Bacterial Cell structure

1. Cell envelope – 3 layers

2 . External structures

3.cytoplasm

Cell envelope – 3 layers

1. Plasma membrane

2.Cell wall

3.Layers outside the cell wall

Bacterial Plasma Membrane Absolute requirement for all living organisms Some bacteria also have internal membrane systems

Plasma Membrane Functions

1. Encompasses the cytoplasm

2. Selectively permeable barrier

3. Interacts with external environment

4.receptors for detection of and response to chemicals in surroundings

5.transport systems

6. metabolic processes

Structure of plasma membrane

A layer of phospholipids and proteins, called the cytoplasmic membrane, encloses the interior of the bacterium, regulating the flow of materials in and out of the cell. This is a structural trait bacteria share with all other living cells; a barrier that allows them to selectively interact with their environment. Membranes are highly organized and asymmetric having two sides, each side with a different surface and different functions. Membranes are also dynamic, constantly adapting to different conditions.

A cell's plasma membrane defines the cell, outlines its borders, and determines the nature of its interaction with its environment. Cells exclude some substances, take in others, and excrete still others, all in controlled quantities. The plasma membrane must be very flexible to allow certain cells, such as red and white blood cells, to change shape as they pass through narrow capillaries. These are the more obvious plasma membrane functions. In addition, the plasma membrane's surface carries markers that allow cells to recognize one another, which is vital for tissue and organ formation during early development, and which later plays a role in the immune response's "self" versus "non-self" distinction**.**

The explanation, the fluid mosaic model, has evolved somewhat over time, but it still best accounts for plasma membrane structure and function as we now understand them. The fluid mosaic model describes the plasma membrane structure as a mosaic of components—including phospholipids, cholesterol, proteins, and carbohydrates—that gives the membrane a fluid character. Plasma membranes range from 5 to 10 nm in thickness. For comparison, human red blood cells, visible via light microscopy, are approximately 8 µm wide, or approximately 1,000 times wider than a plasma membrane. The membrane does look a bit like a sandwich (Figure 1).

