VIVEKANANDA COLLEGE,THAKURPUKUR

TOPIC:LIPID BILAYER
COURSE:CELL BIOLOGY
PAPER:CC8
SEMESTER:4(HONOURS)
NAME OF TEACHER:NINEESHA SEN BANERJEE
DEPARTMENT:BIOCHEMISTRY

Lipid Bilayer Continued……..

The most abundant lipid components in most membranes are phospholipids, which are amphipathic molecules (i.e., they have a hydrophilic and a hydrophobic part). In phosphoglycerides, a principal class of phospholipids, fatty acyl side chains are esterified to two of the three hydroxyl groups in glycerol, and the third hydroxyl group is esterified to phosphate. The phosphate group is also esterified to a hydroxyl group on another hydrophilic compound, such as choline in phosphatidylcholine .Instead of choline, alcohols such as ethanolamine, serine, and the sugar derivative inositol are linked to the phosphate in other phosphoglycerides (Figure 5-28). The negative charge on the phosphate as well as the charged groups or hydroxyl groups on the alcohol esterified to it interact strongly with water. Both of the fatty acyl side chains in a phosphoglyceride may be saturated or unsaturated, or one chain may be saturated and the other unsaturated. Sphingomyelin, a phospholipid that lacks a glycerol backbone, is found mainly in plasma membranes). Instead of a glycerol backbone, it contains sphingosine, an amino alcohol with a long unsaturated hydrocarbon chain. In sphingomyelin, the terminal hydroxyl group of sphingosine is esterified to phosphocholine, so its hydrophilic head is similar to that of phosphatidylcholine.

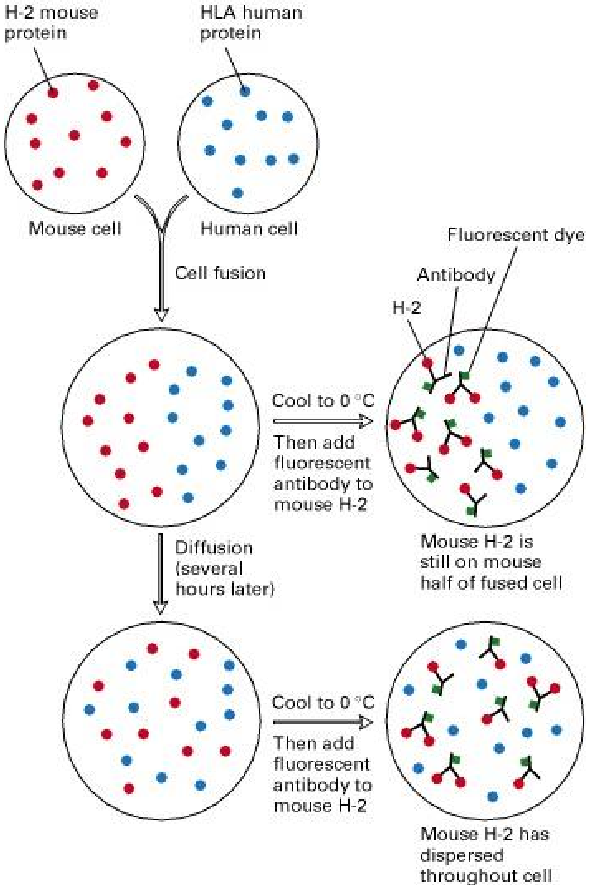
Cholesterol and its derivatives constitute another important class of membrane lipids, the steroids. The basic structure of steroids is the four-ring hydrocarbon shown in Figure 5-29a. Cholesterol, the major steroidal constituent of animal tissues, has a hydroxyl substituent on one ring (Figure 5-29b). Although cholesterol is almost entirely hydrocarbon in composition, it is amphipathic because its hydroxyl group can interact with water. Cholesterol is especially abundant in the plasma membrane of mammalian cells but is absent from most prokaryotic cells. As much as 30 to 50 percent of the lipids in plant plasma membranes consists of cholesterol an certain steroids unique to plants.

Most Lipids and Integral Proteins Are Laterally Mobile in Biomembranes

In both pure phospholipid bilayers and natural membranes, thermal motion permits phospholipid and glycolipid molecules to rotate freely around their long axes and to diffuse laterally within the membrane leaflet. Because such movements are lateral or rotational, the fatty acyl chains remain in the hydrophobic interior of the membrane. In both natural and artificial membranes, a typical lipid molecule exchanges places with its neighbors in a leaflet about 107 times per second and diffuses several micrometers per second at 37 °C. At this rate, a lipid could diffuse the length of a typical bacterial cell (≈1 µm) in only 1 second and the length of an animal cell in about 20 seconds.

In pure phospholipid bilayers, phospholipids do not migrate, or flip-flop, from one leaflet of the membrane to the other. In some natural membranes, however, they occasionally do so, catalyzed by certain membrane proteins called flippases (Chapter 15). Energetically, such movements are extremely unfavorable, because the polar head of a phospholipid must be transported through the hydrophobic interior of the membrane.

Various experiments have shown that many integral membrane proteins, like phospholipids, float quite freely within the plane of a natural membrane. In one such study, outlined in Figure 5-35, two different cells (e.g., mouse and human fibroblasts) are fused and the movement of their distinct surface proteins is then monitored at various times after incubation at 37 °C. Such experiments suggest that many integral proteins are free to diffuse in a sea of lipid in the two-dimensional space of the membrane. According to this concept, known as the fluid mosaic model, the membrane is viewed as a two-dimensional mosaic of laterally mobile phospholipid and protein molecules (see Figure 3-32). As discussed in Chapter 3, some integral membrane proteins consist of two or more noncovalently linked subunits; such multimeric membrane proteins float as a unit in the lipid. The lateral movements of surface proteins and lipids can be quantified by a technique called fluorescence recovery after photobleaching (FRAP). With this method, described in Figure 5-36, the rate at which surface protein or lipid molecules move — the diffusion coefficient — can be determined, as well as the proportion of the molecules that are laterally mobile. FRAP studies with fluorescent-labeled phospholipids have shown that in fibroblast plasma membranes, all the phospholipids are freely mobile over distances of about 0.5 µm, but most cannot diffuse over much longer distances. These findings suggest that protein-rich regions of the plasma membrane, about 1 µm in diameter, separate lipid-rich regions containing the bulk of the membrane phospholipid. Phospholipids are free to diffuse within such a region but not from one lipid-rich region to an adjacent one. Furthermore, the rate of lateral diffusion of lipids in the plasma membrane is nearly an order of magnitude slower than in pure phospholipid bilayers: diffusion constants of 10−8 cm2/s and 10−7 cm2/s are characteristic of the plasma membrane and a lipid bilayer, respectively. This



difference suggests that lipids may be tightly but not irreversibly bound to certain integral proteins in some membranes.