

1. Cellular membranes are somewhat fluid in nature. The fluidity of membranes is related to their composition - shorter, more unsaturated fatty acids make for membranes that retain fluidity at lower temperatures compared to longer, saturated fatty acids. Fish membranes, for example are full of unsaturated and polyunsaturated fatty acids, which makes sense because fish membranes must be fluid at fairly low temperatures.
2. Biological membranes can be in a fluid or a more solid state. The midpoint of the conversion between the solid and the fluid state is referred to as the T_m . Cholesterol is often found in membranes. Though it does not change the T_m of a membrane it does widen the range of the transition temperature between solid and fluid state.
3. Unsaturated fatty acids in glycerophospholipids and sphingolipids tend to lower the T_m of a membrane. Saturated fatty acids tend to raise the T_m . Shorter fatty acids also lower T_m s, but longer ones raise it.
4. The Fluid Mosaic Model explains the fluidity of cellular membranes.
5. Not all molecules move into a cell through specific protein receptors. An example of such an exception is cholesterol, which enters cells via LDLs (talked about later in term) that attach to a receptor on the cell's surface. The entire LDL with the cholesterol is taken into the cell in a process called endocytosis.

Highlights of Membrane Transport

1. Diffusion is a process in solutions where molecules move from a high concentration to a low concentration. Active transport occurs when at least one molecule is moved across a membrane from a low to a higher concentration. This takes energy.
2. We break transport across membranes into two main categories - 1) passive transport (diffusion driven, so materials move only from high concentration to lower concentration and don't require outside energy), and 2) active transport (an energy-requiring process that moves at least one molecule from a low concentration to a higher concentration - this is contrary to simple diffusion).
3. Active transport moves at least one molecule in the opposite direction of where diffusion would operate (that is, active transport moves at least one molecule from a low concentration to a higher concentration).
4. ATP is a primary energy source for active transport, but there are other sources, as well (see below). The term 'pump' is used to describe the protein component of an active transport system. Pumps that move two molecules in the same direction across a membrane are called symports (or synports), whereas pumps that move two molecules in opposite directions across a membrane are

called antiports. Pumps are called electroneutral if their action does not result in a net change in charge and electrogenic if their action changes the charge across the membrane as a result of their action.

5. An example of a passive transport system is a glucose transporter in blood cells that simply lets glucose diffuse into cells. No energy is required for that particular transporter. Other glucose transporters in other cells are active in that they use energy to move glucose against a concentration gradient.

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7. P-type ATP-using transport systems use **phosphoaspartate** as a covalent intermediate in their mechanism of action.

8. The mechanism of transport of the Ca/ATPase pump includes binding of ATP and the relevant ions (calcium, in this case), transfer of phosphate from the ATP to the protein (making phosphorylaspartate), conformational change in the protein causing movement of the ions across the membrane, hydrolysis of the phosphate from an aspartic acid side chain in the protein, a second conformational change to bring the protein back to its original state.

9. Another P type ATPase is the Na/K ATPase. The Na/K ATPase transports three sodiums out of the cell and two potassiums in for each cycle. This is an electrogenic transport mechanism and uses hydrolysis of ATP to drive the process. Movement of Na and K is essential for the cell being able to maintain osmotic balance. The Na/K ATPase is called an antiport because it moves molecules in opposite directions.

10. Another class of transporter proteins that use ATP to move molecules are the ABC transporters. An example is the Multidrug Resistance Protein that is involved in the resistance of cancer cells to chemotherapy agents. They act by binding the compound first. This causes a conformational change in the protein that allows ATP to bind. Binding of ATP causes the protein to 'evert' (move its opening from one side of the membrane to the other). This has the effect of moving the bound compound to the outside of the cell. After this happens, ATP is hydrolyzed to change the protein to evert again and change back to its original conformation (opening facing inwards).

11. The $\text{Na}^+/\text{Ca}^{++}$ exchange pump (not shown in a figure in class, but described) is a secondary transporter. It uses movement of Na^+ in to cells to be a driving force for pumping Ca^{++} out. Remember that Ca^{++} stimulates muscular contraction. If Ca^+ is not pumped OUT, its concentration in muscle cells remains high, stimulating contraction. Digoxigenin is a compound from foxglove that binds the Na^+/K^+ ATPase, preventing development of a Na^+ gradient. As a

consequence, digitoxigenin increases Ca^{++} concentration, since Ca^{++} pumping requires a Na^{+} gradient. Digitoxigenin is used as a heart stimulant.