10.0 Lipids, Membranes and Cellular Transport

Objectives

1. Know the classification of lipids.
2. Try drawing common triacylglycerols and glycerophospholipids.
3. Understand the biological membrane structure and the fluid mosaic model.
4. Know the types of membrane proteins.
5. Understand how lipid asymmetry is maintained.
6. Understand the thermodynamics of transport across the membranes.
7. Know the types of transport.
8. Understand how Na+/K+-ATPase work.

10.1 Know the classification of lipids.

Lipids, also known as fats, are important biological molecules found in many roles in the body. One example is the cell membrane in animal cells, formed from one or more layers of primarily lipid molecules.

Lipds are soluble in nonpolar solvents and insoluble in water and other polar solvents. Lipids are classified into groups of similar molecules, including fatty acids, glycerolipids, glycerophospholipids, sphingolipids, sterols, and many more.

10.3 Biological membrane structure and fluid mosaic model

As mentioned above, biological membrances are primarily composed of lipids and may form single layer membrances, micelles, or double-layer membranes called liposomes or vesicles.

In bilayer cell membranes, the fluid mosaic model is used to explain the structure and behavior of the lipid bilayer. In the fluid mosaic model, a lipid bilayer is embedded with proteins and other structures that can move laterally with ease due to the arrangement of lipid molecules. However, transverse movement requires more energy to flip between the outer membane to the inner or vice versa. In fact, proteins are often two large and require so much energy that they normally never flip. The fluidity of the membrane is determined by temperature, length of the lipid tails, the degree of saturation, and the presence of cholesterol.

10.4 Know the types of membrane proteins.

There are a variety of proteins commonly found embedded in cell membranes:

- Integral proteins
- Peripheral proteins
- Lipid-anchored proteins

Integral proteins (IMPs) are strongly embedded proteins found in membranes that can only be removed using detergents, nonpolar solvents, and denaturization. Many integral proteins are transmembrane, but not all. IMPs serve many functions in the membrane, including transport, channels, receptors, and more.

Peripheral proteins are weakly embedded proteins that are easier to remove, and therefore they are easier to study. They may attach to IMPs or they may be contained in the peripheral areas of the membrane.

Lipid-anchorage proteins, as the name implies, are anchored to the lipids that comprise the membrane bilayer.

10.5 Understand how lipid asymmetry is maintained.

The bilayer membrane is asymmetrical, meaning that the inner and outer membranes are structurally different. This asymmetry is important for the functionality of the membrane, as many reactions must happen outside the cell but not inside, or transport must occur in only one direction, etc.

Asymmetry is maintained through a number of mechanisms. Proteins for example, cannot rotate across the membrane. During membrane synthesis, new membranes are generated by expanding the existing asymmetric membranes.

10.6 Thermodynamics of transport across the membranes.

Transport across the membrane is generally driven by chemical potential and electrical potential. Energy reaches equilibrium across the membrane in the absence of active transport, and can be described using free energy and the concentrations on either side of the membrane.

10.7 Know the types of transport

Transport across lipid membranes occurs via multiple mechanisms:

- Non-mediated
- Mediated

In non-mediated transport (passive diffusion), ions and molecules can flow through the membrane due to difference in gradients across the membrane, such as electrochemical gradients.

Mediated, or active, transport (facilited diffusion) uses an active input of energy to aid the movement of ions and molecules, sometimes against gradients. Active transport mechanisms include ionophores, porins, and conformation-changing proteins.

10.8 Understand how Na+/K+-ATPase work.

One important active-transport protein is NA+/K+ ATPase, a protein found in cellular membranes that maintains concentrations of NA+ and K+ inside and outside the cell. This protein is found in all organs but is particularly important in the brain where it drives many neurochemical processes.

This protein requires an input of energy in the form of ATP hydrolysis, which pushes Na+ out of the cell and pulls K+ ions into the cell. This process accounts for a massive portion of the organism's energy requirements and is used throughout the body.