Phospholipid and Membrane Transport Kit – *In Brief*

Key Teaching Points for the Phospholipid and Membrane Transport Kit©

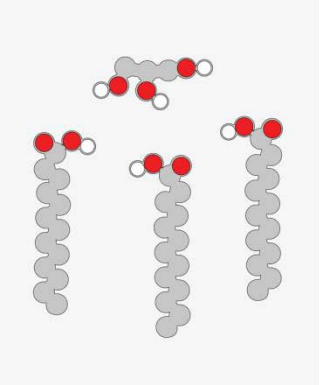
Overall Student Learning Objective: How Does Membrane Composition Influence the Passage of Substances Across It?

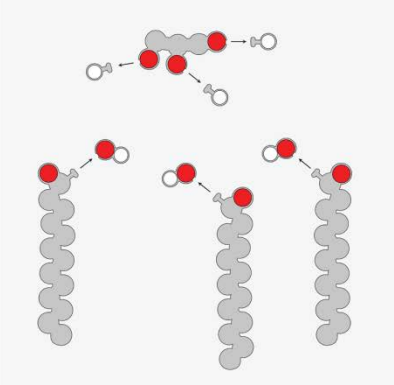
- Lipids are a diverse group of biomolecules that include fatty acids, triglycerides, phospholipids, fat soluble vitamins and steroids.
- Lipids may be saturated or unsaturated.
- A triglyceride is formed when three fatty acids are chemically combined to a glycerol via a dehydration synthesis reaction between each hydroxyl group of the glycerol and the carboxyl group of each fatty acid.
- A phospholipid is formed when glycerol, two fatty acids and a phosphate “head” chemically combine through dehydration synthesis.
- The ability of phospholipids to spontaneously form membranes is inherent to their amphipathic nature.
- Cellular membranes are composed of a phospholipid bilayer.
- Transport proteins embedded in the phospholipid bilayer facilitate transport of substances across cell membranes.
- Movement of a substance across a membrane without the expenditure of energy is referred to as passive transport.
- When the cell must expend energy to move a substance against its concentration gradient, the process is referred to as active transport.

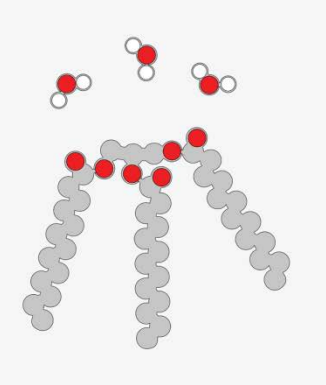
For a more complete lesson guide, please visit:
http://www.3dmoleculardesigns.com/Teacher-Resources.htm

Triglyceride Synthesis

Using the pieces illustrated below, students may model a dehydration synthesis reaction in which a triglyceride and three molecules of water are formed from three fatty acids and glycerol.







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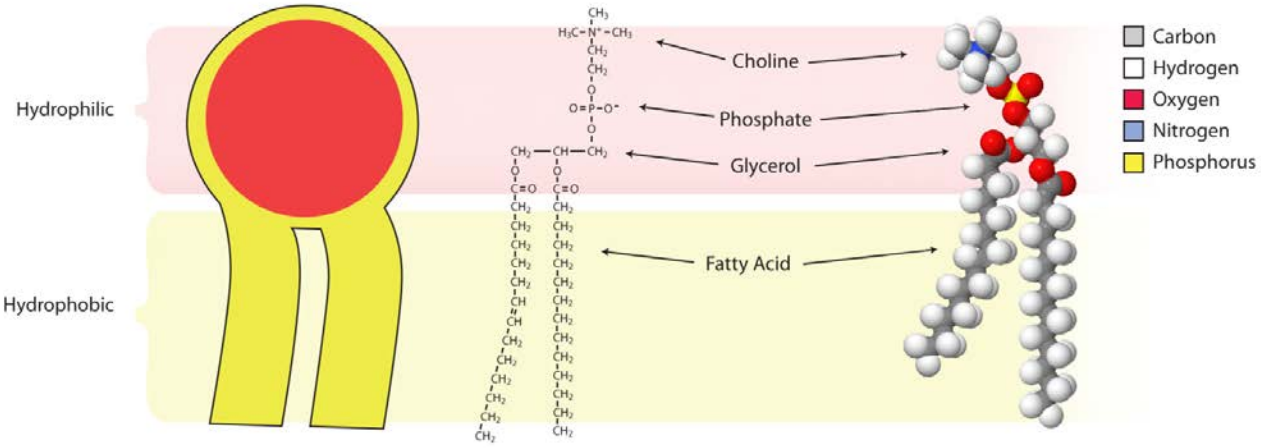
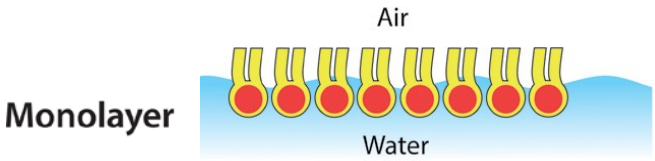
Phospholipid Structure

The general structure of a phospholipid is most often represented by the phosphatidylcholine structure.

