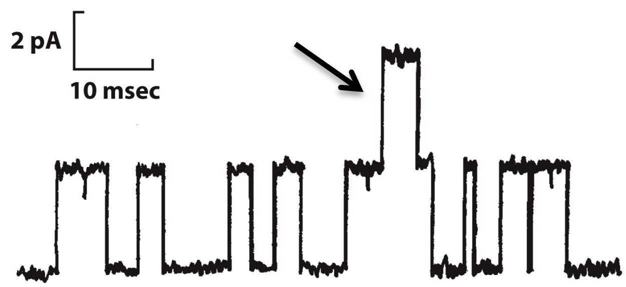
**QUESTIONS**

**1** You have prepared lipid vesicles that contain $K^+$ leak channels, all oriented so that their cytoplasmic surface faces the outside of the vesicles. There is no membrane potential initially. How will $K^+$ ions move and what sort of membrane potential will develop if:

A) There are equal $[K^+]$ outside and inside the vesicles,
B) $K^+$ is only present inside,
C) $K^+$ is only present outside.

**2** Here is the recording of a patch-clamp experiment, in which the patch was from the plasma membrane of a muscle cell. It contains molecules of the acetylcholine receptor (a ligand-gated cation channel). Acetylcholine was added to the solution in the microelectrode.

A) Your friend says that, if a ligand is added, this will cause the opening of the channel, which will remain open until the ligand is removed. What do you respond?
B) Describe what the rectangular peaks are.
C) What would happen if acetylcholine were added on the other side, i.e. outside the electrode?
D) What happened here (arrow)?

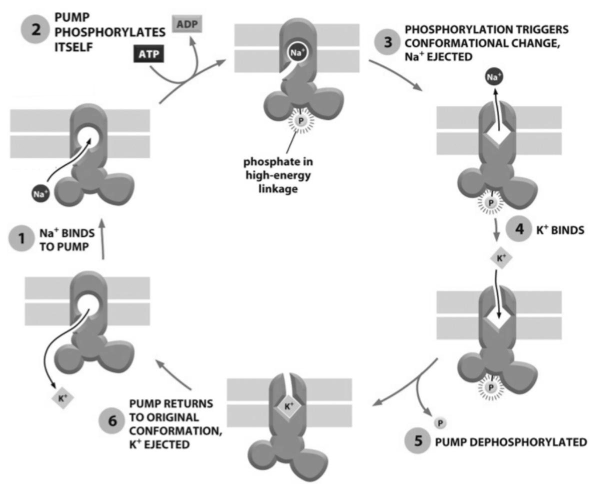



**3** Aquaporins are special channels that transport large amounts of water. Ions cannot pass through these channels, which prevents ion gradients to be completely disrupted. Explain why $Na^+$ and $H^+$ cannot go through.

**4** You prepared lipid vesicles that contain exclusively, as membrane proteins, copies of the $Na^+/K^+$ pump, where we assume 1 $Na^+$ and 1 $K^+$ are transported each cycle, as shown in Figure below. All pumps are oriented so that the cytoplasmic portion faces the outside of the vesicles. Predict what would happen if:

A. The solution inside and outside the vesicles contains both $Na^+$ and $K^+$, but no ATP.
B. The solution inside contains both $Na^+$ and $K^+$; the solution outside contains $Na^+$, $K^+$ and ATP.

C. The solution inside contains $Na^+$; the solution outside contains $Na^+$ and ATP.
D. The solution is as in B), but the pump molecules are randomly oriented.




**5** Acetylcholine-gated cation channels do not discriminate between $Na^+$, $K^+$ or $Ca^{++}$. When these acetylcholine receptors in muscle cells open, why is it then mostly $Na^+$ that enters the cells?

**6** Indicate whether each of the following descriptions matches an ABC transporter (A), a P-type pump (P), or a V-type pump (V). Your answer would be a four-letter string composed of letters A, P, and V only, e.g. PPAV.

( ) The pumps in this family are phosphorylated at a key Asp residue in each transport cycle.
( ) The pumps in this family are responsible for the acidification of synaptic vesicles.
( ) The sodium-potassium pump is a member of this family.
( ) The multidrug resistance protein is a member of this family.

