TEACHER PREPARATION GUIDE.

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Weighing the Invisible: A Yeast Respiration Lab

Biology | TEACHER GUIDE

Planning notes for teachers: materials, setup, expected results, and what to watch for.

Not yet classroom-tested. This is a new lab design that has not been tested in a classroom yet. Expected results, times and costs are estimates, not measured values. Run the full lab yourself before you use it with students or grade it, and adjust amounts to match your materials.

Item	Details
Unit and lessons	Unit 8: Photosynthesis and Respiration. Lessons: Cellular Respiration, Fermentation
Class time	One 50-minute period
Groups	3 to 4 students
Cost	About $2 to $3 per group; shared 0.01 g balances
Standards	HS-LS1-7, HS-LS2-3. SEP: Using Mathematics and Computational Thinking; Planning and Carrying Out Investigations. CCC: Energy and Matter.

Big Idea

Students measure the mass of an invisible product of respiration. Matter is conserved, so the mass that leaves equals the mass of gas released. The sweeteners that do not work (lactose, erythritol) show that yeast can only use molecules it has enzymes for.

Materials for 8 Groups

Item	Amount	Notes
Dry yeast (instant or active dry)	8 packets or a 4 oz jar	3 g per bottle.
Table sugar, light corn syrup, honey	A small amount of each	5 g per bottle.
Lactose powder	50 g	Brewing supply or pharmacy.
Erythritol or an erythritol-based sweetener	50 g	Check the label: many packet sweeteners (for example, some sucralose and stevia packets) contain dextrose, which yeast can use.
Small bottles (250 mL) and cotton balls	24 plus 1 for evaporation	
Balances, 0.01 g	As many as possible	One per group is ideal.

Advance Preparation

1. Assign test sweeteners so each one is run by at least two groups.
2. Have warm water (35 to 40 °C) ready in a large pitcher. Above 45 °C the yeast starts to die.
3. Start the evaporation bottle (5 g sugar, 100 mL warm water, no yeast) at the same time as the groups, and post its 30-minute mass loss.

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Running the Lab

- If you have fewer balances, weigh only at 0 and 30 minutes, and stagger group start times by 2 minutes.
- Put balances away from vents and doors. A cardboard box with one side cut out makes a cheap draft shield.

Expected Results

With 3 g of yeast and 5 g of sugar at about 37 °C, expect roughly 0.1 to 0.3 g lost in 30 minutes for usable sugars, with a slow start for the first 5 to 10 minutes. Lactose and erythritol bottles should lose about the same as the no-sugar bottle. These are estimates; pilot one sugar bottle first.

What Can Go Wrong

- Water too hot kills the yeast. Use a thermometer.
- Drafts make the last digit drift. Shield the balance.
- A packet sweetener with hidden dextrose "works." Turn it into a discussion about reading labels.

Misconceptions to Listen For

- "Gas has no mass." The balance shows it does.
- "The mass was destroyed." It moved into the air as CO_2.
- "Yeast is not alive." Yeast are single-celled fungi that respire.
- "Fermentation releases more energy than aerobic respiration." It releases far less per sugar molecule.

Differentiation and Extensions

- Support: give the conversion setup with blanks. Sentence frame: "Bottle ___ lost the most mass because the yeast ___."
- Extension: compare a cotton plug (some air) with a layer of vegetable oil on top (no air) to discuss aerobic and anaerobic conditions.
- Extension: pair with the ZornScience virtual Feed the Yeast lab.

Safety and Disposal

- Goggles. Warm, not hot, water.
- Yeast mixtures go down the drain with plenty of water.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS1-7:** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
- **HS-LS2-3:** Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Disciplinary core ideas: LS1.C Organization for Matter and Energy Flow in Organisms; LS2.B Cycles of Matter and Energy Transfer in Ecosystems

Science and engineering practices: Using Mathematics and Computational Thinking; Planning and Carrying Out Investigations

Crosscutting concepts: Energy and Matter

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