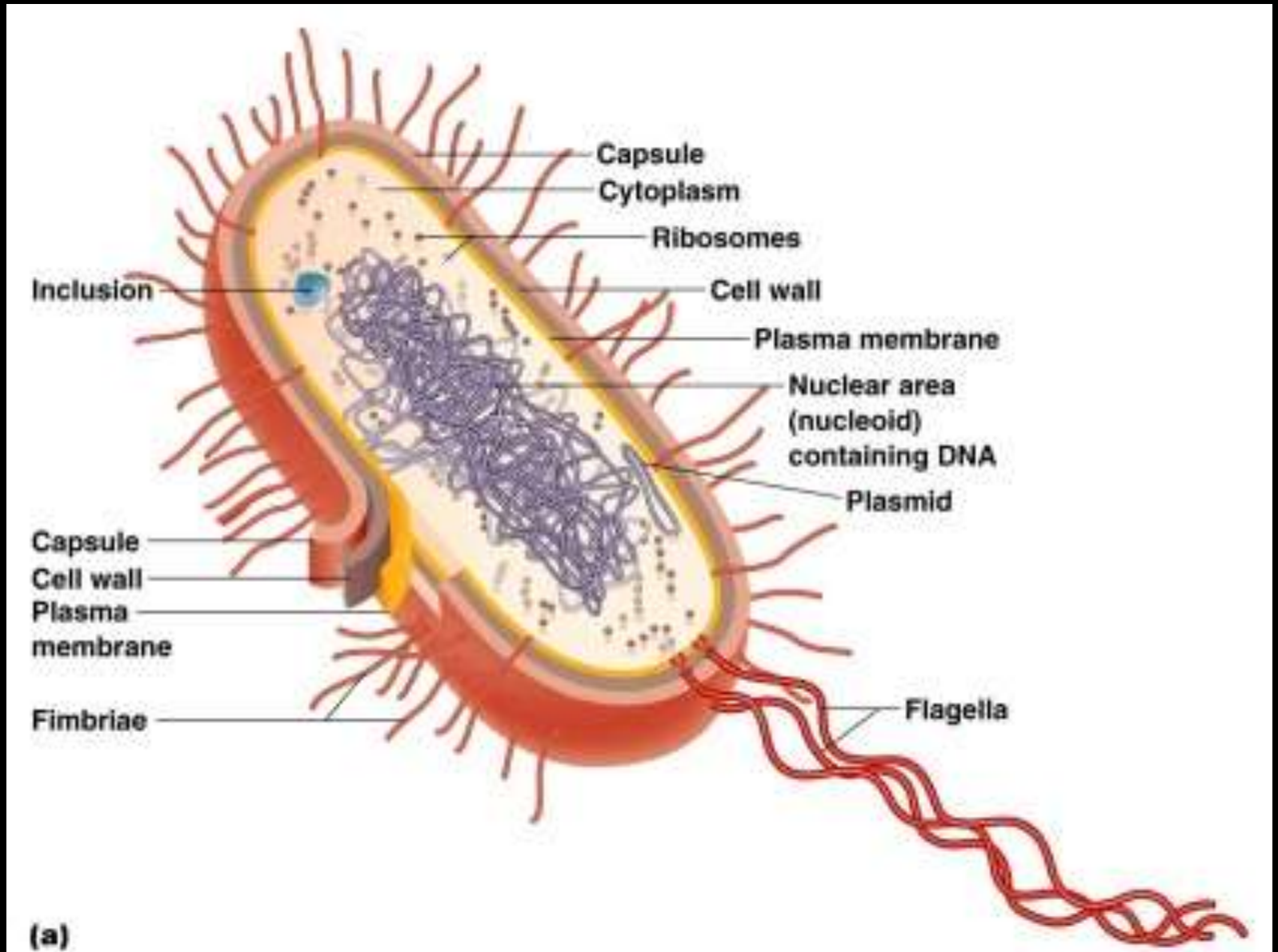
Functional Anatomy of Prokaryotic Cells

Prokaryotic Cell Structure – an Overview

- All prokaryotes are single-celled organisms, and all are bacteria
- Prokaryotes are among the smallest of all organisms.
- Most prokaryotes range from 0.5 to 2.0 μm in diameter (for comparison, a human RBC is about 7.5 μm in diameter
- Structurally, bacterial cells consist of the following:
  1. A cell membrane, usually surrounded by a cell wall and sometimes by an additional outer layer.
  2. An internal cytoplasm with ribosomes, a nuclear region, and in some cases granules and/or vesicles.
  3. A variety of external structures, such as capsules, flagella, and pili.

