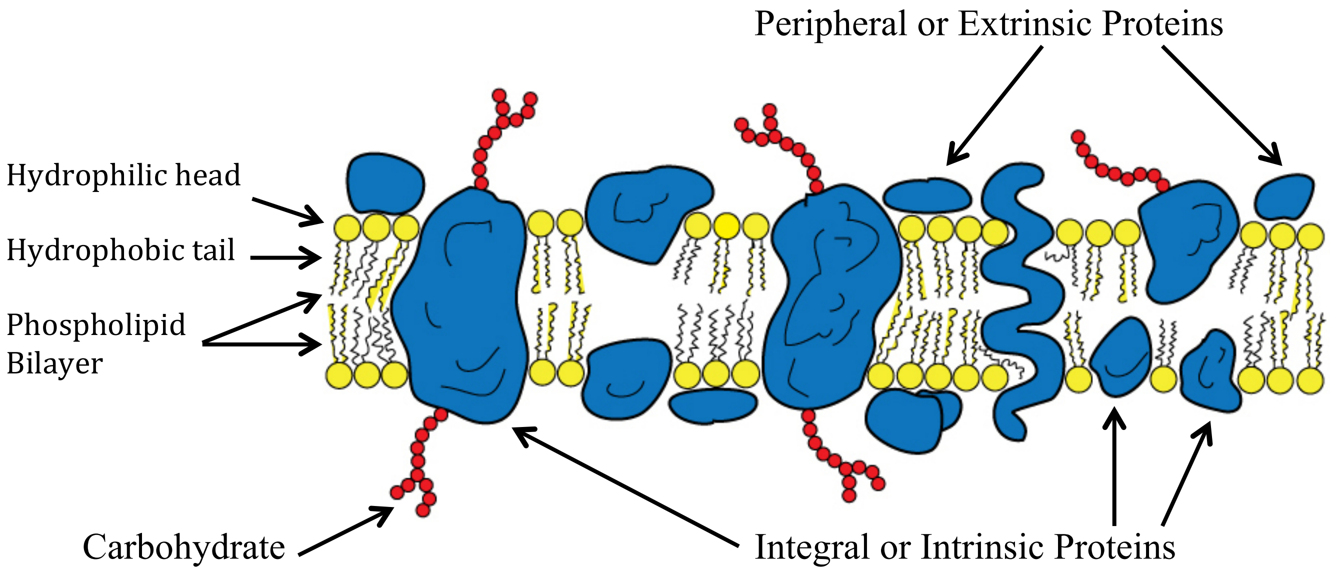
The Cell Membrane or Plasma Membrane

The cell membrane or plasma membrane is an invisible surface layer that contains and limits the cell. It is composed of protoplasm, so is dynamic; its features changing in time and space.

Membrane structure:

The cell membranes of eukaryotic cells contain lipids and proteins in approximately equal amounts, i.e., in a 50:50 ratio, but the membranes of bacteria typically contain lipids and proteins in a 40:60 ratio. The lipid portions of eukaryotic membranes contain around 65% phospholipid, 25% cholesterol and 10% other lipid types. Bacterial membranes typically lack cholesterol (a ring form lipid), so contain higher percentages of phospholipids. The currently accepted model for typical membrane structure was proposed by **Singer and Nicholson** in 1972, and is often referred to as the "**fluid mosaic model**". The protein components of the membrane float "like icebergs in a sea of lipids", and can move freely over the membrane surface.



The lipids (primarily phospholipids) and many of the proteins associated with cell membranes are **amphiphilic** or **amphipathic** molecules with both **polar** (**hydrophilic**) and **non-polar** (**hydrophobic**) groups in their structure. This property determines the orientation of molecules within the membrane (water loving regions toward the surfaces both inside and outside the cell, and water fearing regions toward the membrane interior), and helps maintain membrane stability.

Lipids (mostly phospholipids) provide the structural basis for cell membranes and support a variety of proteins (sometimes forming "rafts" for transport). The ratios of various types of lipids within the membrane influence fluidity VS rigidity. Gasses (O_2, CO_2, N_2, etc.) can pass freely through.

