41.1B: Transport of Electrolytes across Cell Membranes

Ions cannot diffuse passively through membranes; instead, their concentrations are regulated by facilitated diffusion and active transport.

LEARNING OBJECTIVES

Explain the relationship between osmotic pressure and the transport of electrolytes across cell membranes

KEY TAKEAWAYS

Key Points

- Important ions cannot pass through membranes by passive diffusion; if they could, maintaining specific concentrations of ions would be impossible.
- Osmotic pressure is directly proportional to the number of solute atoms or molecules; ions exert more pressure per unit mass than do non-electrolytes.
- Electrolyte ions require facilitated diffusion and active transport to cross the semi-permeable membranes.
• Facilitated diffusion occurs through protein-based channels, which allow passage of the solute along a concentration gradient.
• In active transport, energy from ATP changes the shape of membrane proteins that move ions against a concentration gradient.

Key Terms

• **facilitated diffusion**: The spontaneous passage of molecules or ions across a biological membrane passing through specific transmembrane integral proteins.
• **passive diffusion**: movement of water and other molecules across membranes along a concentration gradient
• **active transport**: movement of a substance across a cell membrane against its concentration gradient (from low to high concentration) facilitated by ATP conversion

Transport of Electrolytes across Cell Membranes

A teaspoon of table salt readily dissolves in water. The solubility of sodium chloride results from its capacity to ionize in water. Salt and other compounds that dissociate into their component ions are called electrolytes. In water, sodium chloride (NaCl) dissociates into the sodium ion (Na\(^+\)) and the chloride ion (Cl\(^-\)). The most important ions, whose concentrations are very closely regulated in body fluids, are the cations sodium (Na\(^+\)), potassium (K\(^+\)), calcium (Ca\(^{2+}\)), and magnesium (Mg\(^{2+}\)); and the anions chloride (Cl\(^-\)), carbonate (CO\(_3^{2-}\)), bicarbonate (HCO\(_3^{-}\)), and phosphate (PO\(_3^{-}\)). Electrolytes are lost from the body during urination and perspiration. For this reason, athletes are encouraged to replace electrolytes and fluids during periods of increased activity and perspiration.

Osmotic pressure is influenced by the concentration of solutes in a solution. It is directly proportional to the number of solute atoms or molecules and not dependent on the size of the solute molecules. Because electrolytes dissociate into ions, adding relatively more solute molecules to a solution, they exert a greater osmotic pressure per unit mass than non-electrolytes such as glucose.

Water passes through semi-permeable membranes by passive diffusion, moving along a concentration gradient and equalizing the concentration on either side of the membrane. Electrolyte ions may not be able to passively diffuse across a membrane, but may instead require special mechanisms to cross the semi-permeable membrane. The mechanisms that transport ions across membranes are facilitated diffusion and active transport. Facilitated diffusion of solutes occurs through protein-based channels. Active transport requires energy in the form of ATP conversion, carrier proteins, or pumps in order to move ions against the concentration gradient.

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**Transport across cell membranes**: Paul Andersen describes how cells move materials across the cell membrane. All movement can be classified as passive or active. Passive transport, such as diffusion, requires no energy as particles
move along their gradient. Active transport requires additional energy as particles move against their gradient. Specific examples, such as GLUT and the Na/K, pump are included.