Interactive Learning Objects

Biology

Cell Membrane Transport Lesson Plan

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Cell Membrane Transport

Learning object description

Cells require materials of various sizes and in varying concentrations. Consequently, cells have a number of mechanisms to transport materials across the membrane in or out of the cell. These mechanisms generally fall into two categories: 1) passive, and 2) active, using cellular energy.

Passive transport mechanisms act as a result of the inherent kinetic energy of molecules and therefore require no expenditure of cellular energy. Diffusion and osmosis are examples of passive transport mechanisms. Diffusion is the movement of a solute from an area where it is present in a high concentration, toward an area in which it is present in a lower concentration. Small molecules such as molecular oxygen and carbon dioxide can cross the membrane easily. Larger polar molecules such as glucose cannot cross the membrane unless they are helped by a membrane protein. This latter mechanism is known as "facilitated diffusion." Passive transport mechanisms move materials along a concentration gradient.

Active transport mechanisms require input of cellular energy to move substances against a concentration gradient. Protein pumps embedded in the plasma membrane each transport a specific substance into or out of the cell. The cell may also use vesicles to move large substances into or out of the cell. Endosytosis and exocytosis are examples of this form of transport.

In this learning object, students examine all of these different types of movement across the membrane. They are able to select from low, medium, and high temperatures to determine the effect that temperature has on the rates at which these processes occur.

Learning objective

The students will be able to:

- Use vocabulary related to transport across the plasma membrane;
- Differentiate between active and passive transport mechanisms;
- Identify membrane structures that permit transport;
- State the relationship between temperature and the rate of transport across the membrane.

Correlation to the Ontario Curriculum

Grade 11 Biology – SBI3U Academic:

- Demonstrate an understanding of cell structure and function and the processes of metabolism and membrane transport
- Describe the fluid mosaic structure of cell membranes, and explain the dynamics of passive transport (facilitated diffusion) and the processes of endocytosis and exocytosis of large particles
- Illustrate and explain important cellular processes (e.g., protein synthesis, respiration, lysosomal digestion), including their function in the cell, the ways in which they are interrelated, and the fact that they occur in all living cells

Vocabulary

- Diffusion
- Passive transport
- Active transport
- Facilitated diffusion
- Concentration gradient
- Endocytosis
- Exocytosis

Pre-viewing

- Introduce students to the concept of diffusion by having them perform some simple investigations either on their own or as demonstrations in small groups or before the whole class. In each case, ask students to explain how diffusion is responsible for the observed effects.
- Diffusion in a gas – spray some air freshener in one corner of the room and have students raise their hands as they are able to detect the scent.
- Diffusion in a liquid – gently place one potassium permanganate crystal in the centre of a Petri dish filled half way with tap water and observe the expansion of the purple zone as the crystal dissolves and the KMnO4 diffuses through the water. This demonstration works well on the overhead projector.
  SAFETY NOTE: KMnO4 is corrosive and should be handled with forceps while wearing safety goggles.
- Diffusion across a membrane – fill a sandwich bag with a saturated starch solution and seal the bag tightly. Place the sealed bag in a 250 mL beaker filled half way with water containing a few drops of iodine solution. Leave the system on the bench for approximately 15 minutes, then observe. Students will find that the interior contents of the bag have become a dark blue precipitate demonstrating that the iodine has entered the permeable sandwich bag while the starch has not moved. Note: freezer bags may not be as permeable.

While viewing

- Have the class work either individually or in pairs, depending on your and their preference and access to computers.
- Have students predict the effect that temperature will have on the rate of transport across the membrane. They should record their predictions and state the explanation behind their thinking.
- As they test each scenario, they should record their findings. Does temperature have the same effect in all situations?
- Have students create a table to compare the various mechanisms of transport across the membrane. Tables should include: mechanism, material transported, direction of transport (in/out), entry structure, active/passive, and a brief description.

Post viewing

- Form student pairs and have them review one another's comparison tables to ensure that they have fully recorded all necessary facts.

Follow-up activity

- As a follow-up to this exploration, you may wish to challenge your class to determine how diffusion plays a role in limiting cell size.
- Prepare a rectangular baking dish containing a 3% agar-phenolphthalein solution and allow it to harden.
  NOTE: do not use nutrient agar. Also prepare a 4% sodium hydroxide (NaOH) solution.
  SAFETY NOTE: students must wear safety goggles while conducting this investigation.
- Each student group needs to cut three cubes from the agar containing phenolphthalein: 1 cm, 2 cm and 3 cm on a side. They will drop their three cubes into a beaker containing the NaOH solution and leave it on the bench for approximately 15 minutes.
- Phenolphthalein is a base indicator and will turn pink in the presence of NaOH.
- Tell students to blot dry each cube and cut them all in half carefully using a scalpel or knife. They should measure, in

millimetres, across the portion of each cube that did not change colour.
- Have students calculate the surface area/volume ratio for each cube, and the volume of the uncoloured area of each cube.
- Ask them to infer from their results why cells are so small and why many cells and organelles have folded membranes rather than smooth membranes.

Assessment

- Assess students' comparison tables for Knowledge and Understanding: understanding of concepts, principles, laws, and theories (e.g., identifying assumptions; eliminating misconceptions; providing explanations); knowledge of facts and terms.
- Lab reports can be assessed for Inquiry: application of the skills and strategies of scientific inquiry, application of technical skills and procedures; and for knowledge and understanding: understanding of concepts, principles, laws, and theories (e.g., identifying assumptions; eliminating misconceptions; providing explanations).