

Aeroponics & Hydroponics Lab Activity Guide

Hands-On Soilless Agriculture, Experimental Design, Data Logging & Authentic Assessment



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Curricular alignment, grade-band milestones, and laboratory scope

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Collaborative Learning in Action

Visual Technology Roadmap



1. Seedling Phase

Inert substrate sprouting with zero soil contamination.



2. Liquid Column

Gravity flow recirculating reservoir saving up to 90% water.



3. High-Pressure Mist

Direct root oxygenation using 30–60 micron aerosol mist.

Teacher Implementation Note

Each grade band module contains an integrated reading passage, hands-on lab directions, daily logging sheets, and aligned rubric criteria. Teachers may print individual modules for classroom student binders or use the entire manual sequentially.

K–8 Aeroponics & Hydroponics STEM Lab Guide

A Comprehensive Project-Based Manual: Inquiry Labs, Data Collection, Close Reading, & Authentic Assessment

Standards: NGSS (LS1.C, ETS1.A-C) & CCSS ELA/Math

Lead STEM Instructors: Dr. Grella & Dr. Madsen

Student Mascot: Sammy the Sprout

Welcome, Junior Agronomists! Traditional agriculture relies on rich soil, vast horizontal land, and significant freshwater reserves. Modern urban agriculture changes the paradigm: **Hydroponics** (growing crops in mineral-rich water) and **Aeroponics** (misting bare roots in air) allow us to harvest nutritious leafy greens using up to 90% less water and zero soil.

This experiential lab guide empowers students in Kindergarten through 8th Grade to investigate plant physiology, fluid dynamics, biochemical nutrition, and environmental stewardship through hands-on vertical farming towers.



Meet "Sammy the Seed"!

Core Safety & Laboratory Protocol

Always wash hands prior to touching plant roots or nutrient solutions. Electrical water pumps and submersible misting nozzles must be handled only under teacher supervision. Keep all power plugs dry, and record pH and electrical conductivity (EC) readings daily before adjusting water tanks.

Grade-Banded Curricular Matrix

Grades K–2: Primary

Foundational Botany

- **Lab 1:** Seed Germination in Rockwool cubes.
- **Observation:** Root vs. Stem sensory drawings.
- **Reading:** "What Does a Plant Eat?" story.
- **Measurement:** Non-standard unit height tallies.

Grades 3–5: Intermediate

Systems & Adaptations

- **Lab 2:** Hydroponic Wick & Flow System.
- **Analysis:** Soil vs. Soilless water conservation rates.
- **Reading:** Capillary action & nutrient uptake.
- **Math:** Metric growth tracking (mm/day).

Grades 6–8: Middle School

Biochemistry & Engineering

- **Lab 3:** Aeroponic Droplet & Mist Cycling.
- **Variables:** pH drift (5.5–6.5) & EC titration.
- **Reading:** NASA aeroponics & food security.
- **Design:** Automated timer optimization.

Grades K–2 Module: Discovering Soilless Life



Sammy inspecting rockwool sprouts

Lab Activity 1: The Sprout Incubator (Rockwool vs. Soil)

Essential Question: Can a baby plant sprout and grow strong roots if it has air and water, but zero soil?

- 1 Preparation:** Soak inert rockwool cubes in pure water for 10 minutes until spongy.
- 2 Planting:** Use a wooden dibble stick to drop two butterhead lettuce seeds 5 mm deep into the cube.
- 3 Control:** Place two identical seeds into a small peat-soil starter pot.
- 4 Daily Logging:** Measure radical emergence (first root) using a counting cube ruler.

Guided Primary Reading: "Sammy's Magic Sponge"

Sammy the seed looked down. "Where is the dark brown dirt?" he asked Dr. Grella. Dr. Grella smiled and showed him a pale green cube made of spun rock, soft like cotton candy. "Plants don't eat dirt, Sammy! Roots drink water and breathe air. This cube holds tiny pockets of air so your roots never choke!"

Comprehension Question: Why do plant roots need air pockets inside their growing sponge?