Cell Structure – an overview



Cell Membrane/Plasma Membrane/ Cytoplasmic membrane

A living, dynamic, constantly changing membrane

Forms the boundary between the cell & its environment

Consists of proteins (20-70%), lipids (28-80%), oligosaccharides (1-5%) & water (20%)

Has the same general structure as the membranes of all other cells

Consists of a continuous bilayer of phospholipid molecules in which globular proteins are embedded

The fluid-mosaic model – the currently accepted structure

The fluid-mosaic model

Proposed by Singer & Nicolson (1972)

Plasma membrane is quasifluid structure in which lipids & proteins are arranged in a mosaic manner

Membrane phospholipids form a **bilayer** or two adjacent layers

The phosphate ends extend toward the membrane surface – the charged (polar) phosphate ends **(head)** are **hydrophilic (water loving)**; thus can interact with a watery environment

The lipid (fatty acid) ends **(tails)** extend inward – consists largely of nonpolar hydrocarbon chains, are **hydrophobic (water fearing);** form a barrier between the cell and its environments

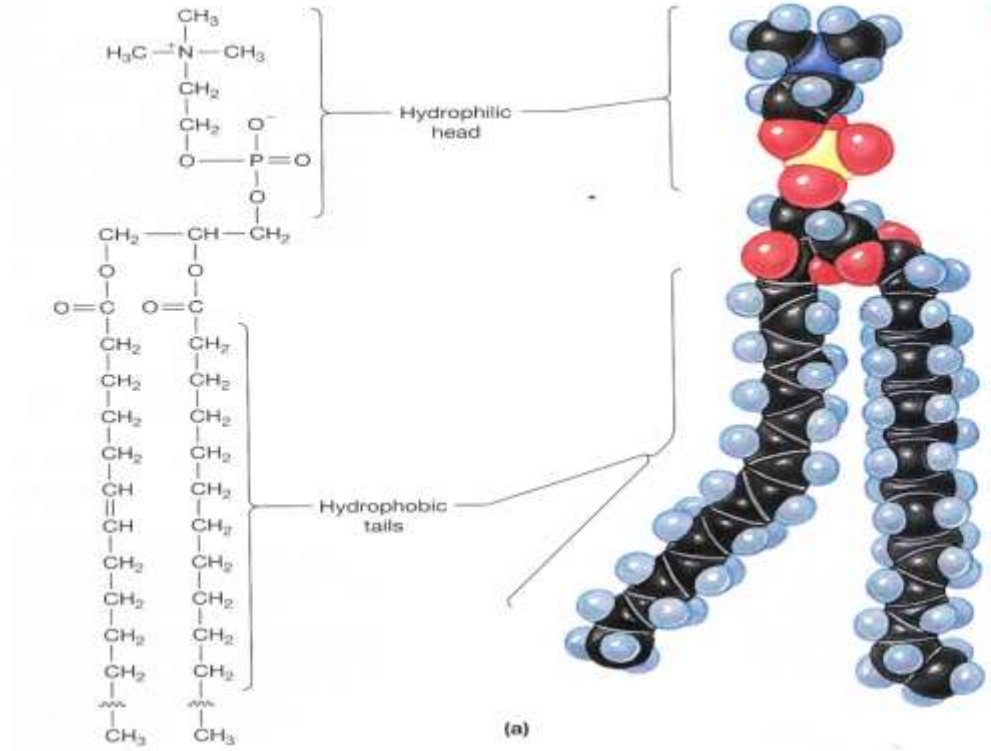
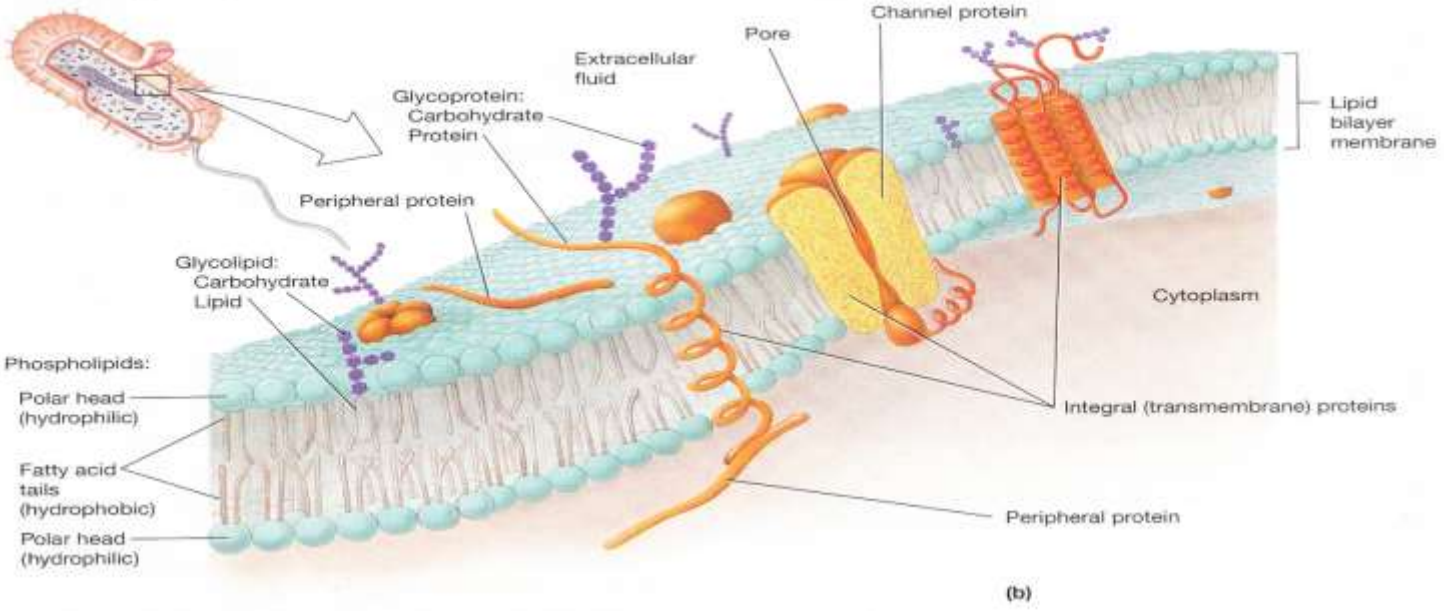


