

CHAPTER 12

MEMBRANE TRANSPORT

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Principles of Membrane Transport

- 12-1 Indicate whether the following statements are true or false. If a statement is false, explain why it is false.
- A. CO_2 and O_2 are water-soluble molecules that diffuse freely across cell membranes.
 - B. The differences in permeability between artificial lipid bilayers and cell membranes arise from variations in phospholipid content.
 - C. Transporters are similar to channels, except that they are larger, allowing folded proteins as well as smaller organic molecules to pass through them.
 - D. Cells expend energy in the form of ATP hydrolysis so as to maintain ion concentrations that differ from those found outside the cell.
- 12-2 Although the extracellular environment has a high sodium ion concentration and the intracellular environment has a high potassium ion concentration, both must be neutralized by negatively charged molecules. In the extracellular case, what is the principal anion?
- (a) HCO_3^-
 - (b) Cl^-
 - (c) PO_4^{3-}
 - (d) OH^-
- 12-3 Circle the molecule in each pair that is more likely to diffuse through the lipid bilayer.
- A. amino acids or benzene
 - B. Cl^- or ethanol
 - C. glycerol or RNA
 - D. H_2O or O_2
 - E. adenosine or ATP
- 12-4 We can test the relative permeability of a phospholipid bilayer by using a synthetic membrane that does not contain any protein components. Some uncharged, polar molecules are found to diffuse freely across these membranes, to varying degrees. Which of the following has the lowest rate of diffusion across an artificial membrane? Why?
- (a) glucose
 - (b) water
 - (c) glycerol
 - (d) ethanol

- 12-5 For each of the following sentences, fill in the blanks with the best word or phrase selected from the list below. Not all words or phrases will be used; each word or phrase should be used only once.

A molecule moves down its concentration gradient by _____ transport, but requires _____ transport to move up its concentration gradient. Transporter proteins and ion channels function in membrane transport by providing a _____ pathway through the membrane for specific polar solutes or inorganic ions. _____ are highly selective in the solutes they transport, binding the solute at a specific site and changing its conformation so as to transport the solute across the membrane. On the other hand, _____ discriminate between solutes mainly on the basis of size and electrical charge.

active	transporter proteins	ion channels
amino acid	hydrophilic	noncovalent
amphipathic	hydrophobic	passive

Transporters and their Functions

- 12-6 A hungry yeast cell lands in a vat of grape juice and begins to feast on the sugars there, producing carbon dioxide and ethanol in the process:



Unfortunately, the grape juice is contaminated with proteases that attack some of the transport proteins in the yeast cell membrane, and the yeast cell dies. Which of the following could account for the yeast cell's demise?

- (a) toxic buildup of carbon dioxide inside the cell
 (b) toxic buildup of ethanol inside the cell
 (c) diffusion of ATP out of the cell
 (d) **inability to import sugar into the cell**
- 12-7 Ion channels are classified as membrane transport proteins. Channels discriminate by size and charge. In addition to Na^+ , which one of the following ions would you expect to be able to freely diffuse through a Na^+ channel? Explain your answer.
- (a) Mg^{2+}
 (b) H^+
 (c) K^+
 (d) Cl^-
- 12-8 Transporters, in contrast to channels, work by _____.
- (a) **specific binding to solutes**
 (b) a gating mechanism
 (c) filtering solutes by charge

- (d) filtering solutes by size
- 12-9 Pumps are transporters that are able to harness energy provided by other components in the cells to drive the movement of solutes across membranes, against their concentration gradient. This type of transport is called _____.
- (a) **active transport**
 - (b) free diffusion
 - (c) facilitated diffusion
 - (d) passive transport
- 12-10 Indicate whether the statements below are true or false. If a statement is false, explain why it is false.
- A. Facilitated diffusion can be described as the favorable movement of one solute down its concentration gradient being coupled with the unfavorable movement of a second solute up its concentration gradient.
 - B. Transporters undergo transitions between different conformations, depending on whether the substrate-binding pocket is empty or occupied.
 - C. The electrochemical gradient for K^+ across the plasma membrane is small. Therefore, any movement of K^+ from the inside to the outside of the cell is driven solely by its concentration gradient.
 - D. The net negative charge on the cytosolic side of the membrane enhances the rate of glucose import into the cell by a uniporter.
- 12-11 It is thought that the glucose transporter switches between two conformational states in a completely random fashion. How is it possible for such a system to move glucose across the membrane efficiently in a single direction?
- 12-12 Active transport requires the input of energy into a system so as to move solutes against their electrochemical and concentration gradients. Which of the following is *not* one of the common ways to perform active transport?
- (a) Na^+ -coupled
 - (b) **K^+ -coupled**
 - (c) ATP-driven
 - (d) light-driven
- 12-13 The Na^+ - K^+ ATPase is also known as the Na^+ - K^+ pump. It is responsible for maintaining the high extracellular sodium ion concentration and the high intracellular potassium ion concentration. What happens immediately after the pump hydrolyzes ATP?
- (a) Na^+ is bound.
 - (b) ADP is bound.
 - (c) **The pump is phosphorylated.**
 - (d) The pump changes conformation.
- 12-14 If ATP production is blocked in an animal cell, the cell will swell up. Explain this observation.