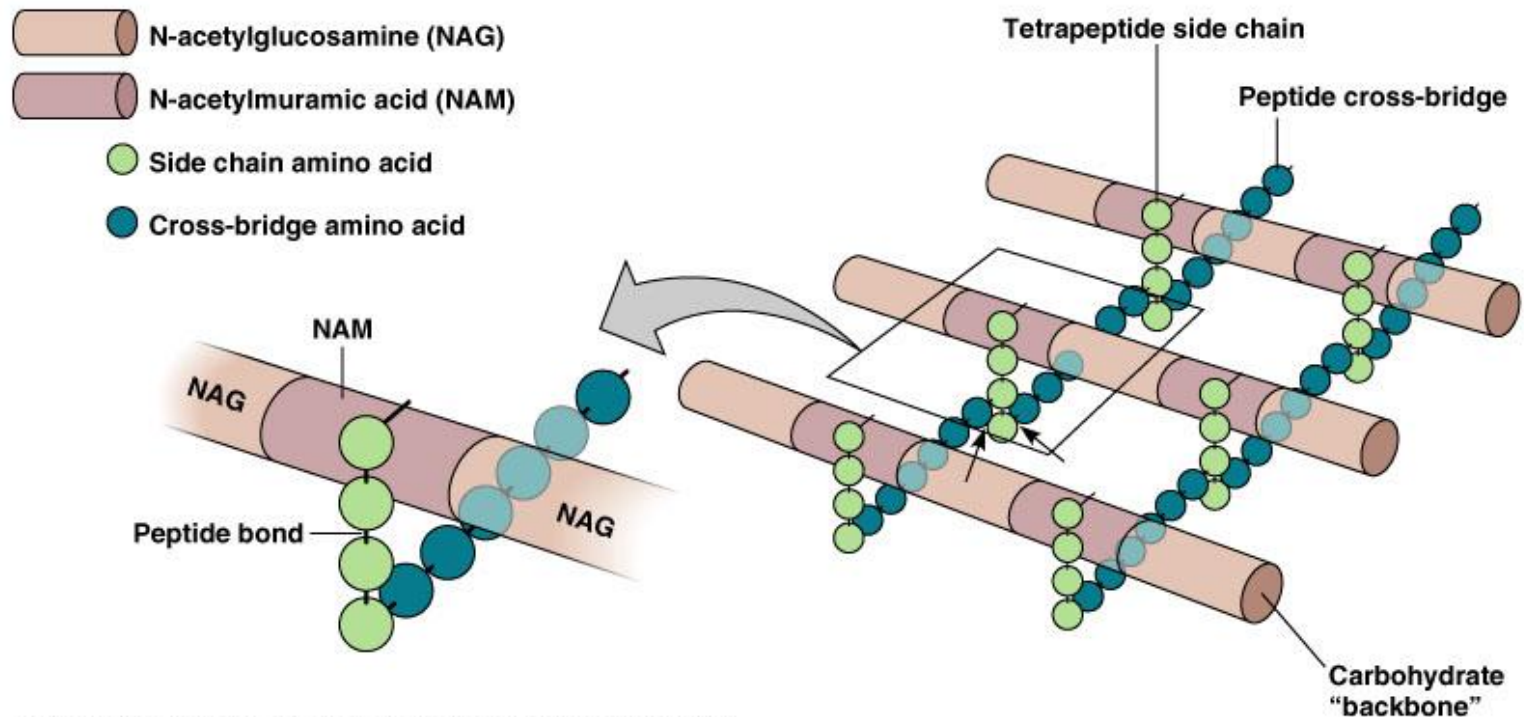
- Determines cell shape
- Prevents osmotic lysis
- Part of cell envelope
- In some cases recognized by host immune system



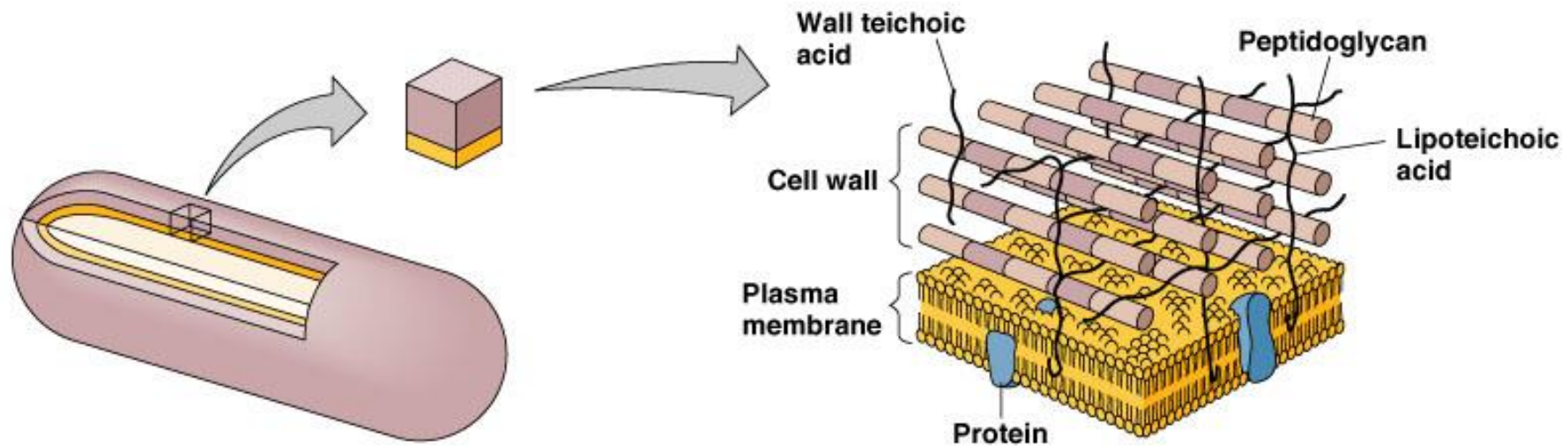
Cell wall structure

Made of peptidoglycan (in bacteria)

