

# PEEBEDU Membranes and Temperature (NGSS) Unit 2: Cells

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Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

Open [peebedu.com](http://peebedu.com) and navigate to **Membrane Fatty Acid Explorer**. Click the **Introduction** button to read about fish adaptations to cold water and the roles of saturated fatty acids, unsaturated fatty acids, and cholesterol in membrane fluidity. Then close the popup and use the temperature slider to observe how membrane fluidity changes.

## Part 1 – Model Evaluation (MAPP Framework)

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*Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Membrane Fatty Acid Explorer as a scientific model.*

### M – Mode

What type of model is the Membrane Fatty Acid Explorer? Describe how this computational simulation represents a cell membrane and its response to temperature changes. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about membrane structure and fluidity.

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## A – Accuracy

(a) Identify two things this simulation represents **accurately** about cell membrane structure and fluidity. For each, name the specific simulation feature and explain what aspect of the fluid mosaic model it demonstrates.

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(b) Identify two things this simulation **oversimplifies or leaves out** about membrane structure and fluidity. Consider what you cannot observe in the simulation that would be important for a complete understanding of how real cell membranes respond to temperature changes.

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## P – Purpose

What is the learning goal of this simulation? Explain how the Membrane Fatty Acid Explorer is designed to help you understand how the composition of a plasma membrane — including phospholipids, cholesterol, and proteins — affects its fluidity at different temperatures. In your answer, connect at least one specific simulation feature to a biological situation in which membrane fluidity is important for cell function.

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## P – Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Membrane Fatty Acid Explorer. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

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## Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for the fluid mosaic model?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the temperature slider help you connect molecular-level changes to whole-organism survival?

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## Part 2 – NGSS Questions

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1.

*Simulation Task: Set the temperature slider to 30°C and observe the phospholipid tails in the membrane. Note how much (or how little) the tails move at this warm temperature.*

Describe what you observe about the movement of the phospholipid tails at 30°C. Explain how the structure of the phospholipid bilayer keeps the membrane organized even when individual molecules are moving.

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HS-LS1-3

2.

*Simulation Task: Slowly decrease the temperature slider from 30°C down to –10°C. Watch how the wiggling of the phospholipid tails changes as the temperature drops. Also observe how the background environment changes (warm ocean, icebergs, frozen surface).*

Describe how phospholipid tail movement changes as temperature decreases. Explain why a cell membrane that becomes too rigid at low temperatures would have difficulty carrying out normal functions such as transporting materials into and out of the cell.

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HS-LS1-3

**3.**

*Simulation Task: Click the Introduction button and read the section comparing saturated and unsaturated fatty acids. Look at the diagrams showing straight tails versus kinked tails. Then close the popup and observe the tail wiggle at  $-10^{\circ}\text{C}$ .*

Explain how the kinks created by double bonds in unsaturated fatty acids prevent the phospholipid tails from packing tightly together. Describe why this structural feature helps cold-water fish maintain membrane fluidity in near-freezing water.

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HS-LS1-3

**4.**

*Simulation Task: Locate the gold-colored cholesterol molecule wedged between the phospholipids in the top row of the bilayer. Slide the temperature from  $-10^{\circ}\text{C}$  to  $30^{\circ}\text{C}$  and back, observing the cholesterol's position relative to the surrounding phospholipids.*

Explain how cholesterol acts as a fluidity buffer in the cell membrane. Describe how its effect at low temperatures differs from its effect at high temperatures and why this helps cells maintain stable internal conditions.

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HS-LS1-3

**5.**

*Simulation Task: At 10°C, find the purple channel protein spanning the bilayer and the green receptor protein with its extensions reaching above the membrane surface. Observe their positions within the phospholipid bilayer.*

Describe the roles of the channel protein and the receptor protein shown in the simulation. Explain why maintaining proper membrane fluidity is important for these proteins to function correctly and how this relates to a cell's ability to respond to signals and transport substances.

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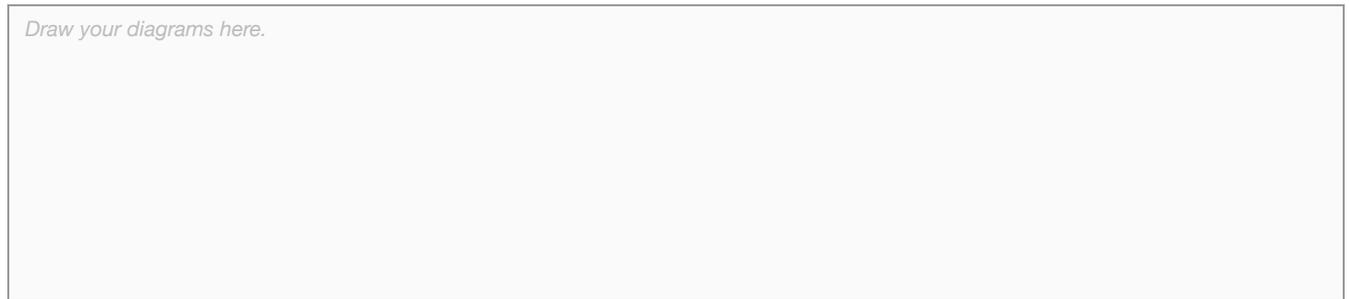
HS-LS1-3

**6.**

*Simulation Task: Compare the membrane at 30°C (tails nearly still, tightly packed) and at -10°C (tails wiggling, more space between them). Think about how fatty acid composition affects what you see at each temperature.*

In the box below, draw two side-by-side diagrams of a phospholipid bilayer cross-section: one representing a membrane with mostly saturated (straight) fatty acid tails at low temperature, and one representing a membrane with mostly unsaturated (kinked) fatty acid tails at the same low temperature. Label the phospholipid heads, tails, and cholesterol. Indicate which membrane would remain more fluid.

*Draw your diagrams here.*



HS-LS1-3

7.

*Simulation Task: Sweep the temperature slider slowly from  $-10^{\circ}\text{C}$  to  $30^{\circ}\text{C}$ . Watch the background change from a frozen surface with ice cracks, to cold water with floating icebergs, to a warm open ocean. Consider how fish survival depends on membrane function at each temperature.*

Suppose ocean temperatures in a region rise significantly over several decades. Explain how this environmental change could affect the membrane fluidity of fish populations in that region and predict how the fatty acid composition of their membranes might shift over many generations in response to the warmer conditions.

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