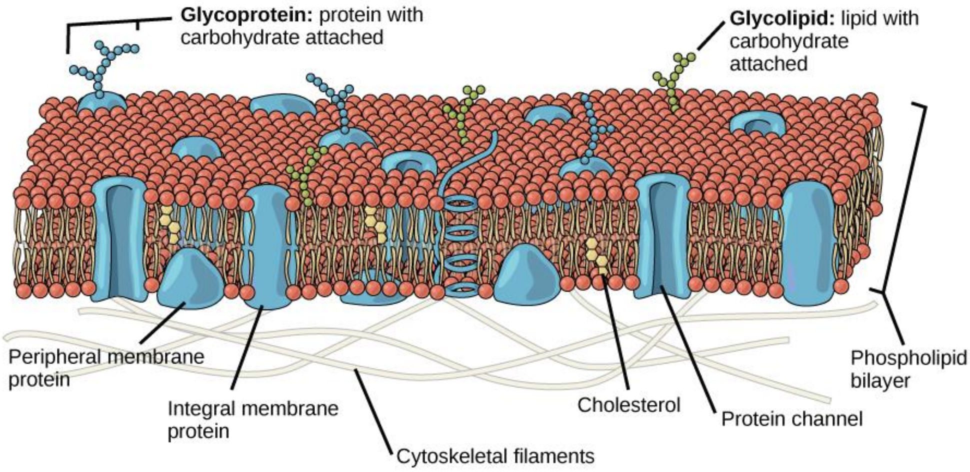


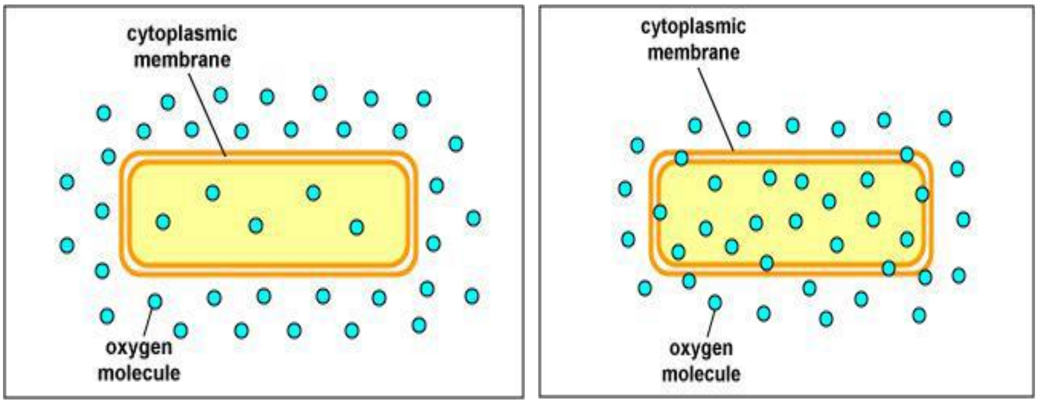
Figure 1. The fluid mosaic model of the plasma membrane structure describes the plasma membrane as a fluid combination of phospholipids, cholesterol, proteins, and carbohydrates

A plasma membrane's principal components are lipids (phospholipids and cholesterol), proteins, and carbohydrates attached to some of the lipids and proteins. A phospholipid is a molecule consisting of glycerol, two fatty acids, and a phosphate-linked head group. Cholesterol, another lipid comprised of four fused carbon rings, is situated alongside the phospholipids in the membrane's core. The protein, lipid, and carbohydrate proportions in the plasma membrane vary with cell type, but for a typical human cell, protein accounts for about 50 percent of the composition by mass, lipids (of all types) account for about 40 percent, and carbohydrates comprise the remaining 10 percent. However, protein and lipid concentration varies with different cell membranes. For example, myelin, an outgrowth of specialized cells' membrane that insulates the peripheral nerves' axons, contains only 18 percent protein and 76 percent lipid. The mitochondrial inner membrane contains 76 percent protein and only 24 percent lipid. The plasma membrane of human red blood cells is 30 percent lipid. Carbohydrates are present only on the plasma membrane's exterior surface and are attached to proteins, forming glycoproteins, or attached to lipids, forming glycolipids

Transport of substances across the bacterial cell membrane by transport (carrier) proteins

Passive Diffusion

Net movement of gases or small uncharged polar molecules across a bacterial cell membrane from an area of higher concentration to an area of lower concentration

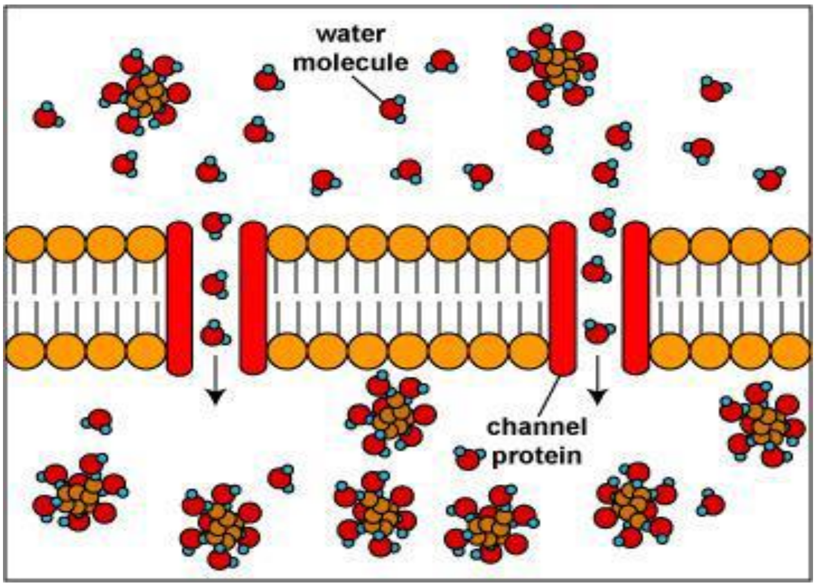


Channel proteins

Transport water or certain ions down a concentration gradient

from an area of higher concentration to lower concentration

While water molecules can directly cross the membrane by passive diffusion their transport can be enhanced by channel proteins called Aquaporins



