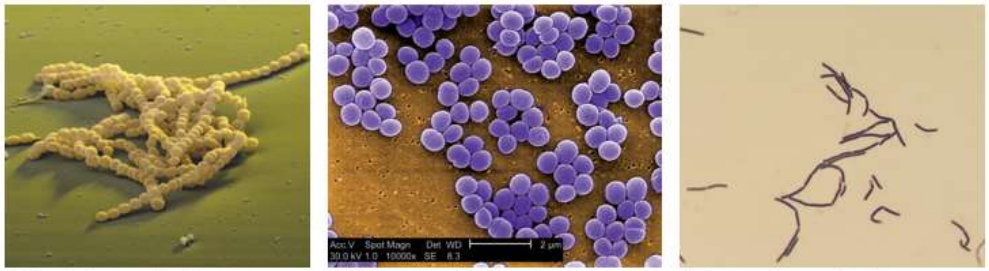
Prokaryotic Cells

Cell arrangements

- Coccus (pl. cocci) or single coccus
- Diplococcus (pl. diplococci) or pair of two cocci
- Tetrad (pl. tetrads) or grouping of four cells arranged in a square, Streptococcus (pl. streptococci) or chain of cocci,
- Staphylococcus (pl. staphylococci) or cluster of cocci,
- Bacillus (pl. bacilli) or single rod,
- Streptobacillus (pl. streptobacilli) or a chain of rods.

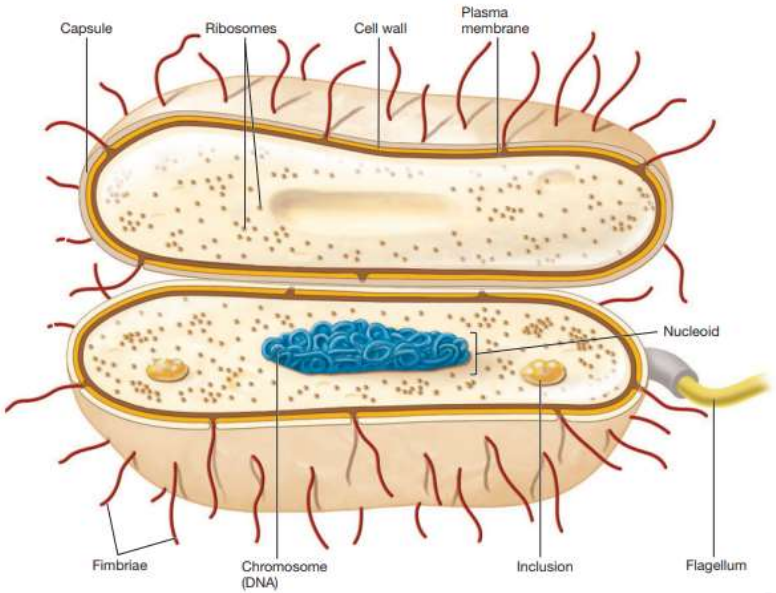


(a) *S. agalactiae*—cocci in chains (b) *S. aureus*—cocci in clusters (c) *B. megaterium*—rods in chains

