Phospholipids and Glycolipids L2

Membrane formation is a consequence of the amphipathic nature of the molecules. Biological membranes are composed of lipid, protein and carbohydrate that exist in a fluid state. Biological membranes are the structures that define and control the composition of the space that they enclose. All membranes exist as dynamic structures whose composition changes throughout the life of a cell.Their polar head groups favor contact with water, whereas their hydrocarbon tails interact with one another, in preference to water. The building block of the phospholipids is phosphatidic acid. Substitutions that can be added to phosphatidic acid include ethanolamine (phosphatidylethanolamines, PE), choline (phosphatidylcholines, PC: also called lecithins), serine (phosphatidylserines, PS), glycerol (phosphatidylglycerols, PG), *myo*-inositol (phosphatidylinositols, PI: these compounds can have a variety in the numbers of inositol alcohols that are phosphorylated generating polyphosphatidylinositols), and phosphatidylglycerol (diphosphatidylglycerols, DPG; more commonly known as cardiolipins). How can molecules with these preferences arrange themselves in aqueous solutions? One way is to form a *micelle*, a globular structure in which polar head groups are surrounded by water and hydrocarbon tails are sequestered inside, interacting with one another. In a nutshell, in membranes phospholipid translocases transport specific phospholipids across a bilayer in a process that is driven by ATP hydrolysis.

Note, the favored structure for most phospholipids and glycolipids in aqueous media is a bimolecular sheet rather than a micelle. The reason is that the two fatty acyl chains of a phospholipid or a glycolipid are too bulky to fit into the interior of a micelle. In contrast, salts of fatty acids (such as sodium palmitate, a constituent of soap), which contain only one chain, readily form micelles. The formation of bilayers (see fig 2-1) instead of micelles by phospholipids is of critical biological importance. A micelle is a limited structure, usually less than 20 nm (200 Å) in diameter. In contrast, a bimolecular sheet can have macroscopic dimensions, such as a millimeter (106 nm, or 107 Å). Phospholipids and related molecules are important membrane constituents because they readily form extensive bimolecular sheet

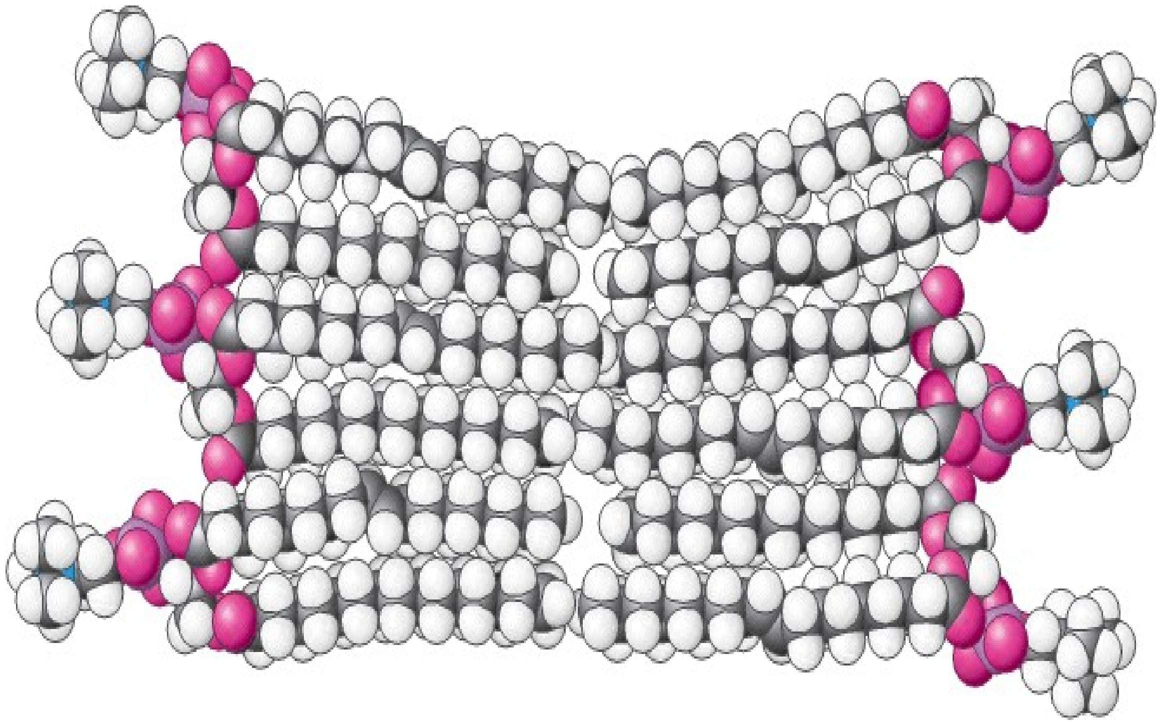

Fig 2-1: Space-Filling Model of a Section of Phospholipid Bilayer Membrane.

The formation of lipid bilayers is a self-assembly process. In other words, the structure of a bimolecular sheet is inherent in the structure of the constituent lipid molecules. The growth of lipid bilayers from phospholipids is a rapid and spontaneous process in water. Hydrophobic interactions are the major driving force for the formation of lipid bilayers.

Note, because lipid bilayers are held together by many reinforcing, noncovalent interactions such as hydrophobic bonds, they are cooperative structures. These hydrophobic interactions have three significant biological consequences:

(1) lipid bilayers have an inherent tendency to be extensive;

(2) lipid bilayers will tend to close on themselves so that there are no edges with exposed hydrocarbon chains, and so they form compartments; and

(3) lipid bilayers are self-sealing because a hole in a bilayer is energetically unfavorable.

Glycolipids

Lipids, such as fats and waxes, that have attached carbohydrate groups called glycans are referred to as glycolipids. There are many different kinds of glycolipids that serve many different biological roles; primarily, though, they are involved with cellular recognition and energy production. Glycans most commonly bond to phospholipids, which have one water-soluble end and one water-insoluble end. They are commonly found as parts of cellular membranes because of some traits related to their polar and nonpolar ends. Generally speaking, a glycolipid will form when a carbohydrate chain is attached to the outer part of a cellular membrane that is composed of lipids.

The most common types of glycolipids are glycosphingolipids, which are made up of ceramides . Ceramides are any group of lipids that are formed by the linking of a fatty acid to sphingosine, are found in cell membranes, and help to regulate the differentiation, proliferation, and death of cells connected to a glycan. Ceramides are made up of fatty acids connected to sphingosines, which are simply amino alcohols that are commonly found in nerve tissue, in the skin and spinal marrow. Glycosphingolipids tend to serve many roles relating to nerve and brain function; they are related to the proper functioning of myelin sheaths around nerves and of various signaling processes across cellular membranes. Some larger glycosphingolipids are actually related to the antigens that define blood type and can help mark the presence of some tumors. Glycosphingolipids are very important kinds of glycolipids; they appear in many different forms and are involved in many different biological processes.