TEACHER PREPARATION GUIDE.

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The Break-Even Light: A Photosynthesis 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: Rates of Photosynthesis, Linking Photosynthesis and Respiration
Class time	One 50-minute period
Groups	3 to 4 students
Cost	About $3 per group; syringes and screen are reusable
Standards	HS-LS1-5, HS-LS2-5. SEP: Planning and Carrying Out Investigations; Analyzing and Interpreting Data. CCC: Energy and Matter; Structure and Function.

Big Idea

This lab uses the well-known floating leaf disk method, but asks a different question: where is the compensation point? It makes the difference between gross and net photosynthesis visible and addresses the misconception that plants respire only at night.

Materials for 8 Groups

Item	Amount	Notes
Fresh spinach	1 bag	Crisp, dark leaves. Avoid baby spinach with thick veins.
Baking soda	1 teaspoon	0.2%: about 2 g per liter of water. Too much makes bubbles stick to disks.
Dish soap	A few drops	1 drop per 300 mL helps the solution enter the leaf.
10 mL syringes (no needle)	8	Reusable.
Fiberglass window screen	1 roll or scraps	Cut about 104 squares so each group has 13 layers.
LED lamps	8	LED keeps the cups from heating.
Clear 9 oz cups and foil	40	

Advance Preparation

1. Cut screen squares a little larger than the cup tops and staple them into stacks of 1, 2, 4, and 6.
2. Optional: use a phone light meter app to measure the light under each stack and post the percents.
3. Pilot one set. If the 0-layer cup is not mostly floating in 15 minutes, move the lamp closer or add a little more baking soda.

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Expected Results

Each layer of typical fiberglass screen blocks a good fraction of the light, so 4 to 6 layers can bring the light below spinach's compensation point. The key's numbers are sample values; your screen and lamp will differ.

What Can Go Wrong

- Disks that will not sink: add a drop more soap and repeat the vacuum step.
- Bubbles stuck to disks: too much baking soda. Remake at 0.2%.
- Side light leaking in: check the foil.
- Hot lamps: heat changes the rates. Use LED.

Misconceptions to Listen For

- "Plants respire only at night." Respiration is happening in every cup.
- "No floating means no photosynthesis." It means no net oxygen.

Differentiation and Extensions

- Support: a model diagram with arrows for O_2 made and O_2 used. Sentence frame: "Under ___ layers, the leaf made oxygen ___ than it used, so the disks ___."
- Extension (sun vs shade leaves): when available, compare leaves from the sunny and shady sides of the same plant, such as English ivy on a wall.
- Extension: pair with the ZornScience virtual Leaf Disk Lab to test light color.

Safety and Disposal

- Remove all needles; use needle-free syringes only.
- Solutions down the drain; spinach in the trash.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS1-5:** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- **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; Analyzing and Interpreting Data

Crosscutting concepts: Energy and Matter; Structure and Function

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