Reference : Prescott's Microbiology

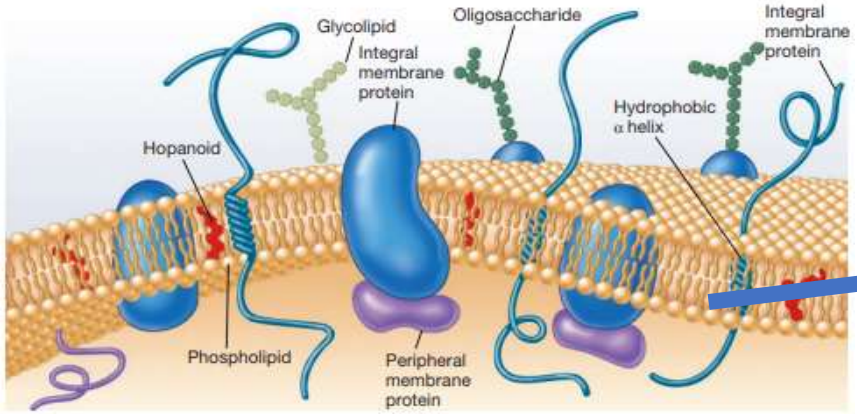
Prokaryotic Cells

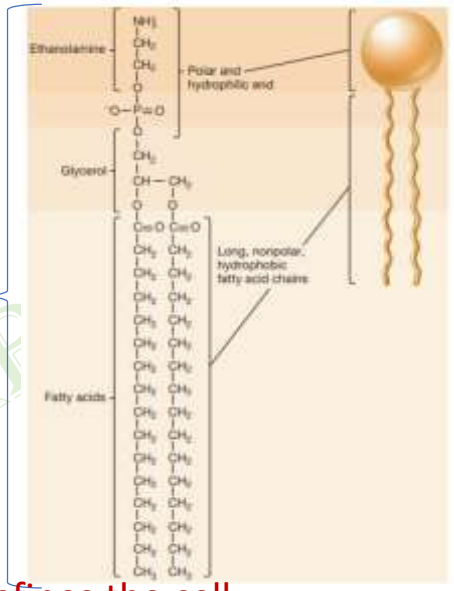
Common Bacterial Structures and Their Functions	
Plasma membrane	Selectively permeable barrier, mechanical boundary of cell, nutrient and waste transport, location of many metabolic processes (respiration, photosynthesis), detection of environmental cues for chemotaxis
Gas vacuole	An inclusion that provides buoyancy for floating in aquatic environments
Ribosomes	Protein synthesis
Inclusions	Storage of carbon, phosphate, and other substances; site of chemical reactions (microcompartments); movement
Nucleoid	Localization of genetic material (DNA)
Periplasmic space	In typical Gram-negative bacteria, contains hydrolytic enzymes and binding proteins for nutrient processing and uptake; in typical Gram-positive bacteria, may be smaller or absent
Cell wall	Protection from osmotic stress, helps maintain cell shape
Capsules and slime layers	Resistance to phagocytosis, adherence to surfaces
Fimbriae and pili	Attachment to surfaces, bacterial conjugation and transformation, twitching
Flagella	Swimming and swarming motility
Endospore	Survival under harsh environmental conditions



Reference : Prescott's Microbiology

Plasma Membrane

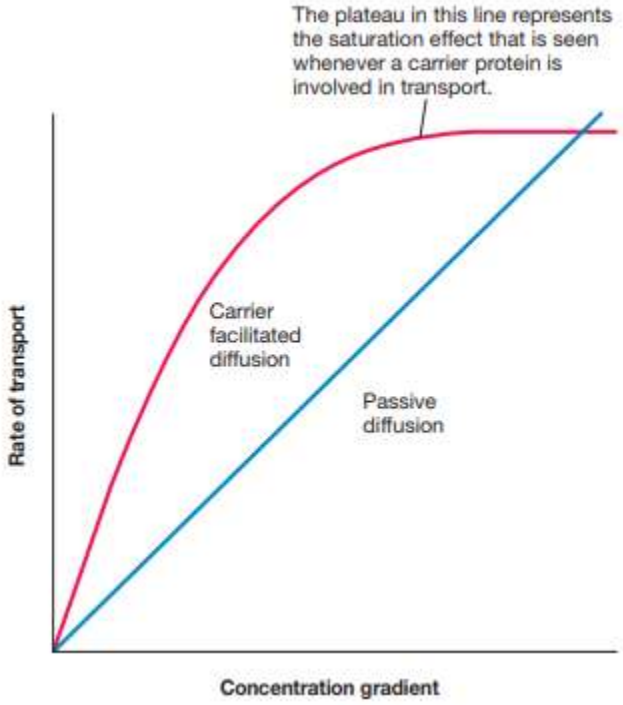




- Cell membranes are 5 to 10 nm thick structures
- Plasma membrane encompasses the cytoplasm and defines the cell.
- Major constituents are Lipid and Protein
- Membrane-associated lipids are amphipathic: structurally asymmetric, with polar and nonpolar ends
- Amphipathic lipids can interact to form a bilayer
- The outer surfaces of the bilayer are hydrophilic
- Two types of membrane proteins - Peripheral and Integral proteins

