Membrane Structure and Function

by S. J. Singer

Department of Biology, University of California at San Diego, La Jolla, California, U.S.A.

It is generally accepted that the phospholipids and proteins of membranes are arranged according to the fluid mosaic model of membrane structure. The phospholipids are predominantly in the form of a bilayer. The proteins that are integral to the membrane are more-or-less globular molecules with an amphipathic three-dimensional structure. The hydrophilic segments of these amphipathic molecules protrude from the membrane surface into the aqueous phase, while the hydrophobic segments are embedded in the non-polar interior of the bilayer. Some integral proteins span the thickness of the membrane, with hydrophilic segments exposed at both membrane surfaces, while others protrude from only one surface. At short range, some integral proteins may form specific subunit aggregates, but the model suggests that generally there is no long-range order imposed on the proteins. Since the bilayer is mostly fluid under physiological conditions, these integral proteins can generally diffuse laterally in the membrane, but cannot move across the membrane.

In addition to integral proteins, peripheral proteins are associated with many membranes. Peripheral proteins are thought to be attached to a membrane at the protruding hydrophilic segments of specific integral proteins, and a particular peripheral protein may therefore be bound at one or the other surface of the membrane. Actin, for example, appears to be a peripheral protein at the cytoplasmic surface of the plasma membranes of many eukaryotic cells, but the attachment site in the membrane is not known. Cold insoluble globulin, collagen, and other proteins appear to be peripheral proteins on the external surfaces of fibroblastic cells in monolayer culture. These peripheral proteins may play important roles in regulating the lateral diffusion of integral proteins in membranes. Examples of such regulation will be presented from studies in our laboratory.