Name: _____   **Period:** _____   **Date:** _____

Open **peebedu.com** and navigate to **Yeast Respiration Lab**. Read the introduction screen, which describes three yeast strains and explains how you will explore the switch between aerobic respiration and alcohol fermentation. Click **Begin Experiment** to enter the workspace.

Part 1 — Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Yeast Respiration Lab as a scientific model.

M — Mode

What type of model is the Yeast Respiration Lab? Describe how this computational simulation represents the metabolic processes of cellular respiration and fermentation in yeast. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how cells obtain energy from organic molecules.

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A — Accuracy

(a) Identify two things this simulation represents **accurately** about how yeast cells switch between aerobic respiration and fermentation. For each, name the specific simulation feature and explain what concept of cellular energetics it demonstrates.

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_____

(b) Identify two things this simulation **oversimplifies or leaves out** about cellular respiration and fermentation. Consider what you cannot observe in the simulation that would be important for a complete understanding of how cells produce ATP from glucose.

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P — Purpose

What is the learning goal of this simulation? Explain how the Yeast Respiration Lab is designed to help you understand how cells use different metabolic pathways depending on oxygen availability. In your answer, connect at least one specific simulation feature to a biological example of why the ability to switch between aerobic and anaerobic metabolism matters for living organisms.

P — Permanency

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

Small-Group Discussion

With your group, discuss the following:

- How does the vessel seal/unseal toggle help you understand the relationship between oxygen availability and metabolic pathway selection?
- What information about the intermediate steps of cellular respiration is missing from this simulation, and why might the designers have chosen to simplify those steps?
- How does the rate graph help you compare the relative ATP yields of aerobic respiration versus fermentation?
- If you could add one feature to this simulation to better represent how cells obtain energy, what would it be and why?

Part 2 — NGSS Questions

1.

*Simulation Task: Select **Glucose** as your substrate and leave the vessel **open**. Watch the rate graph for about 15 seconds. Note which metabolic pathway lines are active and read the equation display at the bottom of the rate graph panel.*

Describe what happens to glucose inside yeast cells when oxygen is available. In your answer, identify the products that the simulation displays and explain why cells produce far more ATP through aerobic respiration than through fermentation.

HS-LS1-7

2.

*Simulation Task: While glucose is being consumed with the vessel open, click **Vessel Sealed**. Watch the O_2 Level meter drop and observe the moment when the equation display switches from aerobic respiration to alcohol fermentation. Note what appears in the beaker and on the Ethanol Produced counter.*

Explain why yeast cells switch from aerobic respiration to alcohol fermentation when the oxygen level drops below 15%. In your answer, describe the role of oxygen in allowing cells to fully break down glucose and explain what the yeast cells produce instead when oxygen is no longer available.

HS-LS1-7

3.

*Simulation Task: With the vessel still sealed and fermentation running, observe the CO_2 bubbles rising through the beaker liquid and the CO_2 molecules accumulating in the headspace above the liquid. Then click **Vessel Open** and watch what happens to the CO_2 in the headspace.*

Explain why CO_2 is produced during both aerobic respiration and fermentation. Describe where the carbon atoms in CO_2 originally come from and why CO_2 accumulates in the sealed vessel but escapes when the vessel is opened.

HS-LS1-7

4.

*Simulation Task: Click **Reset Experiment**. Select **Glucose** and let the simulation run with the vessel open. After 10 seconds, click **Vessel Sealed** and wait until fermentation is fully active. Then click **Vessel Open** again and watch the rate graph as oxygen returns. Observe how the KC/OxPhos line and the fermentation line respond.*

Describe the pattern you observe on the rate graph as the vessel goes from open to sealed and back to open. Explain why the aerobic and fermentation pathways are inversely related and what this tells you about how yeast cells respond to changing oxygen levels in their environment.

HS-LS2-3

5.

Describe the difference in metabolic rates between glucose and starch that you observed on the rate graph. Explain why a complex carbohydrate like starch must be broken down before cells can use it for energy, and predict how this difference would affect CO_2 production and ATP output over time.
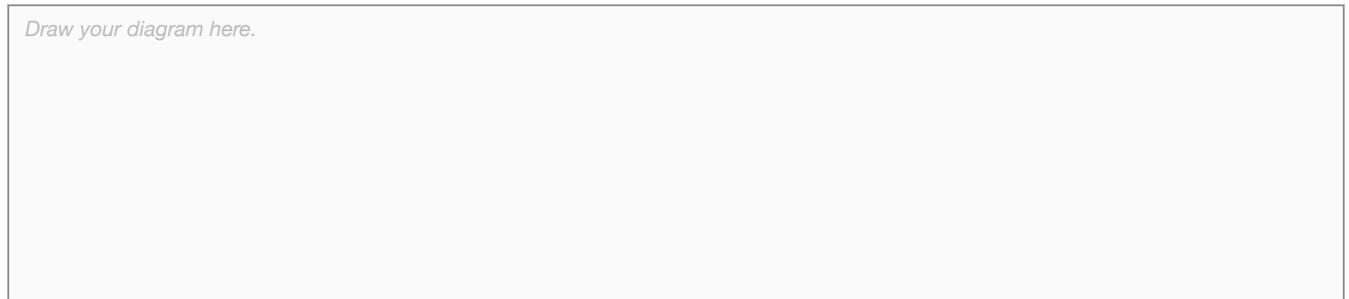
HS-LS1-7

6.

In the box below, draw a diagram that shows what happens to glucose in a yeast cell under two conditions: when oxygen is present and when oxygen is absent. Show the starting molecule (glucose), the products of each pathway, and label where CO_2 and ethanol are produced. Indicate the relative amount of ATP generated by each pathway.

Draw your diagram here.

HS-LS1-7

7.

*Simulation Task: Try all three yeast strains (Baker's Yeast, Ale Yeast, and Champagne Yeast) with **Glucose** and the vessel sealed. Compare their fermentation rates and ethanol production on the rate graph. Think about how these strains are used in bread making, beer brewing, and wine making.*

The ability to break down glucose through fermentation is shared by organisms across all domains of life, from yeast to bacteria to human muscle cells. Explain what the widespread presence of this metabolic pathway across such different organisms suggests about the evolutionary history of life on Earth. Use evidence from the simulation to support your reasoning.

HS-LS4-1