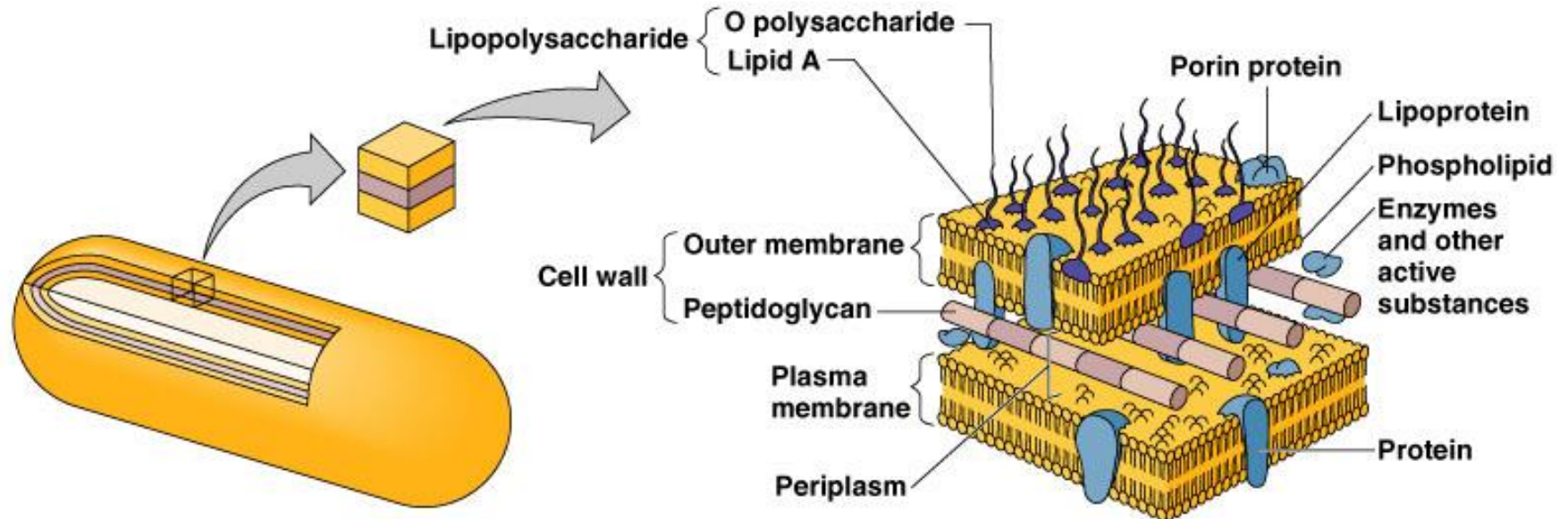
- Polymer of disaccharide N-acetylglucosamine (NAG) & N-acetylmuramic acid (NAM)
- Linked by polypeptides



