TEACHER PREPARATION GUIDE.

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Crowded Cups: A Competition 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 3: Communities and Biodiversity. Lessons: Competition and Niche Partitioning, Limiting Factors
Class time	One setup period and one harvest period about 3 weeks apart, plus 2-minute watering checks
Groups	3 to 4 students
Cost	About $2 to $3 per group
Standards	HS-LS2-6, HS-LS2-1. SEP: Planning and Carrying Out Investigations; Engaging in Argument from Evidence. CCC: Cause and Effect; Stability and Change.

Big Idea

Crowding lowers the size of each individual, while total biomass levels off, which models carrying capacity at the scale of a cup. The grass cup lets students argue about intraspecific versus interspecific competition with their own evidence.

Materials for 8 Groups

Item	Amount	Notes
16 oz plastic cups	32 plus spares	Punch 3 drain holes in each bottom.
Potting mix	About 20 L	Same bag for every cup.
Radish seed (a fast type such as Cherry Belle)	1 packet of about 250 seeds	Untreated.
Annual ryegrass seed	A small bag	Garden center.
Trays, light	4 trays, 2 shop lights	On 14 to 16 hours a day, about 30 cm above the cups.

Advance Preparation

1. Punch drain holes in cups. Pre-label cups if your students are short on time.
2. Decide on a watering rule (for example, 30 mL per cup every Monday, Wednesday and Friday) and post it.
3. Plan for 3 weeks. Radishes grown longer start forming roots that make shoot mass more variable.

Expected Results

Shoot mass per radish should drop as density rises. Total radish mass rises from 2 to 6 plants and then levels off from 6 to 12. The effect of grass varies with how well the ryegrass grows; some classes will find grass hurts radish more, which is still a good argument to evaluate.

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What Can Go Wrong

- Uneven watering. Assign one student as waterer for all four cups.
- Poor germination. Always plant extras and thin on day 7.
- Cups at the edge of the tray get less light. Rotate trays every few days.

Misconceptions to Listen For

- "Competition means fighting." Plants compete by using up shared resources.
- "More plants always means more total growth." The cup's resources set a limit.

Debrief Questions

- How is this cup like a forest after a fire, when many seedlings sprout at once?
- Farmers space crops apart. How does this lab explain that choice?

Differentiation and Extensions

- Support: provide a graph frame. Sentence frame: "As the number of radishes went up, the mass of each radish went ___."
- Extension: add fertilizer as a second factor and ask whether competition becomes weaker.
- Extension (succession): spread soil from a mowed lawn and from an unmowed fence line in trays and count what sprouts in 2 weeks.

Safety and Disposal

- Gloves for soil. Students with dust allergies can measure and record instead.
- Plants and soil can go in compost or the trash.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS2-6:** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- **HS-LS2-1:** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Disciplinary core ideas: LS2.A Interdependent Relationships in Ecosystems; LS2.C Ecosystem Dynamics, Functioning, and Resilience

Science and engineering practices: Planning and Carrying Out Investigations; Engaging in Argument from Evidence

Crosscutting concepts: Cause and Effect; Stability and Change

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