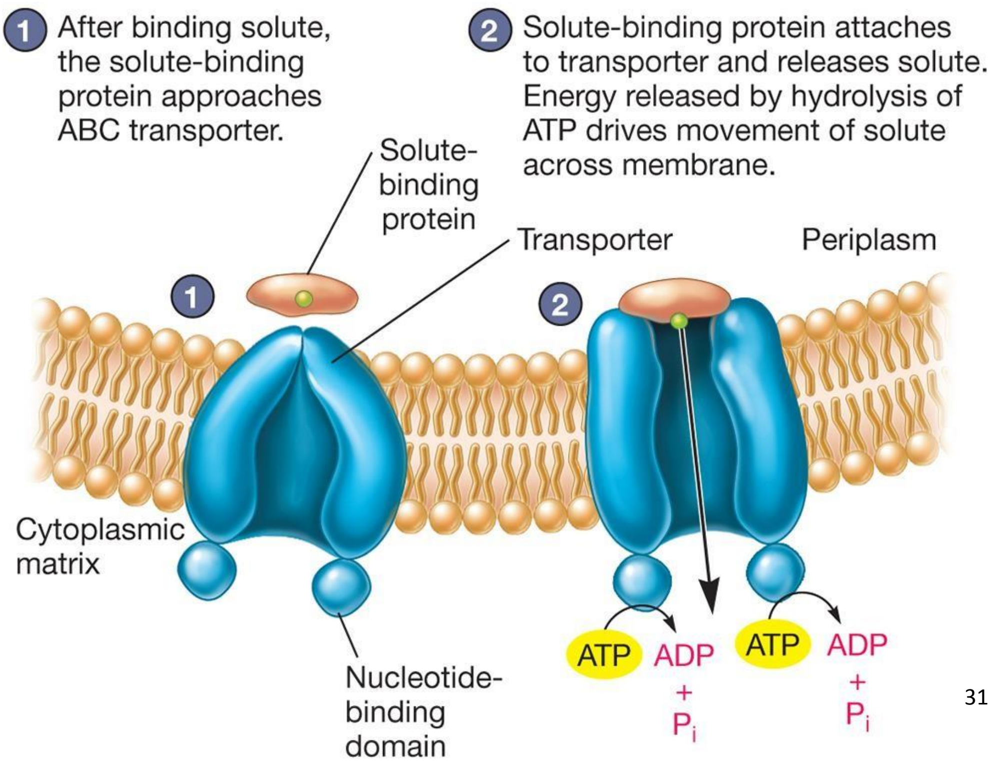
Facilitated Diffusion

Transport of substances across a membrane, along a concentration gradient from an area of higher concentration to lower concentration, by transport proteins such as uniporters and channel proteins Facilitated diffusion is powered by the potential energy of a concentration gradient and does not require the expenditure of metabolic energy These are the least common type of transport system in bacteria The glycerol uniporter in E coli is the only well-known facilitated diffusion system.

1.Similar to passive diffusion
2.movement of molecules is not energy dependent
3.direction of movement is from high concentration to low concentration
4.size of concentration gradient impacts rate of uptake

Active transport

1.energy-dependent process
2.ATP or proton motive force used
3.move molecules against the gradient
4.concentrates molecules inside cell
5.involves carrier proteins (permeases)
6.carrier saturation effect is observed at high solute concentrations



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Bacterial Cell Walls

Peptidoglycan (murein) rigid structure that lies outside the cell plasma membrane, two types based on Gram stain Gram-positive: stain purple; thick peptidoglycan Gram-negative: stain pink or red; thin peptidoglycan and outer membrane