(a) Structure of peptidoglycan in gram-positive bacteria

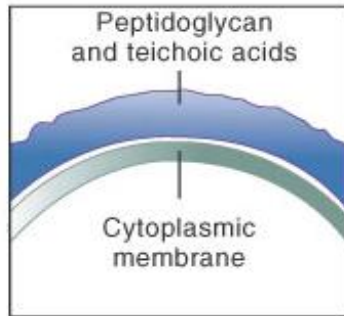


(b) Gram-positive cell wall



(c) Gram-negative cell wall

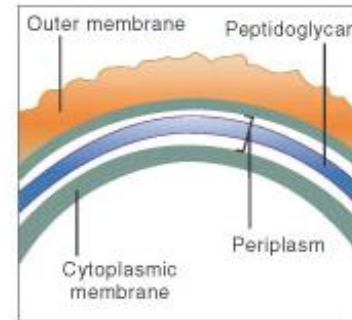
Gram-positive cell walls



Gram-Positive

- Thick peptidoglycan
- Teichoic acids
- No outer membrane
- No periplasm

Gram-negative cell walls



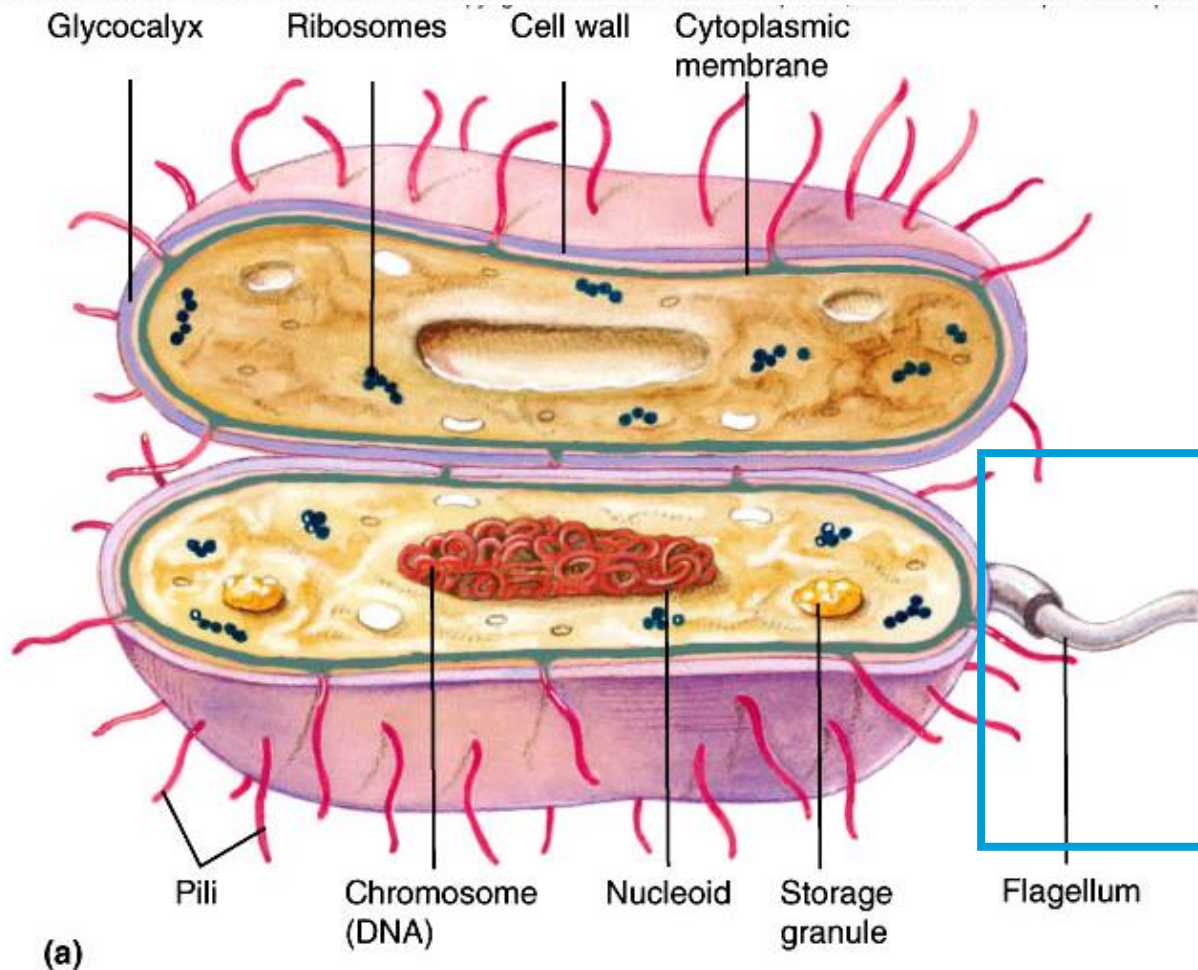
Gram-Negative

- Thin peptidoglycan
- No teichoic acids
- Outer membrane
- Have periplasm

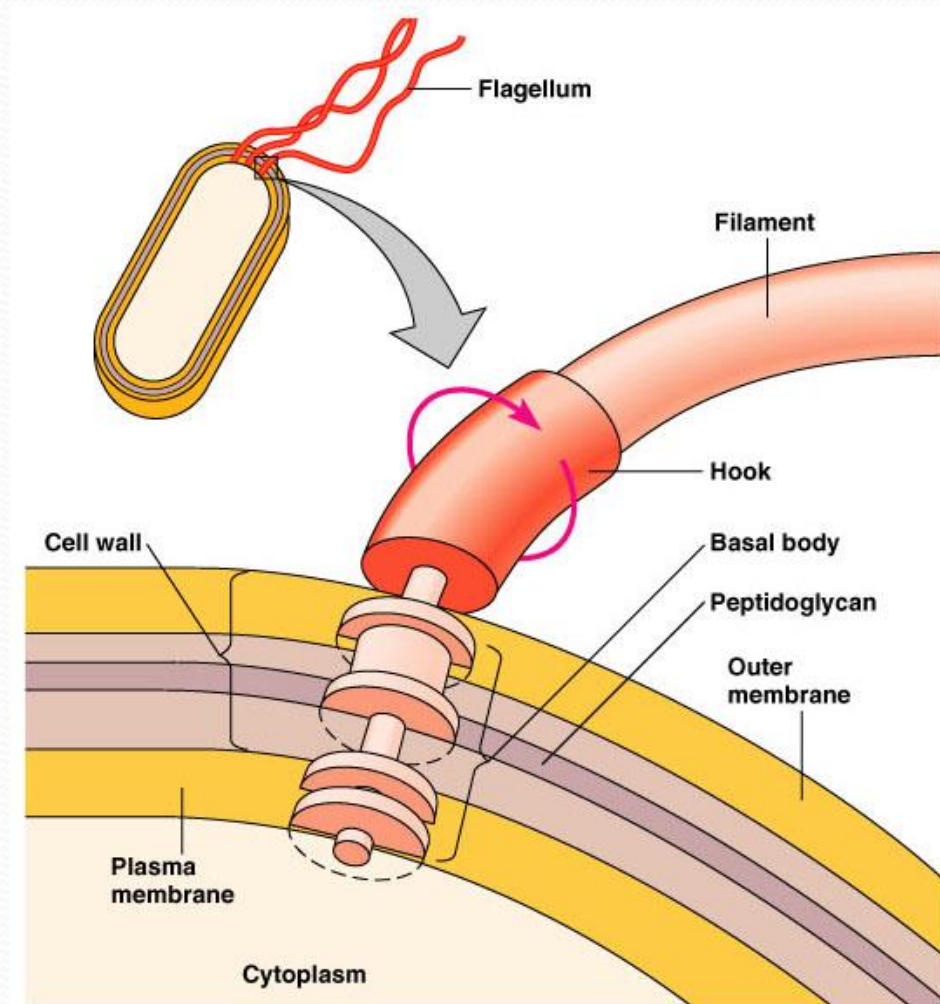
Clinical Importance of Cell Wall

- Differentiate Gram-positive from Gram-negative bacteria (Investigation and diagnosis)
- Cell wall provide antigenic variation critical for host immune defense and autoimmune diseases
- Cell wall is target for antibiotics, Gram-negative cell wall provide resistance for many antibiotics
- Gram-negative outer membrane
- Lipopolysaccharide (Lipid A) secretes Endotoxines in Gram-negative bacteria

Bacteria Flagella



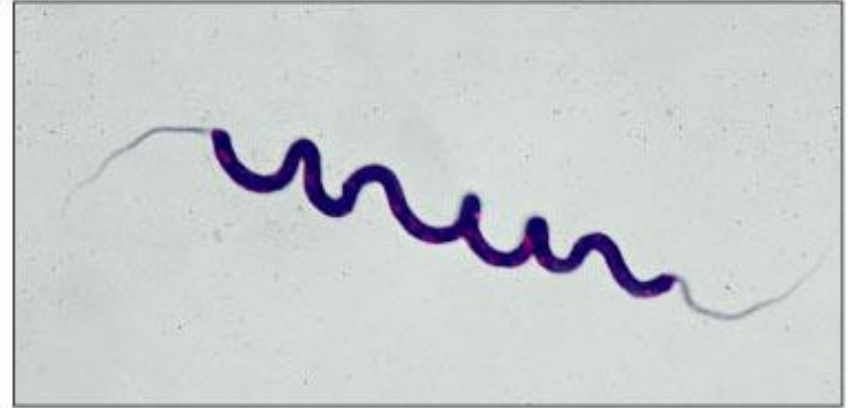
- Structure:
 - Outside cell wall
 - Made of chains of flagellin
 - Attached to a protein hook
 - Anchored to the wall and membrane by the basal body
- Function: Motility