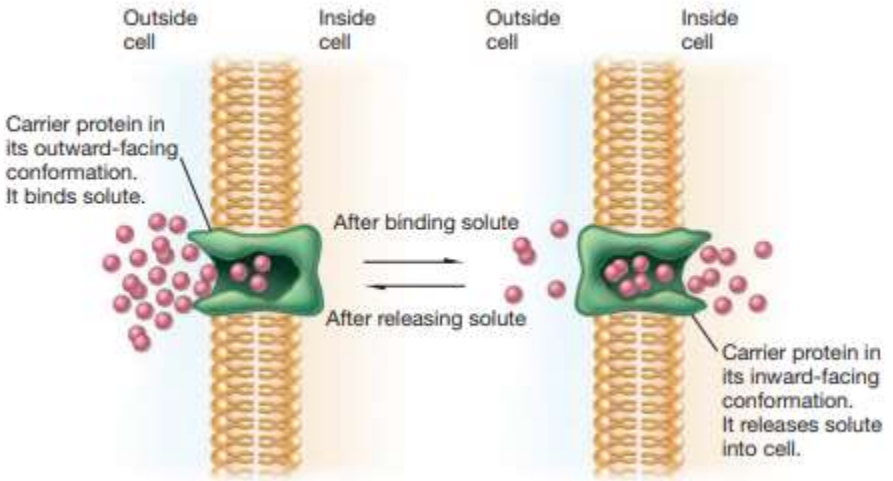
Reference : Prescott's Microbiology

Facilitated Diffusion



Facilitated Diffusion, substances move across the plasma membrane with the assistance of transport proteins that are either channels or carriers.

An example of channel-mediated facilitated diffusion is **Aquaporins** which transport water.



A Model of Facilitated Diffusion

Reference : Prescott's Microbiology

Active transport

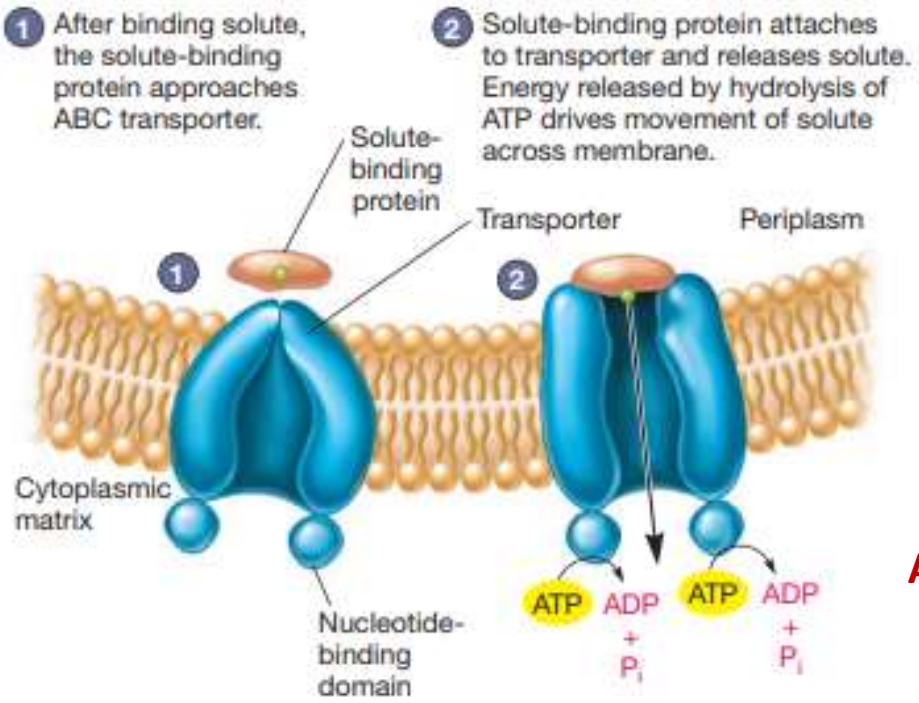
Active transport is the transport of solute molecules, against a concentration gradient with the input of metabolic energy.

Three types of active transport are observed in bacteria:

primary active transport, secondary active transport, and group translocation.

Primary active transport is mediated by active transporters

- Energy provided by ATP hydrolysis to move substances against a concentration gradient without modifying them
- Uniport in nature



ABC Transporter Function

Secondary active transport

- Secondary active transport couples the potential energy of ion gradients to transport of substances without modifying them.
- Secondary active transporters are cotransporters
- They move two substances simultaneously: the ion whose gradient powers transport and the substance being moved across the membrane
- **Symport** When the ion and other substance both move in the same direction, it is called symport
- **Antiport** When they move in opposite directions, it is called antiport
- The ion gradients used by secondary active transporters arise primarily in three ways.
- During energy-conserving processes, electron transport generates a proton gradient in which protons are at a higher concentration outside the cell than inside.
- The proton gradient is used for secondary active transport.