Cell Wall Functions

1. Maintains shape of the bacterium

2.protect cell from osmotic lysis

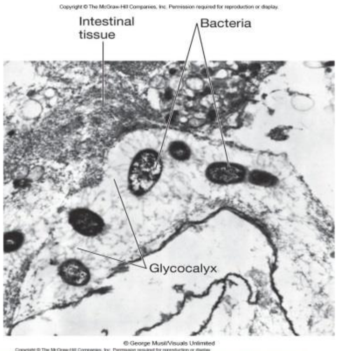
3. protect from toxic materials

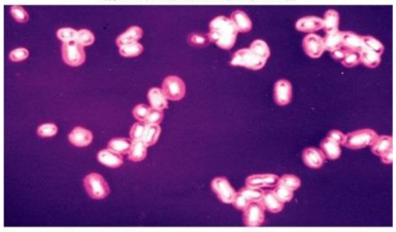
4 May contribute to pathogenicity

Cell Envelope Layers Outside the Cell Wall

Capsules

- Usually composed of polysaccharides
- Well organized and not easily removed from cell
- Visible in light microscope
- Protective advantages
  - resistant to phagocytosis
  - protect from desiccation
  - exclude viruses and detergents





K. pneumoniae

Pili and Fimbriae

1 Fimbriae (s., fimbria); pili (s., pilus)

– short, thin, hairlike, proteinaceous appendages (up to 1,000/cell)

– can mediate attachment to surfaces, motility, DNA uptake

2 Sex pili (s., pilus)

– longer, thicker, and less numerous (1-10/cell)

– genes for formation found on plasmids

– required for conjugation

Flagella

1.Threadlike, locomotors appendages extending outward from plasma membrane and cell wall

2.Functions

– motility and swarming behavior

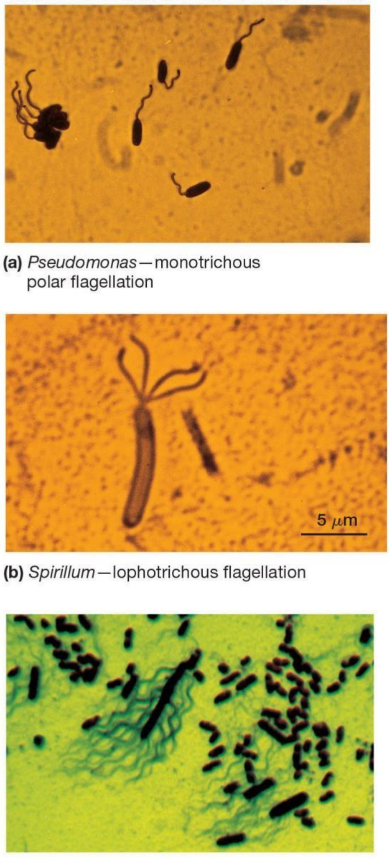
– attachment to surfaces

– may be virulence factors

Thin, rigid protein structures that cannot be observed with bright-field microscope unless specially stained, Ultrastructure composed of three parts, Pattern of flagellation varies

Patterns of Flagella Distribution

- Monotrichous – one flagellum
- Polar flagellum – flagellum at end of cell
- Amphitrichous – one flagellum at each end of cell
- Lophotrichous – cluster of flagella at one or both ends
- Peritrichous – spread over entire surface of cell