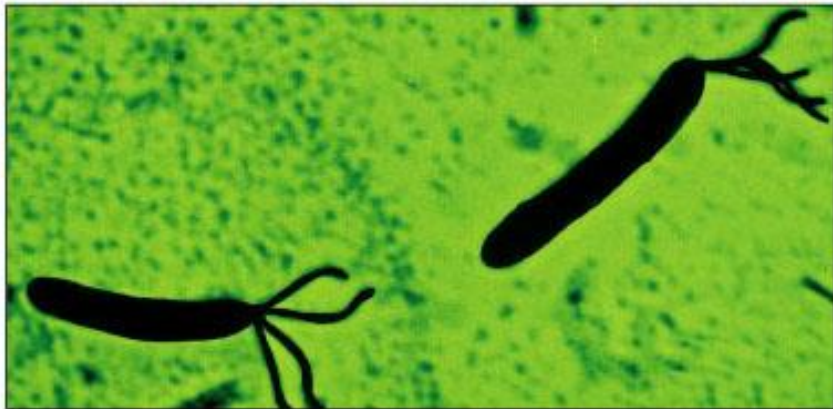
Flagella Arrangement



(a) Monotrichous



(b) Amphitrichous



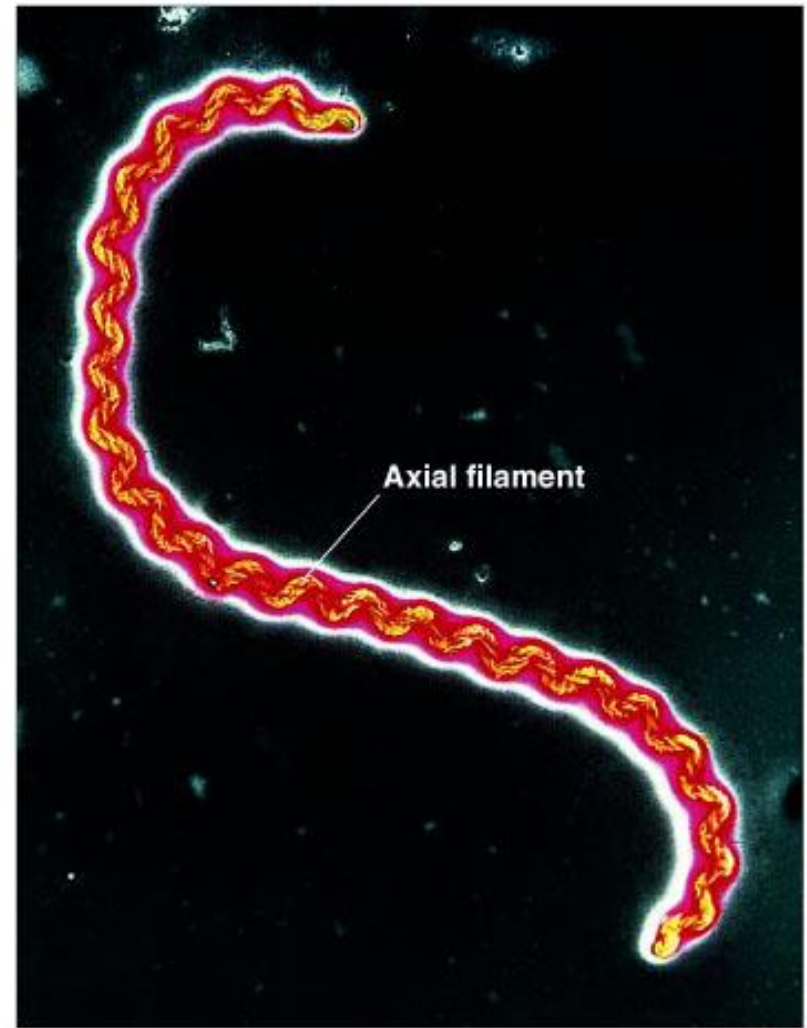
(c) Lophotrichous



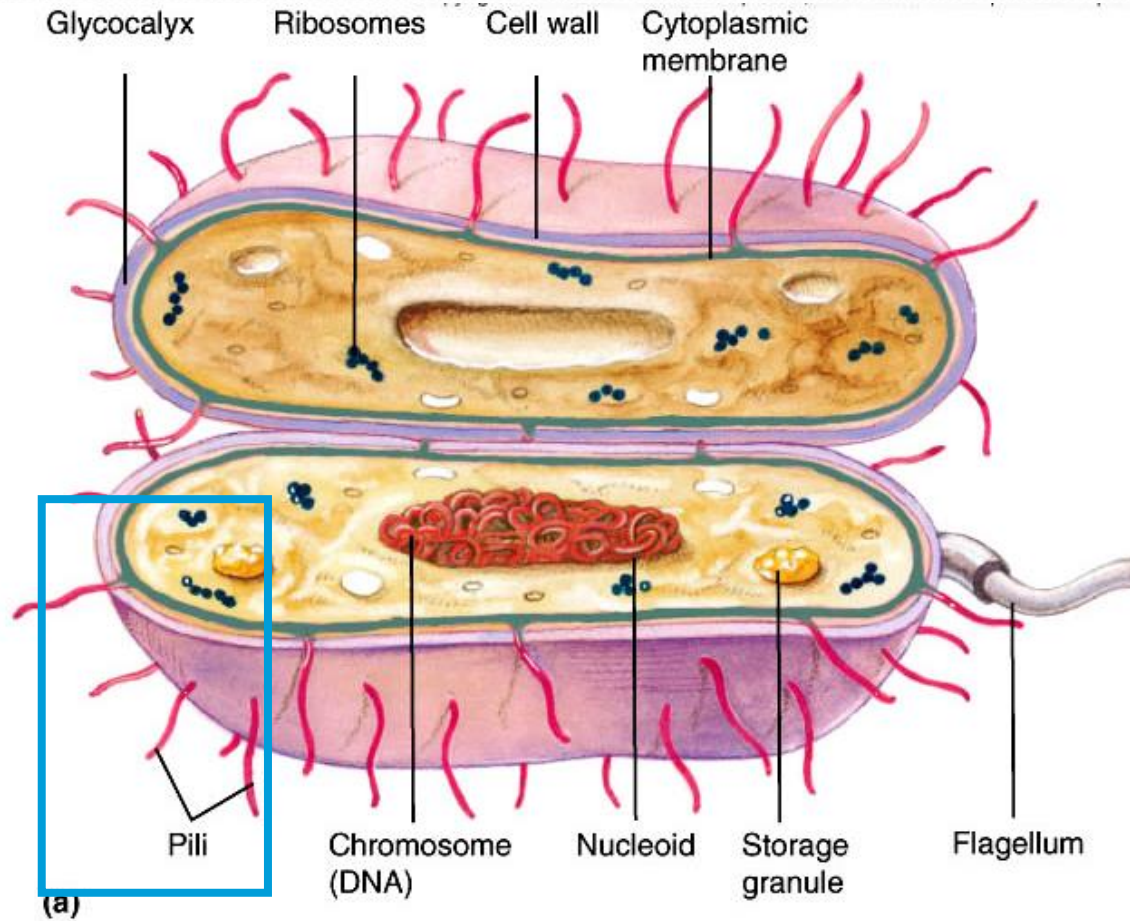
(d) Peritrichous

Axial Filaments

- Endoflagella
- Found only in spirochetes
- Anchored at one end of a cell
- Rotation causes cell to move



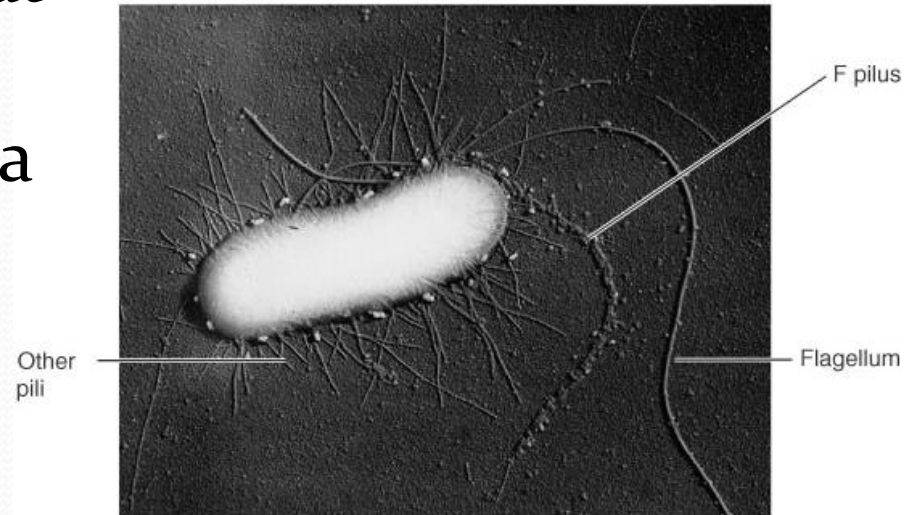
Pili and Fimbriae



Filamentous appendages that are shorter, straighter and more numerous than flagella