Reference : Prescott's Microbiology

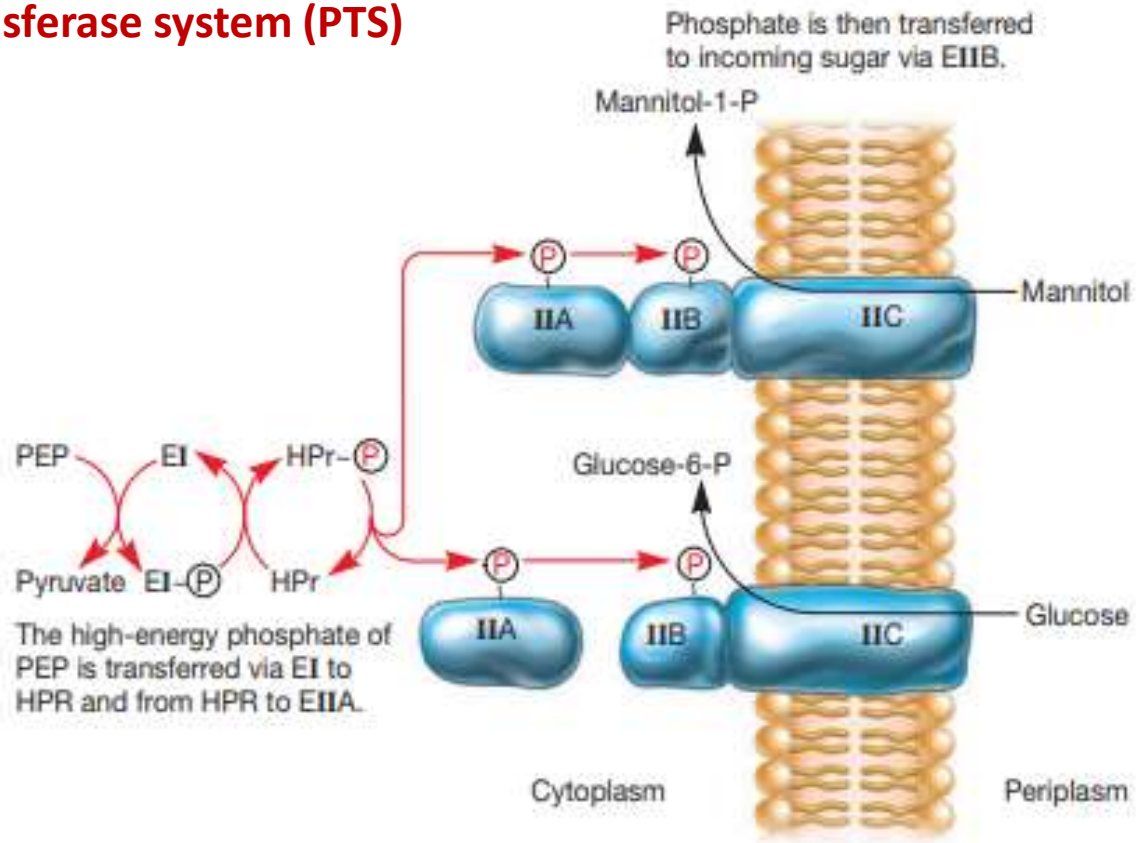
Secondary active transport

- Some bacteria use an alternate method, in which a V-type ATPase hydrolyzes ATP and uses the energy released to create either a proton gradient or a sodium gradient across the plasma membrane.
- A proton gradient can be used to create another ion gradient such as a sodium gradient.
- This is accomplished by an antiporter that brings protons in as sodium ions are moved out of the cell.
- The sodium gradient can then be used to drive uptake of nutrients by a symport mech
- Lactose permease of E. coli is a well-studied secondary active transporter

Reference : Prescott's Microbiology

Group Translocation

Phosphoenolpyruvate: sugar phosphotransferase system (PTS)



Reference : Prescott's Microbiology

Siderophores (Greek for iron bearers). Siderophores are low molecular weight organic molecules that bind ferric iron and supply it to the cell