Figure 4.7 The fluid-mosaic model of the cell membrane. **(a)** The basic structural component of the membrane is the phospholipid molecule. A phospholipid has two long fatty acid "tails" of hydrocarbon. The tails are very hydrophobic—they do not interact with water and form an oily barrier to most water-soluble substances. The "head" of the molecule consists of a charged phosphate group, usually joined to a charged nitrogen-containing group. The head is very hydrophilic—it interacts with water. **(b)** The fluid mosaic model of membrane structure. The phospholipids form a bilayer in which the hydrophobic tails form the central core and the hydrophilic heads form the surfaces that face both the interior of the cell and the outside environment. In this fluid bilayer, proteins float like icebergs. Some extend through the bilayer; others are anchored to the inner or outer surface. Proteins and membrane lipids to which carbohydrate chains are attached are called *glycoproteins* and *glycolipids*, respectively. A few bacteria, such as mycoplasmas, have cholesterol molecules in their cell membranes, as do most eukaryotes. Mycoplasmas lack cell walls; cholesterol molecules add rigidity to the cell membrane.



The fluid-mosaic model

Two types of globular Proteins:

- Extrinsic (peripheral) proteins: soluble & therefore dissociate from the membrane
- include those that make the cell identifiable as a particular organism
- some embedded in or loosely attached to the inner or outer surfaces of the membrane
- those on the inner surfaces are usually enzymes
- Intrinsic (integral) proteins: insoluble & therefore cannot (or rarely) dissociate
- extend through the entire membrane & act as carriers or form pores or channels through which materials enter and leave the cells