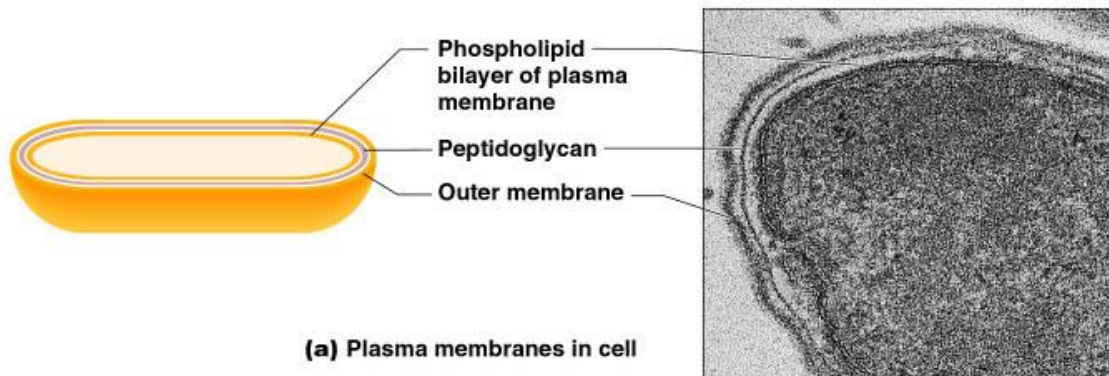
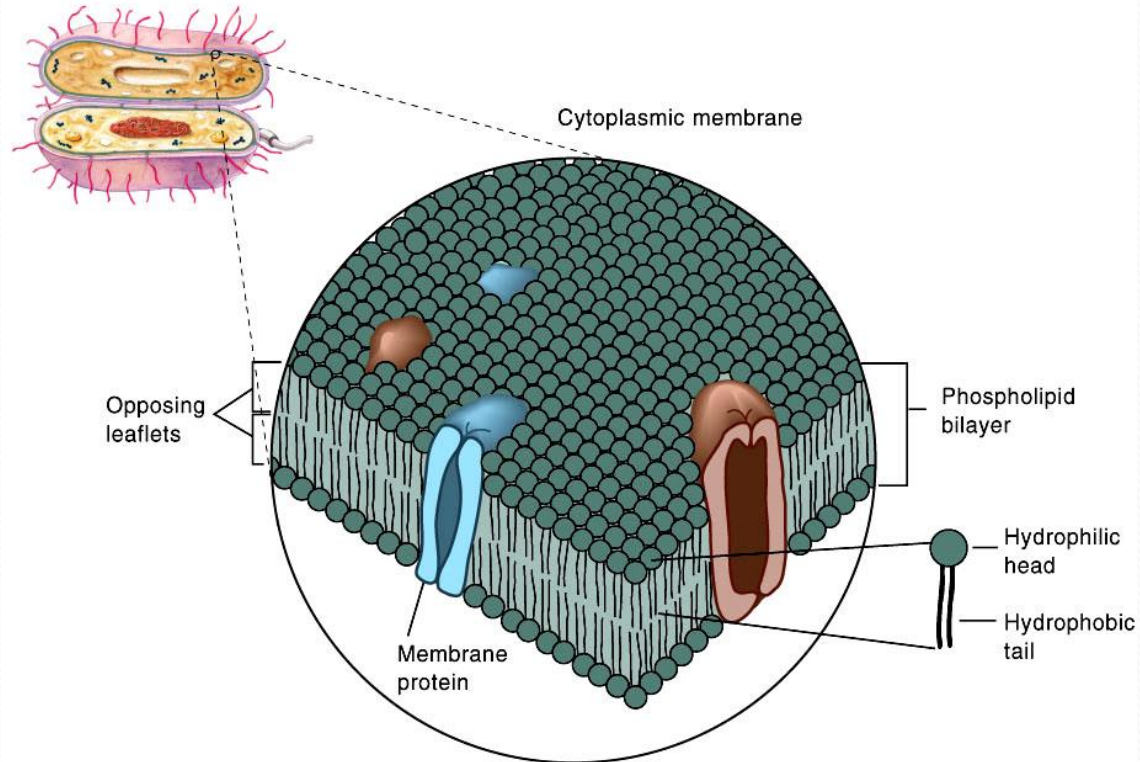
Found mostly in Gram (-) Bacteria

Fimbriae allow attachment while Pili are used to transfer DNA from one cell to another



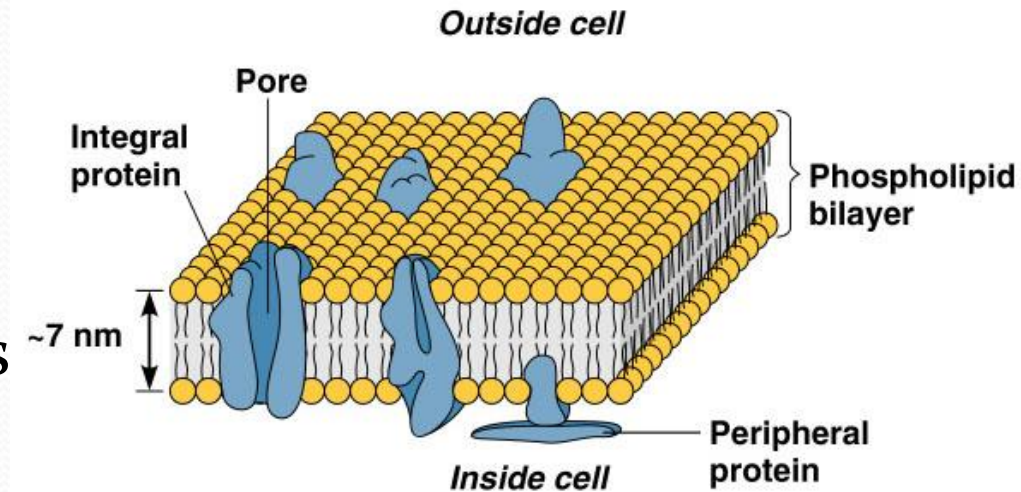
Plasma Membrane

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Structure

- Phospholipid bilayer
- Peripheral proteins
- Integral proteins
- Transmembrane proteins



(b) Phospholipid bilayer of membrane

Functions:

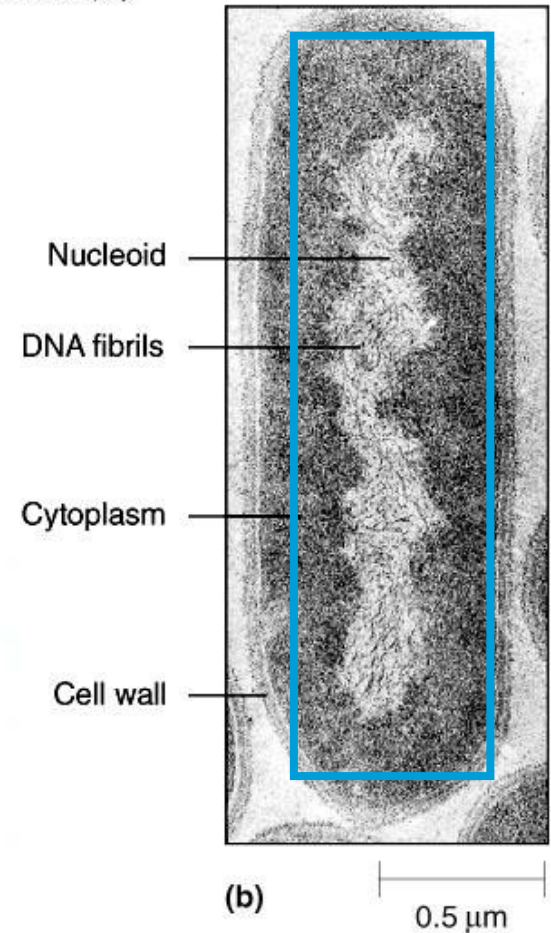
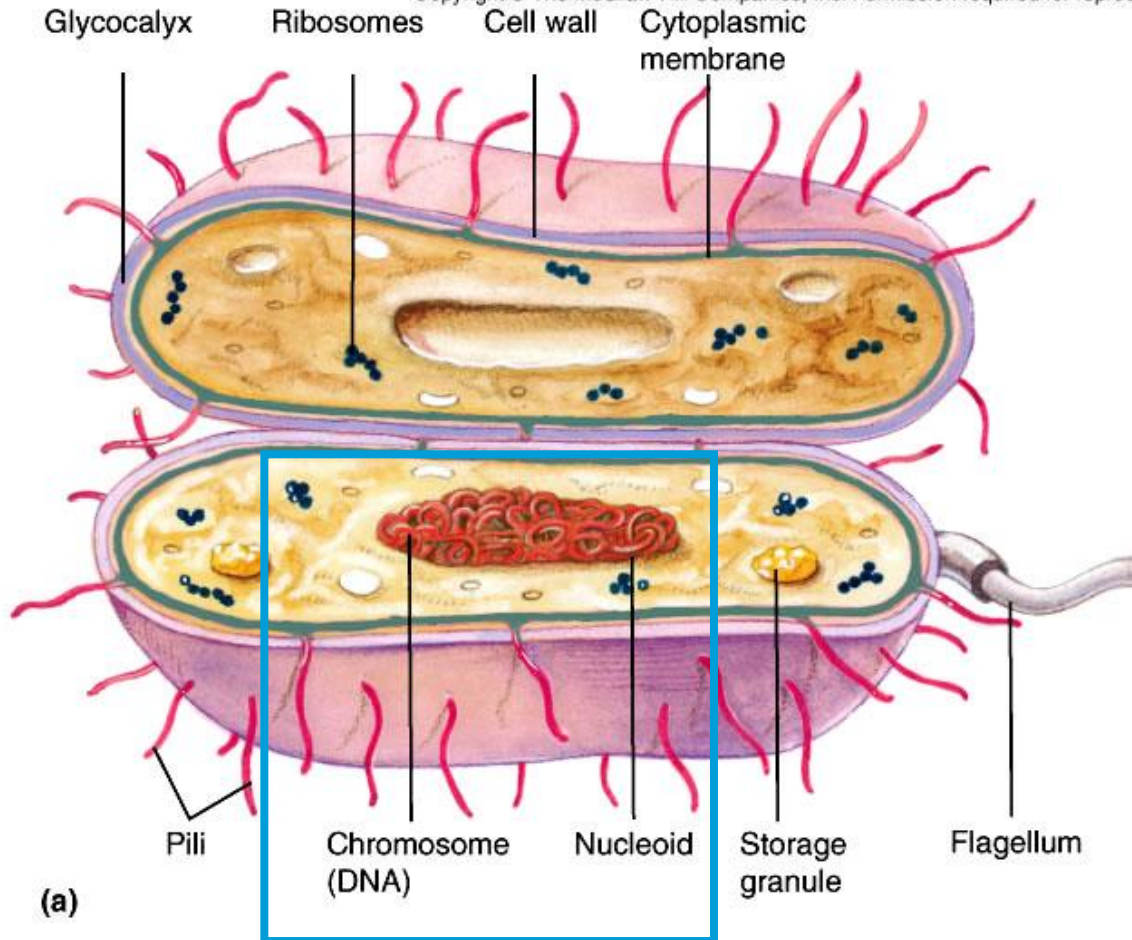
- Selective permeability allows passage of some molecules
- Enzymes for ATP production and cell wall synthesis
- Photosynthetic pigments


Movement Across Membranes

- Simple diffusion: Movement of a solute from an area of high concentration to an area of low concentration
- Facilitative diffusion: Solute combines with a transporter protein in the membrane (with concentration gradient & no energy expended)
- Active Transport (against concentration gradient & energy expended)

Nuclear Area (Nucleoid) and Plasmid

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- Prokaryotic cells have no true Nuclei, DNA is packaged as Nucleoid and some small circular DNA pieces named Plasmid
 - The number of Nucleoids and Chromosomes depends on growth condition