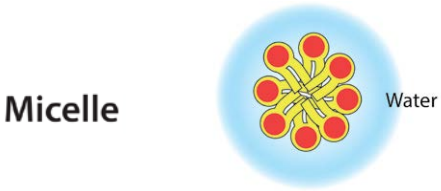


The Spontaneous Assembly of Membranes (The Kessler Activity)

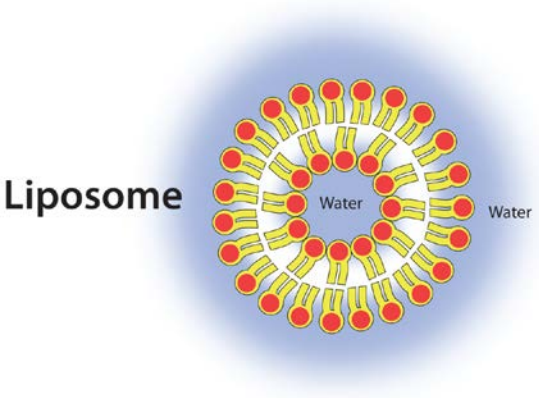
Challenge 1: Use 8 of the simplified representations of a phospholipid to form a single layer in the beaker of water diagram. Correct hydrophobic/hydrophilic interactions must be maintained.



Challenge 2: Using the same 8 phospholipids, arrange them in the beaker so that they are **submerged** in the water while still maintaining the correct hydrophobic/hydrophilic interactions.



Challenge 3: Construct a structure that is BOTH **submerged** in the water AND **contains** water on the inside. You may use as many of the phospholipids in your kit as you wish to complete the task.



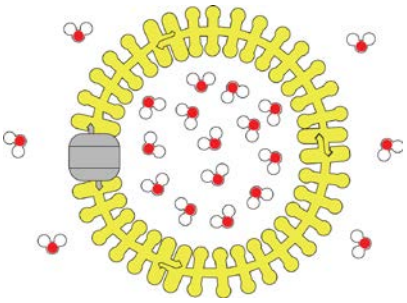
Passive and Active Transport

The phospholipid bilayer is only one aspect of the gatekeeper system responsible for the plasma membrane's **selective permeability**. Membrane-bound proteins play a key role in regulating the transport of ions and molecules through the plasma membrane.

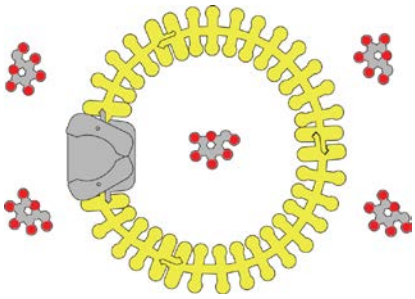
Passive Transport

Movement of a substance across a membrane without the expenditure of energy is referred to as **passive transport**.

A substance will generally diffuse from where it is more concentrated to where it is less concentrated. In other words, the substance will diffuse down its **concentration gradient**. Some transport proteins, referred to as **channel proteins**, function by having a hydrophilic channel that certain molecules or ions use to cross the plasma membrane. There is a common misconception that a polar water molecule can easily cross the hydrophobic bilayer of the plasma membrane. Simple diffusion of water across the membrane does not occur at a rate fast enough in order to meet the survival needs of a cell.

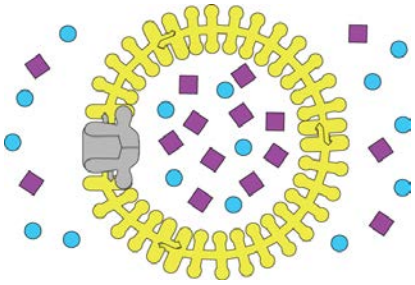


Aquaporin is an example of a channel protein found in the plasma membrane which passively assists in the transport of water across the cell membrane. This occurrence may be referred to as **facilitated diffusion**.