Proteins associated with membranes may be located on the surface (either externally or internally) as **peripheral proteins**, or they may be imbedded in the lipid matrix as **integral proteins**. Some integral proteins extend through the membrane and have exposed surfaces on both sides (through and through proteins). Many membrane proteins have **tertiary structure** (are globular in form), while others occur as helices (**secondary structure**). Protein complexes, i.e., proteins with **quaternary structure**, often carry carbohydrate chains on their external surfaces, so are categorized as **glycoproteins**.

Note – **Archaea** have cell membranes unlike those of other cells and are not well represented here.

Membrane Functions:

Cell membranes effectively separate the cell contents (**cytoplasm**) from external environments (where-ever cells live).

Cell membranes are selectively and differentially permeable, so determine what and how much enters or exits the cell. Water can pass through most cell membranes by means of **osmosis**, and gasses such as carbon dioxide, nitrogen and oxygen can pass by means of **simple diffusion**. These are passive processes and movement is influenced by concentration gradients. Ions (Na^+, K^+, Cl^-, H^+ etc.), and small organic compounds (amino acids, monosaccharides, etc.) can move passively through membranes by means of **facilitated diffusion**, i.e., they must be assisted by proteins such as **permease** enzymes. Ions travel through protein channels that are often "gated", so their movement can be blocked (when the "gates close). The movement of these charged particles is influenced by both electrical and concentration gradients. Membranes can **actively transport** substances against their concentration and/or electrical gradients using protein complexes called **porters**. If only one substance is being moved, the proteins involved are called **uniporters**, but if two different types of substances are being moved by the same protein complex, the complex is called either a **symporter** (when substances are moved in the same direction), or an **antiporter** (when substances are being moved in opposite directions). Membrane proteins also play a role in **phagocytosis** (cell eating), **pinocytosis (**cell drinking), and **receptor mediated endocytosis,** as receptor proteins on cell surfaces appear to be involved in all of these processes. Bacteria sometimes use **PEP group translocation** to bring monosaccharides into their cytoplasm. In this case, proteins (phosphotransferase enzymes) add phosphate groups (pulled from PEP), to the sugar molecules as they pass through the membrane.

Membrane proteins play a role in **taxis**, i.e., the directed movement of cells in their environment. Movement directed toward a stimulus is called positive taxis, while movement directed away is called negative taxis. Many different types of microorganisms respond to chemicals recognized as nutrient sources (food), so will swim toward regions where the chemicals are in higher concentration. Movement toward a chemical attractant is called **positive chemotaxis**, and movement away from a chemical repellant (e.g., toxins), would be **negative chemotaxis**. Microorganisms capable of using light as an energy source, will display **positive phototaxis**, and those with a preference of darkness will show **negative phototaxis**. Certain types of bacteria display taxis in response to other stimuli **(gravitaxis** (formerly called geotaxis), **magnetotaxis, thermotaxis, galvanotaxis, etc.)** but such responses may not involve membrane receptors.

Prokaryotic cell membranes are involved in the synthesis of important compounds, **adenosine tri-phosphate (ATP)** being the most significant. The enzyme complex **ATP-synthase** is found only within prokaryotic cell membranes. The cell membranes of bacteria are also involved in the synthesis of cell wall components.

Many membrane functions are dependent upon the proteins moving over the cell surface. Protein functions include: 1) serving a **structural components**; 2) serving as **carrier molecules**; 3) serving as **porters** (pumps) that actively transport ions and various types of molecules; 4) serving as **channels** for the passive flow of water, ions and other substances; 5) serving as **receptors** (usually **glycoproteins**) for a variety of substances (nutrients, oxygen, toxins, etc.). When bound to signaling molecules or ligands, these proteins change in conformation and trigger physiological changes within cells (**signal transduction**); 6) serving as **enzymes** that catalyze various reactions. Individual proteins or protein complexes may be involved in more than one of these functions, e.g., ATP-synthase allows hydrogen protons to cross the membrane (flow through it), and at the same time, synthesizes ATP.