Ribosomes: Sites of Translation

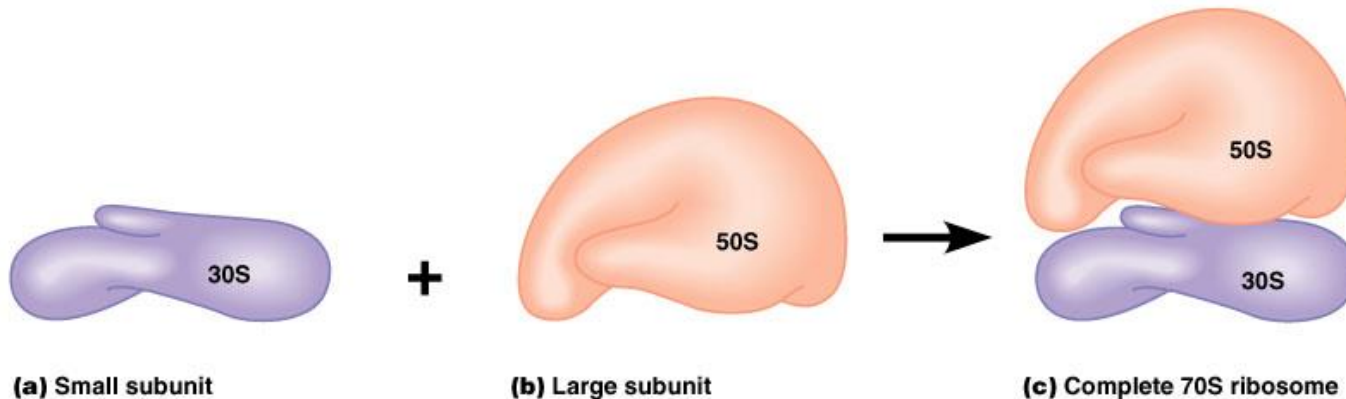
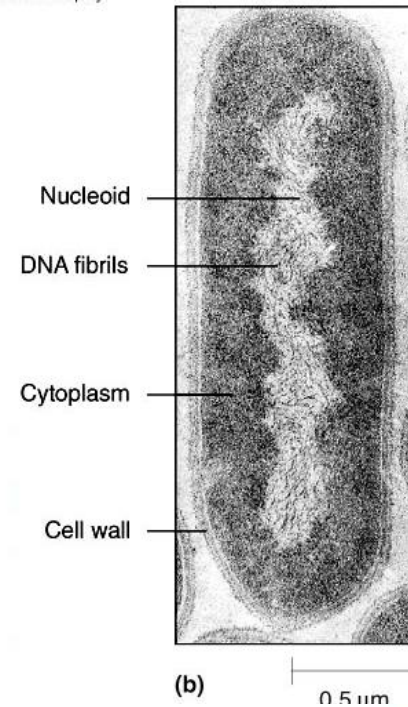
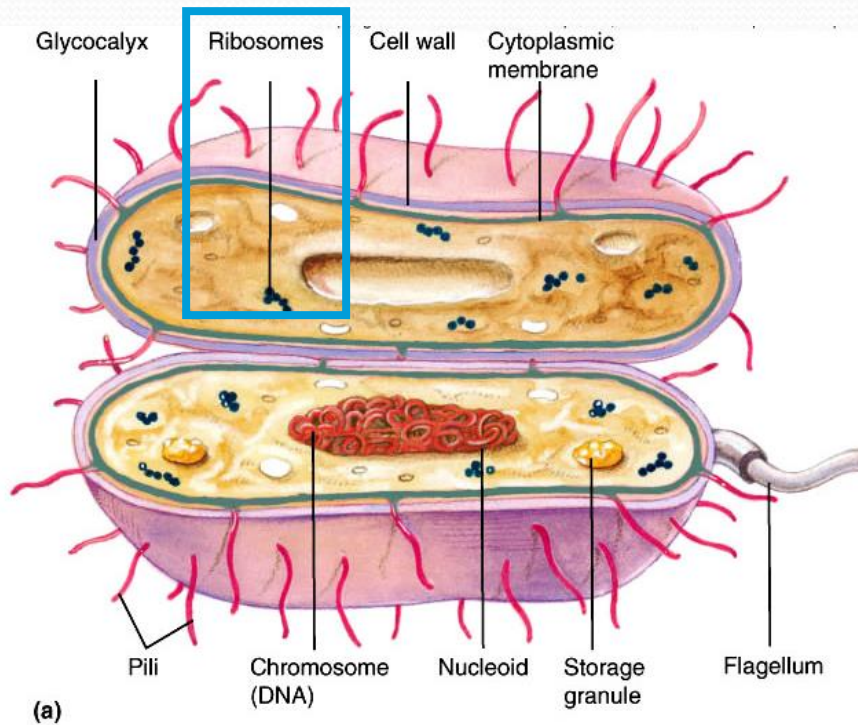


Table 3.3 A Summary of Prokaryotic Cell Structures

Structure	Characteristics
Extracellular	
Filamentous appendages	Composed of subunits of proteins that form a helical chain.
Flagella	Provides the most common mechanism of motility .
Pili	Different types of pili have different functions. The common types , often called fimbriae , enable cells to adhere to surfaces. A few types mediate twitching or gliding motility. Sex pili are involved in a mechanism of DNA transfer.
Surface layers	
Glycocalyx	Layer outside the cell wall, usually made of polysaccharide .
Capsule	Distinct and gelatinous . Enables bacteria to adhere to specific surfaces; allows some organisms to thwart innate defense systems and thus cause disease.
Slime layer	Diffuse and irregular. Enables bacteria to adhere to specific surfaces .
Cell wall	
Gram-positive	Thick layer of peptidoglycan that contains teichoic acids and lipoteichoic acids .
Gram-negative	Thin layer of peptidoglycan surrounded by an outer membrane. The outer leaflet of the outer membrane is lipopolysaccharide .
Cell Boundary	
Cytoplasmic membrane	Phospholipid bilayer embedded with proteins . A barrier between the cytoplasm and the outside environment. Also functions as a discriminating conduit between the cell and its surroundings.
Intracellular	
DNA	Contains the genetic information of the cell.
Chromosomal	Carries the genetic information that is essential to a cell. Typically a single, circular, double-stranded DNA molecule.
Plasmid	Carries genetic information that may be advantageous to a cell in certain situations.
Endospore	A type of dormant cell that is extraordinarily resistant to damaging conditions including heat, desiccation, ultraviolet light, and toxic chemicals.
Gas vesicles	Small, rigid structures that provides buoyancy to a cell.
Granules	Accumulations of high molecular weight polymers , which are synthesized from a nutrient that a cell has in relative excess .
Ribosomes	Intimately involved in protein synthesis . Two subunits, 30S and 50S, join to form the 70S ribosome , which serves as the structure that facilitates the joining of amino acids.



