

bioengineering for sustainability

a 3-unit workshop, brought to you by Project Dolly

so what is this, exactly?

Think of this as Project Dolly's "Quick Reads," but hands-on. Over three units, students go from "wait, what even is bioengineering" to running their own mini experiments, using nothing fancier than jars, plants, and pH strips.

Every unit keeps coming back to one running example: a duckweed-based biofuel-and-water-cleanup experiment. One tiny plant, three big ideas: energy, water, and data. Watch it connect across the whole curriculum.

Who it's for: middle schoolers through early high schoolers **How long:** three 45–60 minute sessions (or squish it into one workshop day) **What you need:** nothing fancy, see the companion DIY Lab Guide **Prerequisites:** curiosity. That's it.

unit 1: the basics (bioengineering & sustainability)

By the end, students can: - Explain what bioengineering actually is (hint: it's biology and engineering having a baby). - Spot a closed-loop system in the wild. - Explain why "self-sustaining" is the dream for future habitats.

How the session goes 1. *Warm-up (5 min):* What's a problem biology could solve that a machine can't? 2. *What is bioengineering, really? (15 min):* Real-world hits: algae biofuel, bioremediation, lab-grown materials. Nature, but make it engineering. 3. *Meet the case study (10 min):* Introduce the duckweed experiment. The big question: can one fast-growing plant help with energy, water, and food all at once? 4. *Closed-loop mapping (15 min):* Students diagram inputs → process → outputs → reused inputs, first with duckweed, then with something of their own choosing (fish tank, compost bin, space habitat, go wild). 5. *Wrap (5 min):* Tease unit 2.

You'll need: whiteboard/paper, a printed closed-loop template if you're feeling extra.

unit 2: biology's greatest hits (clean energy & clean water)

By the end, students can: - Explain how biofuel gets made from biomass and why it counts as renewable. - Name two ways plants clean water. - Connect the duckweed case study to both energy and water.

How the session goes 1. *Warm-up (5 min):* Where does the energy in "biofuel" actually come from? 2. *Biofuels & renewable energy (15 min):* Photosynthesis as an energy-capture hack. Biomass in, fuel out. Compare to fossil fuels (spoiler: they lose). 3. *Water filtration & bioremediation (15 min):* Plants and natural materials (sand, charcoal, gravel) pulling contaminants out of water. Duckweed doing double duty as a nutrient sponge. 4. *Preview the lab (10 min):* Set up the filtration-comparison activity (Lab Guide, Activity 2) and let students guess the winner. 5. *Wrap (5 min):* Set up unit 3, time to prove all this with actual numbers.

You'll need: biomass/biofuel samples or images, filtration materials for demo if you've got them.

unit 3: prove it with data (environmental analytics)

By the end, students can: - Explain what makes a measurement actually useful (consistent, labeled, repeatable). - Collect real environmental data: pH, growth rate, water clarity. - Turn raw numbers into a graph that says something.

How the session goes 1. *Warm-up (5 min):* Why measure instead of just eyeballing it? 2. *What to measure & why (10 min):* Growth rate, pH, turbidity, the greatest hits of environmental data. Why units and consistency matter. 3. *Data collection demo (15 min):* Ruler + grid paper (or phone camera) for growth, pH strips for water, a simple spreadsheet to log it all. 4. *Graph it (10 min):* Students plot a sample dataset and read the trend. 5. *Wrap-up & quiz (5 min):* Post-Workshop Quiz time, then a quick chat about where else this data habit could come in handy.

You'll need: pH strips, ruler or grid paper, phone camera (optional), spreadsheet template, graph paper.

the assessment part

A 5-question Pre/Post Quiz rides along as its own document, hand it out before Unit 1 and again after Unit 3 to actually measure the learning, not just vibes.

the case study, recapped

- **Unit 1:** duckweed as a closed-loop system (grows, gets harvested, regrows).
- **Unit 2:** duckweed as both fuel source and water filter.
- **Unit 3:** duckweed's growth rate and water stats as real, graphable data.

Same plant, three lenses. That's the whole point.