Membrane Transport

Movement of substances through the plasma membrane happens in essentially two ways: 1. passively and 2. actively

In Passive processes substances penetrate the membrane without any energy input from the cell.

In active processes the cell provides the metabolic energy (ATP) that drives the transport process to move the substance across the membrane.

Passive Processes: Diffusion

Diffusion is the tendency of molecules or ion to scatter evenly throughout the environment. Molecules are said to diffuse e along or down their concentration gradient.

Because the driving force is the kinetic energy of the molecules themselves, the speed of diffusion is influenced by the size of the molecules and the temperature.

Because a plasma membrane has a hydrophobic lipid interior, it acts as a barrier to free diffusion. Molecules will diffuse passively through the plasma membrane if they are 1. lipid soluble, 2. small enough to pass through membrane pores, or 3. assisted by carrier molecules.

The unassisted diffusion of lipid soluble or very small particles is called <u>simple diffusion</u>. Simple diffusion of water is known as <u>osmosis</u>.

Substance that commonly undergo simple diffusion include; oxygen, carbon dioxide, fats, and alcohol.

<u>Osmosis</u> is the diffusion of a solvent, such as water, through a selectively permeable membrane. Since water is highly polar, it cannot pass through the lipid bilayer, but it is small enough to pass through the pores of most plasma membranes.

<u>Facilitated diffusion</u>. Certain molecules, notably glucose and other simple sugars, are both lipid insoluble and too large to pass through the plasma membrane pores. Facilitated diffusion is the process in which these molecules are transported across the plasma membrane by carrier molecules. It is believed that these carrier molecules engulf the substance and then change their shape to release the molecule into the cytosol. Unlike osmosis, which is a very non-selective process relying only on particle size, facilitated diffusion is very specific. The carrier molecule for glucose will only recognize glucose, etc.

Passive Processes: Filtration

Filtration is the process by which water and solutes are forced through a membrane or capillary wall by fluid, or hydrostatic, pressure. In filtration the gradient is a pressure gradient rather than a concentration gradient. Filtration is not selective: only blood cells and protein molecules too large to pass through the membrane are held back.

Active Processes

Whenever a cell used its energy from ATP to move substances across the membrane, the process is referred to as active.

What are some instance when active transport would be necessary? Whenever a substance is unable to cross the membrane because it may be to large to pass through the pores, unable to dissolve in the bilipid membrane core, or required to move against rather than with a concentration gradient.

We can divide these active processes into two types: 1. active transport and 2. vesicular transport.

Active Transport

This type of transport requires carrier proteins that combine specifically and reversibly with the transported substances. Here we see solute pumps that move the substance uphill against their concentration gradients. To do this work cells must harness the energy of the ATP supplied by their cellular metabolism.

Many active systems are coupled systems; that is they move more than one substance at the same time. When the substances are moved in the same direction we call it a symport system. When the substances are moved in opposite directions we call it an antiport system.

Active transport systems are also distinguished according to the source of energy that drives the transport. In primary active transport the energy is provided directly by the hydrolysis of ATP. In secondary active transport the energy comes indirectly from passive ion gradients created by operation of primary active transport pumps.

Explain the sodium potassium pump here. Include secondary active transport. Page 72 Marieb.

Vesicular (Bulk) Transport

Large particles and macromolecules are transported through plasma membranes by vesicular transport. This transport process is energized by ATP and is divided into two types; 1. exocytosis and 2. endocytosis.

Exocytosis

Is a mechanism that moves substances from the cell interior to the cell exterior. It accounts for hormone secretion, neurotransmitter release, mucus secretion, and sometimes ejection of wastes. The substance to be release is first enclosed in a membranous sac called a vesicle. The vesicle migrates to the plasma membrane, fuses with it, then ruptures to release the substance.

Endocytosis

Is a mechanism that moves large substances from the exterior of the cell into the interior. The substance to be taken into the cell is progressively enclosed by an infolding portion of the plasma membrane. Once a membranous vecicle is formed it pinches off from the plasma membrane and moves into the cytoplasm where its contents can be digested.

Endocytosis can be divided into three types

phagocytosis
pinocytosis
receptor-mediated endocytosis

<u>Phagocytosis</u> is cell eating. Here parts of the plasma membrane and cytoplasm protrude and flow around some relatively large or solid material and engulf it. This forms a vesicle called a phagosome. The phagosome usually fuses with a lysosome and the contents are then digested.

<u>Pinocytosis</u> is cell drinking. This is similar to phagocytosis except the plasma membrane surrounds a tiny droplet of extracellular fluid. Also, unlike phagocytosis, pinocytosis is a routine activity for most cells.

<u>Receptor-mediated endocytosis</u> is similar to phagocytosis and pinocytosis however it is extremely selective. In this process there are receptors on the surface of the plasma membrane which bind only with substances specific to them. Both the receptors and the substances are then internalized in a small vesicle called a coated pit. This system is used for substances such as insulin, low- density lipoproteins (cholesterol) and iron.

Mention familial hypercholesterolemia. protein receptors for receptor mediated uptake of cholesterol are absent so the cholesterol builds up in the blood stream leading to atherosclerosis and coronary artery disease.

Generating a resting membrane potential

A membrane potential is a voltage across the plasma membrane. In their resting state all body cells exhibit a resting membrane potential that typically ranges from -20 to -200 millivolts. This means that all cells are polarized. The (-) sign before the voltage indicates that the inside of the cell is negative compared to the outside.

The resting potential is determined by the concentrations of two anions, Na^+ and K^+ and by the differential permeability of the membrane to these ions. Body cells have a preponderance of K^+ inside and are surrounded by extracellular fluid containing relatively more Na^+. At rest the plasma membrane is slightly permeable to K^+ but nearly impermeable to Na^+. Thus K^+ goes out of the cell along its concentration gradient and Na^+ is strongly attracted to the inside of the cell by its concentration gradient. Because the Na^+ permeability is much lower than that of K^+, Na^+ influx is less and so is inadequate to balance K^+ outflow. The result is a relative loss of positive ions within the cell, which thus establishes the resting membrane potential.