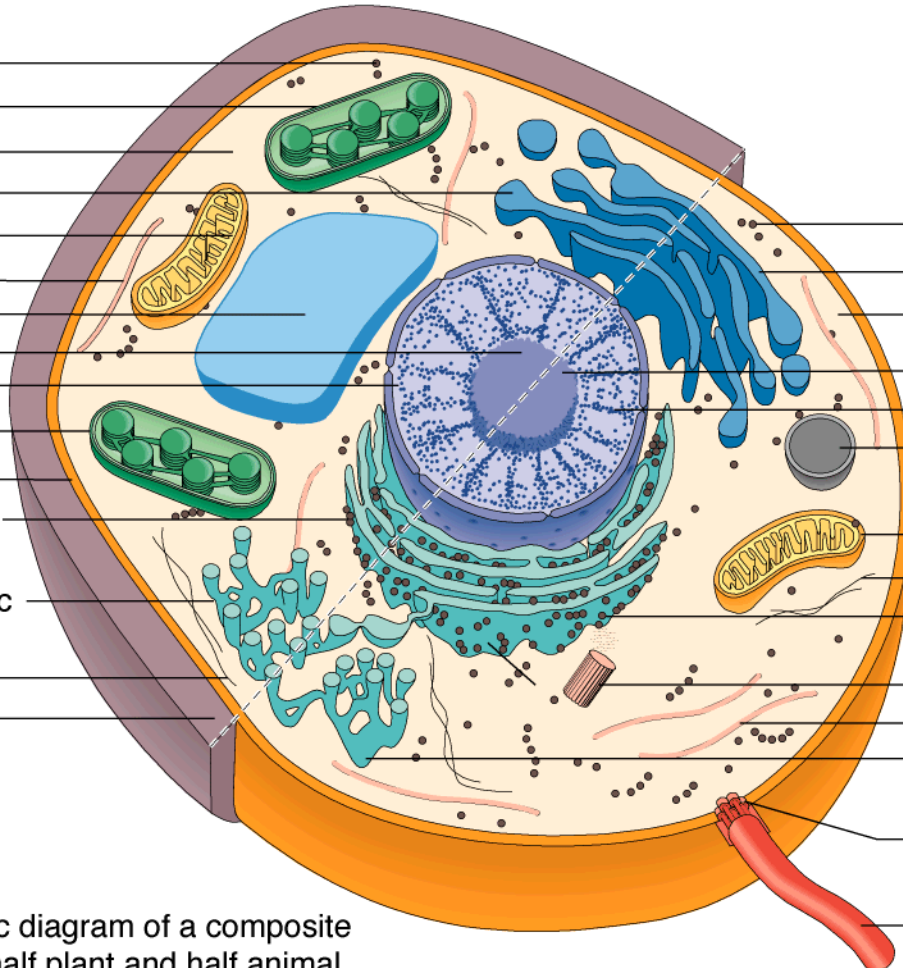
Eukaryotic Cells

PLANT CELL

- Ribosome
- Chloroplast
- Cytoplasm
- Golgi complex
- Mitochondrion
- Microtubule
- Vacuole
- Nucleolus
- Nucleus
- Thylakoid
- Plasma membrane
- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum
- Microfilament
- Cell wall

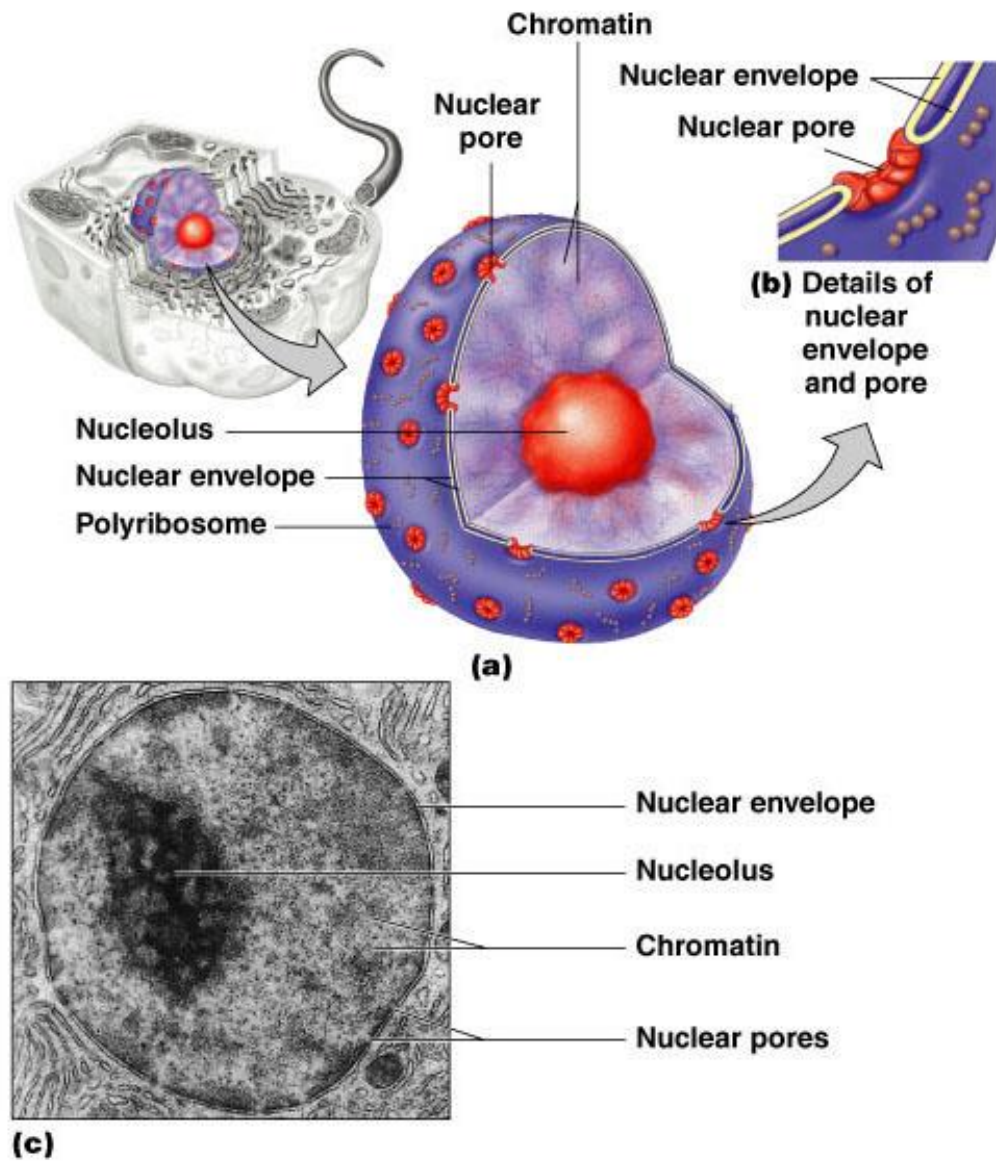
ANIMAL CELL

- Ribosome
- Golgi complex
- Cytoplasm
- Nucleolus
- Nucleus
- Lysosome
- Plasma membrane
- Mitochondrion
- Microfilament
- Rough endoplasmic reticulum
- Centrioles
- Microtubule
- Smooth endoplasmic reticulum
- Basal body
- Flagellum



(a) Highly schematic diagram of a composite eucaryotic cell, half plant and half animal

Nucleus



Prokaryote

- One circular chromosome, not in a membrane
- No histones
- No organelles
- Peptidoglycan cell walls
- Binary fission

Eukaryote

- Paired chromosomes, in nuclear membrane
- Histones
- Organelles
- Polysaccharide cell walls
- Mitotic spindle



Thank you...