Structure of the Cell Membrane

A cell's plasma membrane defines the boundary of the cell and determines the nature of its contact with the environment. Rather than being a static bag, plasma membranes are dynamic and constantly in flux. It must be sufficiently flexible to allow certain cells, such as red blood cells and white blood cells, to change shape as they pass through narrow capillaries. In addition, the surface of the plasma membrane carries markers that allow cells to recognize one another, which is vital as tissues and organs form during early development, and which later plays a role in the "self" versus "non-self" distinction of the immune response. The plasma membrane also carries receptors, which are attachment sites for specific substances that interact with the cell. Each receptor is structured to bind with a specific substance. Receptors on plasma membrane's exterior surface interact with hormones or neurotransmitters, and allow their messages to be transmitted into the cell.

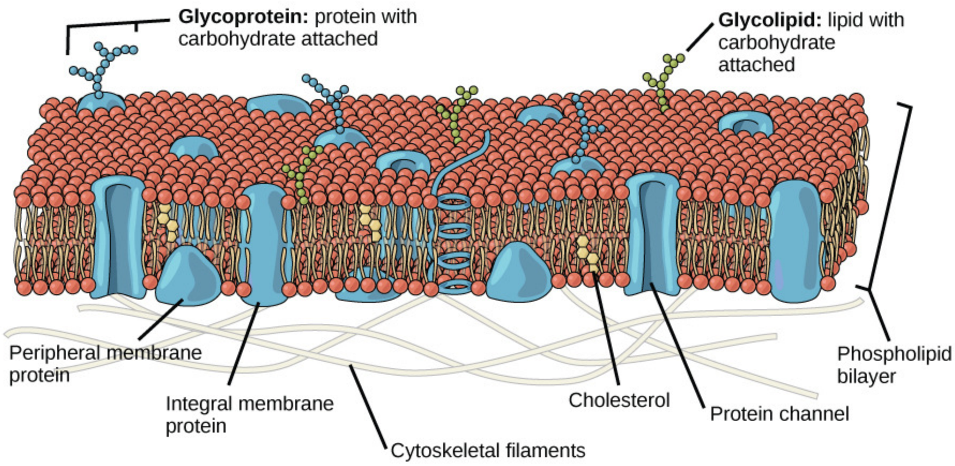
Fluid Mosaic Model:

In 1972, S. J. Singer and Garth L. Nicolson proposed a new model of the plasma membrane. This was called the fluid mosaic model. This model describes the structure of the plasma membrane as a mosaic of components—including phospholipids, cholesterol, proteins, and carbohydrates. Both phospholipid molecules and embedded proteins are able to diffuse rapidly and laterally in the membrane. Fluidity of the plasma membrane is necessary for the activities of certain enzymes and transport molecules within the membrane. Plasma membranes range from 5–10 nm thick. It is made up primarily of a bilayer of phospholipids with embedded proteins, carbohydrates, glycolipids, glycoproteins, and in animal cells, cholesterol. Amount of cholesterol in animal plasma membranes regulates the fluidity of the membrane and changes based on the temperature of the cell's environment.

The main fabric of the membrane is composed of two layers of phospholipid molecules, and the polar ends of these molecules are in contact with aqueous fluid both inside and outside the cell. Thus, both surfaces of the plasma membrane are hydrophilic (water-loving) while the interior of the membrane, between its two surfaces, is a hydrophobic (water-hating) or non-polar region because of the fatty acid tails. This region has no attraction for water or other polar molecules.

Proteins make up the second major chemical component of plasma membranes. Integral proteins are embedded in the plasma membrane and may span all or part of the membrane. They serve as channels or pumps to move materials into or out of the cell. Peripheral proteins are found on the exterior or interior surfaces of membranes, attached either to integral proteins or to phospholipid molecules. Both proteins may serve as enzymes, as structural attachments for the fibers of the cytoskeleton, or as part of the cell's recognition sites.

Carbohydrates are the third major component of plasma membranes. They are always found on the exterior surface of cells and are bound either to proteins (forming glycoproteins) or to lipids (forming glycolipids). These carbohydrate chains may consist of 2–60 monosaccharide units and may be straight or branched. Along with peripheral proteins, carbohydrates form specialized sites on the cell surface that allow cells to recognize each other.



Phospholipids:

Phospholipid molecule consists of three-carbon glycerol backbone with two fatty acid molecules attached to carbons 1 and 2, and a phosphate-containing group attached to the third carbon. This arrangement gives the overall molecule an area described as its head (phosphate-containing group), which has a polar character or negative charge, and an area called the tail (fatty acids), which has no charge. The head can form hydrogen bonds, but the tail cannot. A molecule with this arrangement of a positively or negatively charged area and an uncharged, or non-polar, area is referred to as amphiphilic or "dual-loving."

This characteristic is vital to the structure of plasma membrane because, in water, phospholipids tend to become arranged with their hydrophobic tails facing each other and hydrophilic heads facing out. Thus, they form a lipid bilayer, a barrier composed of double layer of phospholipids that separates the water and other materials on one side of the barrier from the water and other materials on the other side. Phospholipids heated in an aqueous solution tend to spontaneously form small spheres or droplets (called micelles or liposomes), with hydrophilic heads forming the exterior and their hydrophobic tails on the inside.