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# EDITORIAL

## Cellular Membranes

Cells retain their individual identity through the integrity of their boundaries—their plasma membranes. Membranes also compartmentalize cells by delimiting organelles. The versatility of cellular membranes is the subject of this year's *Frontiers in Biology* issue. The articles assembled in this issue emphasize the principles and processes of cell biology that rely on cellular membranes. These include mechanisms by which proteins and other solutes are transported across or are excluded by membranes, the nature of various proteins that reside in or near the membrane, and mechanisms by which cells interact with other cells or the substratum. Research on a wide variety of organisms—from prokaryotes to mammals—is now revealing fundamental similarities in the way cells accomplish these tasks.

The membrane barrier must be overcome to allow the controlled movement of an assortment of molecules (ions, nutrients, proteins, etc.) into and out of a cell. Cells therefore are equipped with mechanisms to selectively transport molecules through membranes. Nikaido and Saier discuss the structure and function of transporters in bacteria, which have a double membrane that must be penetrated. These proteins transport ions and nutrient molecules across both the outer and inner membranes. The transport proteins are similar in structure to each other and also to the transporters of mammalian cells. Proteins that are to be secreted from cells or whose destination is the inside of an organelle bounded by a membrane must also be allowed through the membrane barrier. Rapoport reviews recent progress in understanding how proteins are transported through the membrane of the endoplasmic reticulum. The proteins appear to move from the cytoplasm through a channel in the membrane. The transport proteins responsible for moving proteins across the endoplasmic reticulum of mammalian cells turn out to be similar to the proteins that participate in protein transport in yeast and bacteria.

Another way in which the membrane border can be breached is through the fusion of two distinct membranes. In some cases, vesicles empty their contents into another compartment or to the outside of a cell. In other circumstances separate cells will fuse, such as the sperm and egg during fertilization. Viral particles can also fuse with cell membranes. White summarizes the characteristics of these various fusion events and the proteins that participate in them. She notes that a viral fusion protein appears to be similar to a fusion protein on the sperm membrane. Exocytosis, another process that relies on fusion, is dependent on the family of proteins called "annexins." Creutz describes the annexins and how they promote calcium-dependent contact and fusion of membranes.

Cellular membranes are heterogeneous. The particular functions of certain regions of the membrane require that proteins be selectively distributed to the proper membrane domains. Nelson reviews the pathways that lead to restricted expression of proteins on the cell surface. Again, the mechanisms appear to be shared in bacteria, yeast, and mammalian cells.

On its inner surface, the cell's plasma membrane and the proteins within it contact the cytoskeleton. As described by Luna and Hitt, the cytoskeleton is a proteinaceous scaffold that contributes to a cell's shape, the stabilization of the membrane, and the regulation of cell movement. Cell surface receptors that mediate adhesion of cells to other cells or to surfaces also interact with proteins of the cytoskeleton. These adhesion receptors allow the membrane to perform another of its functions—that of recognition. Lasky describes the selectin family of adhesion receptors that are found on cells of the immune system and blood vessel cells. These molecules bind to carbohydrate structures on the surface of other cells and target leukocytes to areas of inflammation.

Dingwall and Laskey review the properties and functions of the nuclear membrane. Proteins and messenger RNA are transported across the nuclear membrane through nuclear pore complexes. The authors summarize the function of the pore complex, signaling mechanisms at the nuclear membrane, and the role of the nuclear membrane in DNA replication.

This special section provides a gateway into the dynamic processes that are dependent on cellular membranes. In some cases, these articles describe true "frontiers" in that much uncharted territory remains. Already impressive progress has been made, and fundamental molecular mechanisms that appear to be shared by remotely related organisms are beginning to be understood.

Linda J. Miller and L. Bryan Ray