(a) *Pseudomonas*—monotrichous polar flagellation

(b) *Spirillum*—lophotrichous flagellation

(c) *P. vulgaris*—peritrichous flagellation

Three Parts of Flagella

1 Filament

– extends from cell surface to the tip

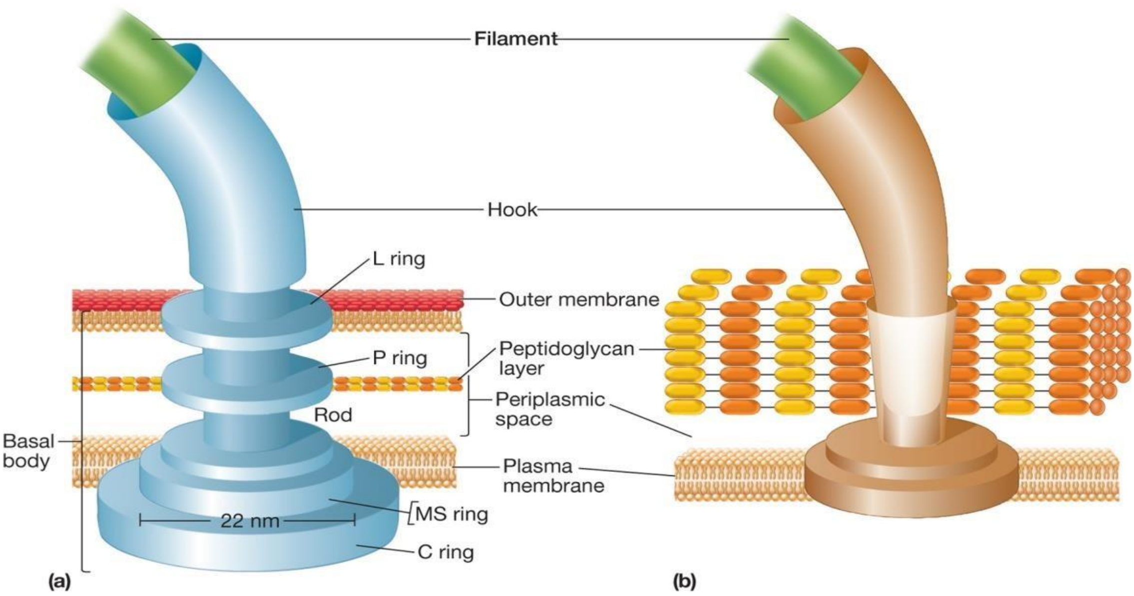
– hollow, rigid cylinder of flagellin protein

2 Hook

– links filament to basal body

3 Basal body

– series of rings that drive flagellar motor



Bacterial Cytoplasm

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Ribosomes

Ribosomes are microscopic "factories" found in all cells, including bacteria. They translate the genetic code from the molecular language of nucleic acid to that of amino acids—the building blocks of proteins. Proteins are the molecules that perform all the functions of cells and living organisms. Bacterial ribosomes are similar to those of eukaryotes, but are smaller and have a slightly different composition and molecular structure. Bacterial ribosomes are never bound to other organelles as they sometimes are (bound to the endoplasmic reticulum) in eukaryotes, but are free-standing structures distributed throughout the cytoplasm. There are sufficient differences between bacterial ribosomes and eukaryotic ribosomes that some antibiotics will inhibit the functioning of bacterial ribosomes, but not a eukaryote's, thus killing bacteria but not the eukaryotic organisms they are infecting

Nucleoid

The nucleoid is a region of cytoplasm where the chromosomal DNA is located. It is not a membrane bound nucleus, but simply an area of the cytoplasm where the strands of DNA are found. Most bacteria have a single, circular chromosome that is responsible for replication, although a few species do have two or more. Smaller circular auxiliary DNA strands, called plasmids, are also found in the cytoplasm.

Plasmids

Plasmids are passed on to other bacteria through two means. For most plasmid types, copies in the cytoplasm are passed on to daughter cells during binary fission. Other types of plasmids, however, form a tubelike structure at the surface called a pilus that passes copies of the plasmid to other bacteria during conjugation, a process by which bacteria exchange genetic information. Plasmids have been shown to be instrumental in the transmission of special properties, such as antibiotic drug resistance, resistance to heavy metals, and virulence factors necessary for infection of animal or plant hosts. The ability to insert specific genes into plasmids have made them extremely useful tools in the fields of molecular biology and genetics, specifically in the area of genetic engineering.