Microbial Growth

- Most bacterial and archaeal cells reproduce by binary fission
- Binary fission is a simple type of cell division, the steps are:

1. Cell Elongation The cell elongates as new material is synthesized
2. Replication of chromosome
3. Separation of the newly formed DNA molecules
4. Septum (cross wall) Formation at midcell
5. Generation of Two progeny cells, each having its own chromosome and a complement of other cellular constituents

Reference : Prescott's Microbiology

Binary fission

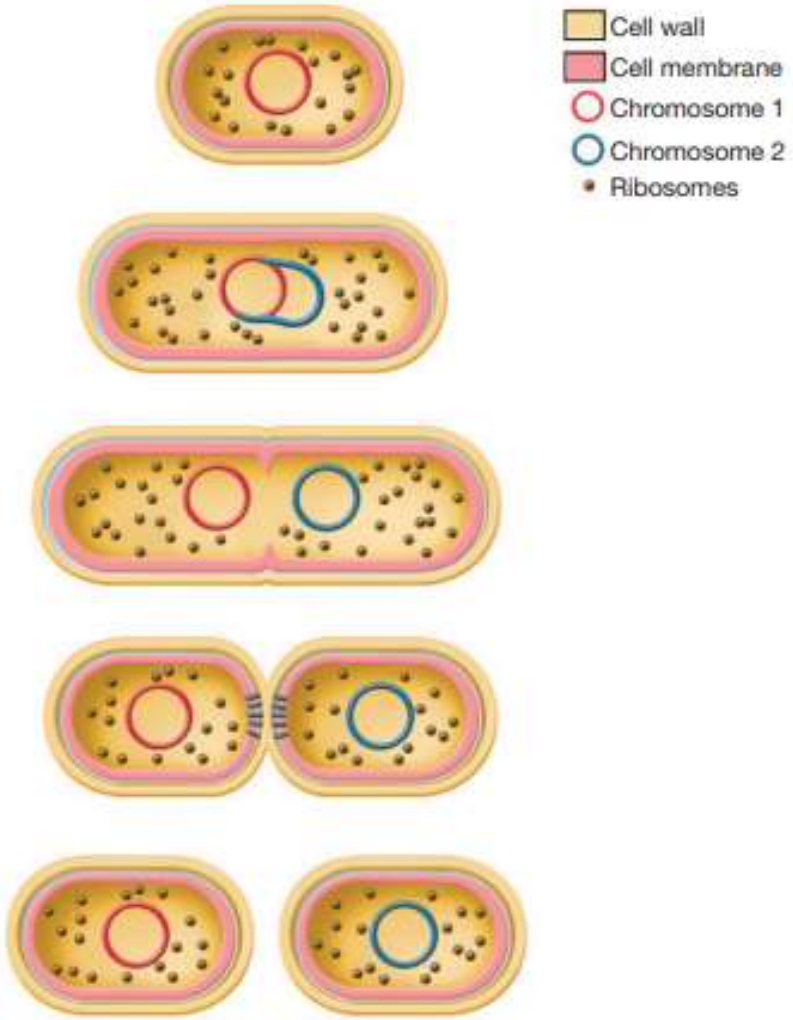
(a) A young cell at early phase of cycle

(b) A parent cell prepares for division by enlarging its cell wall, plasma membrane, and overall volume. DNA replication then starts.

(c) The septum begins to grow inward as the chromosomes move toward opposite ends of the cell. Other cytoplasmic components are distributed to the two developing cells.

(d) The septum is synthesized completely through the cell center, creating two separate cell chambers.

(e) At this point, the daughter cells are divided. Some species separate completely as shown here, while others remain attached, forming chains, doublets, or other cellular arrangements.



Reference : Prescott's Microbiology

Reference : Prescott's Microbiology

cell cycle consists of three phases: (1) a period of growth after the cell is born, which is similar to the G1 phase of the eukaryotic cell cycle; (2) chromosome replication and partitioning period, which functionally corresponds to the S and mitosis events of the M phase of the eukaryotic cycle; and (3) cytokinesis

bacterial chromosome replication and partitioning occur concurrently

some rapidly dividing bacteria are able to initiate new rounds of replication before the first round of replication and cytokinesis is finished

e. Each circular chromosome has a single site at which replication starts called the origin of replication, or simply the origin

Replication is completed at the terminus, which is located directly opposite the origin.