TEACHER PREPARATION GUIDE.

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The Seedling Mass Ledger

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 1: Matter and Energy in Ecosystems. Lessons: The Carbon Cycle, Producers, Consumers, and Food Webs
Class time	Two short sessions 10 days apart (about 20 minutes each), plus overnight drying
Groups	3 to 4 students
Cost	About $2 to $3 per group (seeds and bags); shared balance and oven
Standards	HS-LS2-4, HS-LS1-6, HS-LS2-5. SEP: Planning and Carrying Out Investigations; Using Mathematics and Computational Thinking. CCC: Energy and Matter.

Big Idea

Many students believe plants get their mass from soil or water. In this lab there is no soil, and dry mass removes the water, so the only story left is carbon moving between the seedlings and the air. Dark seedlings lose dry mass to respiration. Light seedlings lose less or gain, because photosynthesis adds carbon from CO_2.

Materials for 8 Groups

Item	Amount	Notes
Untreated wheat berries or mung beans	About 500 seeds (60 g wheat)	Grocery bulk bin or sprouting seed. Not garden seed with coating.
Paper towels, zip bags or lidded cups	24 towels, 16 bags	Quart zip bags work well.
Cardboard box	1 large box	One shared dark box for every group's bag C.
Shop light or LED grow light	1 to 2	Keep 20 to 30 cm above the bags, on 14 to 16 hours a day. A timer helps.
Balance, 0.01 g	1 to 2	Shared.
Drying oven, toaster oven or food dehydrator	1	Set to 60 to 70 °C. Do not exceed 80 °C, or tissue can scorch.
Foil trays	24	Fold squares of foil and label with marker.

Advance Preparation

1. Two weeks ahead: run a pilot with one set of seeds in light and one in the dark. Check that your lamp makes green leaves by day 6 or 7.
2. Sort out seeds that are cracked or tiny. Uniform seeds make group data agree better.
3. Decide where the dark box and the lamp will sit for 10 days, away from heaters and drafts.

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Running the Lab

- Day 0 takes about 20 minutes. Dry Set A the same night so it is ready to weigh with B and C.
- Assign one student per group to check moisture each day (1 minute at the start of class).
- Day 10: harvest, dry overnight, and weigh next class. Reweigh one tray after another hour of drying to confirm the mass is stable.
- Collect class data in a shared table and graph percent change for light and dark side by side.

Expected Results

Twenty wheat seeds have a dry mass of roughly 0.7 to 0.9 g. In the dark, expect a loss of about 15% to 30% by day 10. In good light, expect a smaller loss, and some groups may see a gain once leaves are fully green. If light seedlings lose nearly as much as dark ones, the lamp is too weak or too far away. Running to day 14 makes the light gain clearer.

What Can Go Wrong

- Mold: rinse seeds before starting, keep towels damp but not soaked, and leave bags slightly open.
- Lost tissue: roots tangle in the towel. Have students pull slowly and pick off root bits.
- Incomplete drying gives masses that are too high. Dry until two weighings agree within 0.01 g.
- Treated seeds: never use garden seed with a colored coating.

Misconceptions to Listen For

- "The plant's mass comes from the soil or the water." There is no soil here, and dry mass excludes water.
- "Plants do not respire." The dark set shows respiration directly.
- "Taller means heavier." The dark seedlings are tall and pale but lighter in dry mass.

Debrief Questions

- Where is the carbon from the dark seedlings now? Where will it go next?
- If a tree's dry mass comes from the air, why do farmers still add fertilizer? (Small amounts of N, P and K are needed to build proteins and DNA.)
- Connect to the carbon cycle: which arrow did each set of seedlings represent?

Differentiation and Extensions

- Support: give the percent change formula with the numbers filled in for Set A. Sentence frames: "The dark seedlings lost ___ g because ___." "The mass went into the ___ as ___."
- Extension: use the respiration equation to estimate the grams of CO_2 released. About 1.47 g of CO_2 is released for every 1 g of glucose respired (264 g ÷ 180 g).
- Extension: add a Day 14 harvest or a dim-light set to find the light level where gains begin.

Safety and Disposal

- Untreated seeds only. Students wash hands after handling seeds.
- Teacher runs the oven. Dried seedlings go in the trash or compost.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS2-4:** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- **HS-LS1-6:** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

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- **HS-LS2-5:** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

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: Planning and Carrying Out Investigations; Using Mathematics and Computational Thinking

Crosscutting concepts: Energy and Matter

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