Membrane in Motion

Model how membrane structure controls a cell's response

BIO.4.a "Use models to illustrate how the structural characteristics of lipids and proteins in the cell membrane regulate cellular processes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each membrane structure named in the passage, circle the process it affects, and number matching structures and processes with the same number to show their connections.

What Happens After a Meal?

1. After a meal, a muscle cell faces a flood of glucose in the blood. Its membrane is a flexible bilayer of phospholipids. Each phospholipid has a water-attracting head facing fluid and two water-repelling tails pointing inward. The tails form a nonpolar interior. Small, nonpolar oxygen molecules can pass through that interior, but charged ions and glucose do not cross it easily. Proteins embedded in the bilayer provide routes and signals that the lipids alone cannot. This arrangement makes the membrane a selective boundary rather than a solid wall around the cell.

2. One membrane protein, the insulin receptor, has an outer region that binds insulin because their shapes fit. Insulin binding starts a signal inside the muscle cell. The signal causes vesicles containing GLUT4 transport proteins to fuse with the cell membrane, placing more GLUT4 at its surface. If glucose is more concentrated outside than inside, GLUT4 lets glucose enter down its concentration gradient. GLUT4 does not spend ATP directly to move each glucose molecule. A model with an insulin arrow ending at the receptor and glucose arrows passing through GLUT4 shows how one protein starts a response while another carries out transport.

3. Temperature changes can test the bilayer's structure. In cold conditions, phospholipid tails tend to pack closely, which makes the membrane less fluid. Cholesterol tucked between the tails limits this tight packing, helping the membrane remain fluid enough for proteins to move and work. In warm conditions, cholesterol also restrains excessive phospholipid movement. A model of a cold membrane without cholesterol would show more tightly packed tails than a cold membrane with cholesterol. Slower protein movement could interfere with placing GLUT4 in the membrane, even if the insulin receptor detects insulin. Lipids therefore affect a protein-controlled process without acting as transport proteins themselves.

2 ANSWER WITH EVIDENCE

Use the passage

1. In a membrane model, would you draw an oxygen arrow or a glucose arrow passing directly between the phospholipid tails? Explain your choice using the tails' structure.

2. Suppose the insulin receptor's outer region changes shape so insulin no longer fits. How should your model change the arrows for the signal and for glucose entering through GLUT4?

3. A model shows glucose moving through GLUT4 into a muscle cell. What must be true about glucose concentrations on the two sides, and what structure should the arrows pass through?

4. Compare two models of a cold membrane, one with cholesterol and one without it. How should tail spacing differ, and how could that difference affect GLUT4 placement?

3 YOUR TURN

Your own words

A cell has more Ca^{2+} outside than inside. Opening a Ca^{2+} channel begins a signal that makes the cell release a stored chemical. In two panels, sketch the bilayer and channel before and after opening; label the heads, tails, channel, and Ca^{2+} movement, then write one sentence under each panel explaining how the channel's shape affects the response.

ANSWER KEY

Membrane in Motion

PART 1 · READ AND MARK

Underline each membrane structure named in the passage, circle the process it affects, and number matching structures and processes with the same number to show their connections. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In a membrane model, would you draw an oxygen arrow or a glucose arrow passing directly between the phospholipid tails? Explain your choice using the tails' structure.	**Draw the oxygen arrow between the tails. Their nonpolar interior allows small, nonpolar oxygen to pass, while glucose does not cross it easily.**
2	Suppose the insulin receptor's outer region changes shape so insulin no longer fits. How should your model change the arrows for the signal and for glucose entering through GLUT4?	**Show no signal arrow starting at the receptor. With no insulin-triggered signal to place more GLUT4 in the membrane, show fewer glucose arrows entering through GLUT4.**
3	A model shows glucose moving through GLUT4 into a muscle cell. What must be true about glucose concentrations on the two sides, and what structure should the arrows pass through?	**Glucose must be more concentrated outside than inside. The arrows should pass through GLUT4 proteins in the membrane.**
4	Compare two models of a cold membrane, one with cholesterol and one without it. How should tail spacing differ, and how could that difference affect GLUT4 placement?	**Draw more tightly packed tails without cholesterol. The resulting lower fluidity could slow protein movement and interfere with placing GLUT4 in the membrane.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: I draw and label the phospholipid heads and tails, a closed Ca^{2+} channel, and Ca^{2+} outside; the closed channel blocks entry, so the release signal does not begin. Panel 2: I draw the same bilayer with an open Ca^{2+} channel and an arrow showing Ca^{2+} moving inward; the open channel allows entry, beginning the signal to release the stored chemical.

Accept models that connect a specific lipid or protein structure to its effect on movement or signaling. For Part 3, the channel must cross the bilayer, and Ca^{2+} must move from outside to inside only when the channel is open.