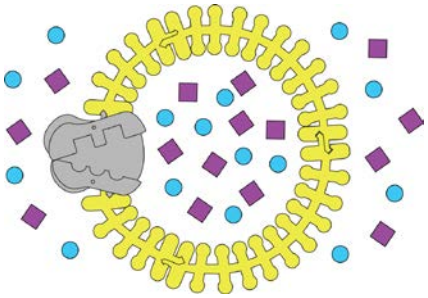
A **carrier protein** binds a solute molecule on one side of the membrane, undergoes a shape change (conformational change) and deposits the solute molecule on the other side of the membrane. GLUT 1 is an example of a protein channel, frequently found in the plasma membrane of red blood cells, that facilitates the movement of glucose across the cell's plasma membrane.

Gated channels are channel proteins that open or close in response to a stimulus. In nerve cells, the stimulus is a change in voltage across the membrane from generation of an action potential. Voltage-gated sodium channels open to allow a stream of sodium ions to enter the cell.



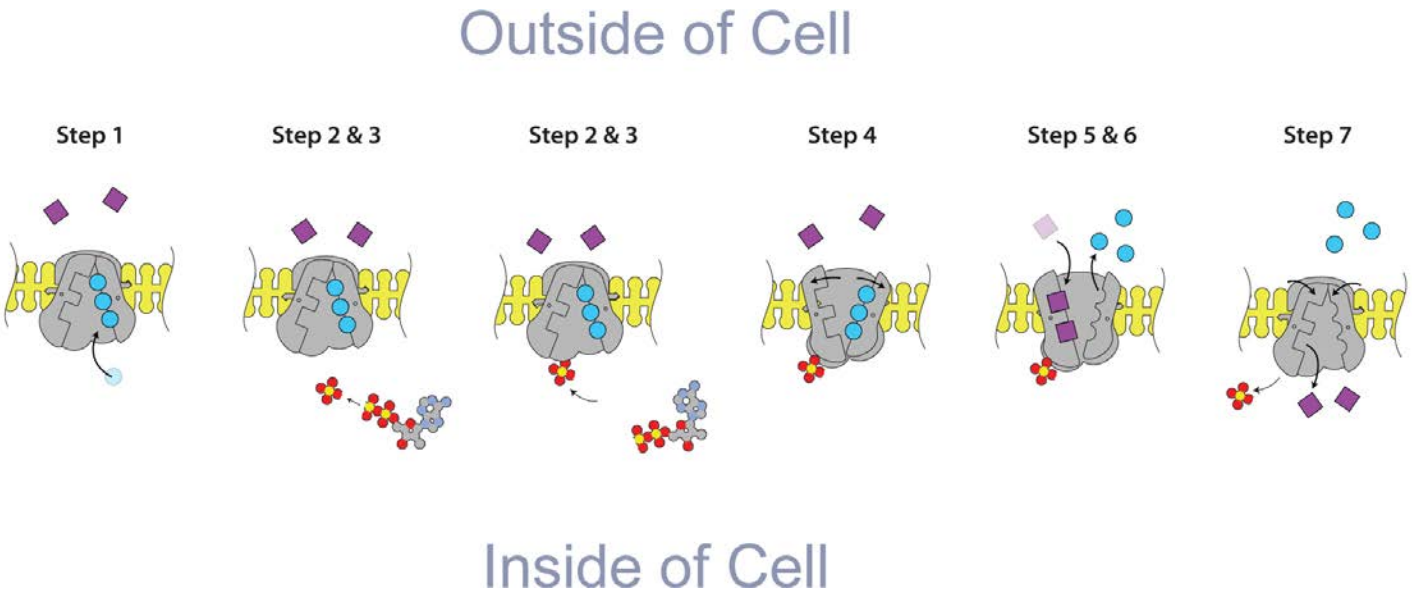
Active Transport

When the cell must expend energy to move a substance against its concentration gradient, the process is referred to as **active transport**.



Transport proteins that move solutes against their concentration gradients are all carrier proteins. The sodium-potassium pump is a special carrier protein that moves sodium ions against their gradient OUT of the cell and potassium ions against their gradient IN to the cell.

A typical animal cell has a much higher concentration of potassium ions (K^+) and a much lower concentration of sodium ions (Na^+) on the inside of the cell than the outside. The sodium-potassium pump uses energy in the form of ATP to move these ions against their concentration gradients and establish the “normal” intracellular ion concentrations.



The Phospholipid and Membrane Transport Kit© can be purchased from 3D Molecular Designs (*www.3dmoleculardesigns.com*).