**7.** Match each definition below with its term from the list.

1 An aqueous pore in a lipid membrane, with walls made of protein, through which selected ions or molecules can pass.
2 the movement of a small molecule or ion across a membrane due to a diference in concentration or electrical charge.
3 General term for a membrane-embedded protein that serves as a carrier of ions or small molecules from one side of the membrane to the other.
4 Movement of a molecule across a membrane that is driven by ATP hydrolysis or other form of metabolic energy.
5 Driving force for ion movement that is due to diferences in ion concentration and electrical charge on either side of the membrane.

A. active transport
B. channel
C. electrochemical gradient
D. membrane transport protein
E. passive transport
F. transporter

**8:** Order the molecules on the following list according to their ability to diffuse through a lipid bilayer, beginning with the one that crosses the bilayer most readily. Explain your order.
1. $Ca^{2+}$
2. $CO_2$
3. Ethanol
4. Glucose
5. RNA
6. $H_2O$

**9:** TRUE/FALSE
Decide whether each of these statements is true or false, and then explain why.

A: The plasma membrane is highly impermeable to all charged molecules.

B: Transport by transporters can be either active or passive, whereas transport by channels is always passive.

C: A symporter would function as an antiporter if its orientation in the membrane were reversed; that is, if the portion of the protein normally exposed to the cytosol faced the outside of the cell instead.

D: The co-transport of $Na^+$ and a solute into a cell, which harnesses the energy in the $Na^+$ gradient, is an example of primary active transport.

E: Transporters saturate at high concentrations of the transported molecule when all their binding sites are occupied; channels, on the other hand, do not bind the ions they transport and thus the lux of ions through a channel does not saturate.

F: The membrane potential arises from movements of charge that leave ion concentrations practically unaffected, causing only a very slight discrepancy in the number of positive and negative ions on the two sides of the membrane.

G: The aggregate current crossing the membrane of an entire cell indicates the degree to which individual channels are open.

H: Transmitter-gated ion channels open in response to specific neurotransmitters in their environment but are insensitive to the membrane potential; therefore, they cannot by themselves (in the absence of ligand) generate an action potential.

**10:** How is it possible for some molecules to be at equilibrium across a biological membrane and yet not be at the same concentration on both sides?

**11:** a model for a uniporter that could mediate passive transport of glucose down its concentration gradient is shown the figure below. How would you need to change the diagram to convert the transporter into a pump that transports glucose up its concentration gradient by hydrolyzing ATP? Explain the need for each of the steps in your new illustration.

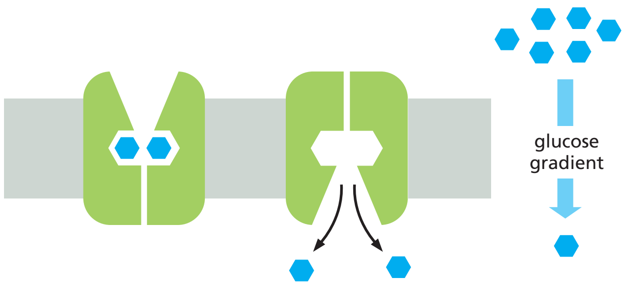



Figure 11–2 Hypothetical model showing how a conformational change in a transporter could mediate passive transport of glucose (Problem 11–27). The transition between the two conformational states is proposed to occur randomly and to be completely reversible, regardless of binding-site occupancy.

**12:** What two properties distinguish an ion channel from a simple aqueous pore?

**13:** Aquaporins allow water to move across a membrane, but prevent the passage of ions. How does the structure of the pore through which the water molecules move prevent passage of ions such as K+, Na+, Ca+, and Cl–? H+ ions present a different problem because they move by relay along a chain of hydrogen-bonded water molecules (Figure 11–9). How does the pore prevent the relay of H+ ions across the membrane?

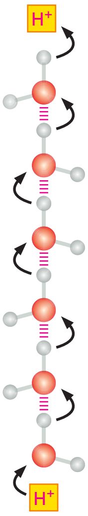



Figure 11–9 Rapid diffusion of $H^+$ ions by a molecular relay system involving the making and breaking of hydrogen bonds between adjacent water molecules

**14:** Acetylcholine-gated cation channels do not discriminate among Na+, K+, and Ca2+ ions, allowing all to pass through freely. How is it, then, that when acetylcholine receptors in muscle cells open there is a large net inlux principally of Na+?