The fluid-mosaic model

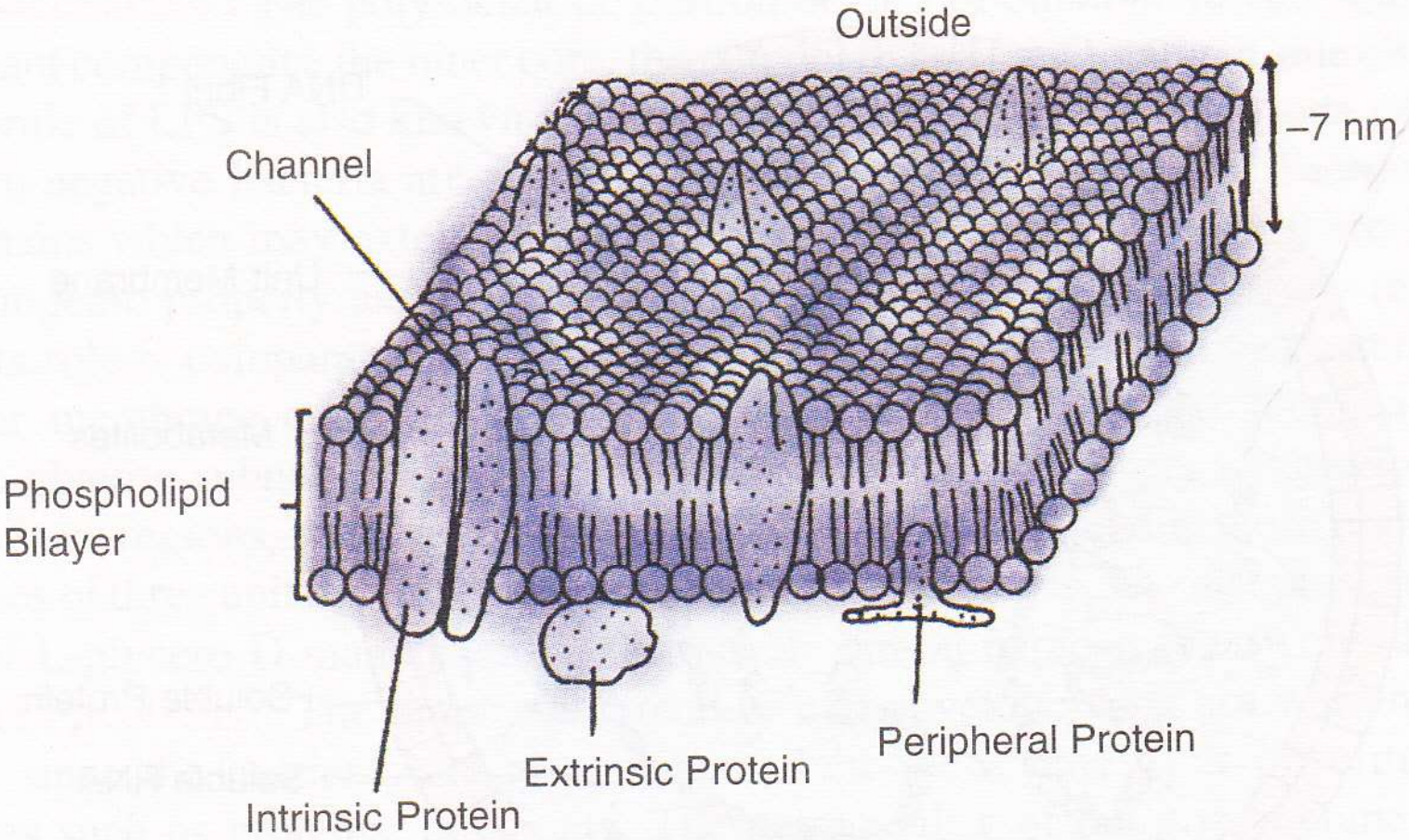


Fig. 4.12 : Fluid mosaic model of bacterial membrane (diagrammatic, based on Singer and Nicolson, 1972).

Cell Membrane/Plasma Membrane/ Cytoplasmic membrane

Functions: Site of many metabolic activities

1. Regulates the movement of materials into and out of the cell by transport mechanisms
2. Consists of enzymes involved in biosynthetic pathways that synthesizes different components of the cell wall
3. Possess attachment sites for bacterial chromosome and plasmid DNA
4. Inner membrane invaginates to form mesosomes; a site for respiratory activity
5. Provides ‘selective permeability’ – prevents escape of cellular materials outside the cell; facilitates selective entry of organic & inorganic substances inside

Cytoskeleton

A network of protein fibres made up of:

- **microtubules** – hollow tubes
- **microfilaments-** filamentous fibres

Cytoskeletal elements include:

FtsZ
MreB
Crescentin
ParM
SopA
MinCDE system
Bactofilin
Crenactin