AP BIOLOGY

Cell Transport

Essential Question

How do the mechanisms for transport across membranes support energy conservation?

Understandings

*Students will understand that:*

Cell membranes separate the internal environment of the cell from the external environment. Growth and homeostasis are maintained by the constant movement of molecules across membranes.

The structure of cell membranes results in selective permeability. Selective permeability is a direct consequence of membrane structure, as described by the fluid mosaic model. The selective permeability of membranes allows for the formation of concentration gradients of solutes across the membrane.

A variety of processes allow for the movement of ions and other molecules across membranes, including passive and active transport, endocytosis and exocytosis.

Knowledge:

*Students will know:*

Phospholipids have both hydrophilic and hydrophobic regions. The hydrophilic phosphate regions of the phospholipids are oriented toward the aqueous external or internal environments, while the hydrophobic fatty acid regions face each other within the interior of the membrane.

Embedded proteins can be hydrophilic, with charged and polar side groups, or hydrophobic, with nonpolar side groups.

Cell membranes consist of a structural framework of phospholipid molecules that is embedded with proteins, steroids (such as cholesterol in eukaryotes), glycoproteins, and glycolipids that can flow around the surface of the cell within the membrane.

Small nonpolar molecules, including N2, O2, and CO2, freely pass across the membrane. Hydrophilic substances, such as large polar molecules and ions, move across the membrane through embedded channel and transport proteins.

Polar uncharged molecules, including H2O, pass through the membrane in small amounts.

Passive transport is the net movement of molecules from high concentration to low concentration without the direct input of metabolic energy.

Passive transport plays a primary role in the import of materials and the export of wastes.

Membrane proteins are required for facilitated diffusion of charged and large polar molecules through a membrane. Large quantities of water pass through aquaporins. Charged ions, including Na+ and K+, require channel proteins to move through the membrane. Membranes may become polarized by movement of ions across the membrane.

External environments can be hypotonic, hypertonic or isotonic to internal environments of cells. Water moves by osmosis from areas of high water potential/low osmolarity/ low solute concentration to areas of low water potential/high osmolarity/high solute concentration. Osmoregulation maintains water balance and allows organisms to control their internal solute composition/water potential.

Active transport requires the direct input of energy to move molecules from regions of low concentration to regions of high concentration.

The processes of endocytosis and exocytosis require energy to move large molecules into and out of cells— In exocytosis, internal vesicles fuse with the plasma membrane and secrete large macromolecules out of the cell. In endocytosis, the cell takes in macromolecules and particulate matter by forming new vesicles derived from the plasma membrane.

Membrane proteins are necessary for active transport.

Metabolic energy (such as from ATP) is required for active transport of molecules and/ or ions across the membrane and to establish and maintain concentration gradients. The Na+/K+ ATPase contributes to the maintenance of the membrane potential.

Skills:

*Students will be able to:*

Utilize the structure of a cell membrane and its relationship to selective permeability to predict which way molecules will move across a concentration gradient.

Graph data and use equations to calculate water potential and solute potential from the data.

Use biological concepts to explain both visually and in text models.

Curriculum Standards - 2019 College Board Course & Exam Description

Describe the roles of each of the components of the cell membrane in maintaining the internal environment of the cell.

Describe the Fluid Mosaic Model of cell membranes.

Explain how the structure of biological membranes influences selective permeability.

Describe the mechanisms that organisms use to maintain solute and water balance.

Describe the mechanisms that organisms use to transport large molecules across the plasma membrane.

Explain how the structure of a molecule affects its ability to pass through the plasma membrane.

Explain how concentration gradients affect the movement of molecules across membranes.

Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.

Describe the processes that allow ions and other molecules to move across membranes.

Mission Integration

(*Note: could be combined with performance task/design thinking culminating assessment)*

Performance Task or Design Thinking Culminating Assessment

Determination of solution molarity using water potential. Students are presented with a series of unidentified molarity sucrose solutions. They will need to design a way to determine the molarity using potato cores. After conducting their experiment, they will graph the data and then use a best fit line equation to determine water potential and then the molarity of each colored solution.

Other Evidence (formative assessments, summative assessments)

*what homework and other out of class experiences are needed to equip students?*

Mastering Biology

Water potential practice problems

Topic Overview

*Order of topics presented (Calendar)*

Membrane Structure

Passive Transport

Active Transport

Nervous system (as an application of the transport mechanisms)

Learning Plan

*Learning Activities - What experiential or inductive learning will help students to explore the big ideas and questions to achieve desired understandings? for their expected performances?*

Membrane Headbandz game

POGILs – membrane structure and membrane function

Water potential FRQ sample

Sodium Potassium pump lab bench drawings

The Lab Assistant Did It (potato core molarity lab)

Agar cubes in Bromothymol Blue for diffusion

Water Potential practice problems

Resources

Biology in Focus 2nd edition

Mastering Biology

Membrane Headbandz game – cards

POGILs – membrane structure and membrane function

Water potential FRQ sample

Sodium Potassium pump lab bench drawings – directions, markers for lab bench

The Lab Assistant Did It (potato core molarity lab) – directions, 5 sucrose solutions ranging from 0 to 1.0M concentrations, food coloring, balances, potatoes, potato cores, weigh boats, paper towels

Agar Cubes with Bromothymol blue – agar-agar cubes made with bromothymol blue, vinegar, timer, directions

Water potential practice problems

Nervous system lecture notes for students to annotate