K–2 Weekly Data Collection Log: Leaf & Root Spotter

Day	Water Given	Root Sprouted? (Yes/No)	My Sketch / Number of Leaves
Day 1	2 Pipette squirts	[] Yes [] Not yet	Leaves: ____ Root length: ____ mm
Day 3	2 Pipette squirts	[] Yes [] Not yet	Leaves: ____ Root length: ____ mm
Day 5	2 Pipette squirts	[] Yes [] Not yet	Leaves: ____ Root length: ____ mm
Day 7	3 Pipette squirts	[] Yes [] Not yet	Leaves: ____ Root length: ____ mm

Teacher Observation Check: Student accurately distinguishes stem from root hairs.

Score: [/ 4 Stars]

Grades 3–5 Module: Hydroponic Columns & Conservation

Lab Activity 2: Vertical Hydroponic Tower Dynamics

Investigation: Investigate continuous liquid flow in vertical hydroponics towers (350 mm base reservoir) and observe how gravity recirculates mineral-rich water to produce rapid foliage.

- 1 Solution Prep:** Mix 5 mL of Nitrogen-Phosphorus-Potassium (N-P-K) liquid nutrients into 4 Liters of filtered water.
- 2 Transplant:** Seat 10 germinated seedlings into net pots lined with expanded clay pebbles.
- 3 Pump Circulation:** Run submersible pump delivering upward flow through the 350 mm vertical core.



Hydroponic Column Flow Diagram

Science Article: "How Hydroponics Saves 90% More Water"

In traditional open-field farms, when farmers spray water onto dirt, over 80% is lost to ground runoff, deep seepage, and evaporation before roots drink it. In closed-loop hydroponics, water is trapped inside plastic pipes and recirculated. The only water consumed is what the plant absorbs to perform photosynthesis and transpiration!

Data Logging & Water Balance Table

Tower ID	Starting Water Vol (L)	7-Day Water Level (L)	Water Consumed	Avg Foliage Height	Growth Rate (mm/day)
Hydro Unit Alpha	10.0 L	9.1 L	0.9 L	84 mm	+12.0 mm/d
Hydro Unit Beta	10.0 L	8.9 L	1.1 L	96 mm	+13.7 mm/d
Soil Control Pot (x10)	10.0 L	1.2 L (lost/drain)	8.8 L	46 mm	+6.5 mm/d

Math Extension Challenge

Calculate water efficiency: $Growth\ (mm) \div Water\ Used\ (L)$. Which agricultural system yielded more plant growth per liter of water?

Grades 6–8 Module: Aeroponics, Mist Nozzles & Root Gas Exchange



High-Pressure Misting & Bare Roots

Lab Activity 3: Droplet Particle Size & Root Oxygenation

Engineering Inquiry: Compare submerged roots with roots suspended in 100% relative humidity mist. Discover why ultra-fine droplet sizes (30–60 microns) accelerate metabolic oxygen exchange and prevent root rot.

- 1 Timer Setup:** Program the high-pressure mist pump cycle (e.g., 15 seconds ON, 5 minutes OFF).
- 2 pH & EC Calibration:** Use digital probes to balance solution pH between 5.8 and 6.2; calibrate EC to 1.4 mS/cm.
- 3 Microscopy:** Examine root hairs under 40x magnification to count adventitious branching.

Informational Text: "Aeroponics: From NASA Spinoff to Urban High-Rises"

In the 1990s, NASA partnered with plant physiologists to grow crops in zero gravity on space stations. Soil was too heavy, while submerged water leaked into spaceship electronics. Aeroponic mist provided roots with 100% access to atmospheric oxygen, driving cellular ATP production while cutting fertilizer consumption by 60%.

Biochemical Parameter Tracking Log

Date & Time	pH Reading (5.5–6.5)	EC (mS/cm)	Mist Interval (On/Off)	Root Color & Turgor	Action Taken
Oct 12, 09:00	6.4	1.2	15s ON / 5m OFF	Bright White, Firm	Added 2 mL pH Down
Oct 14, 09:00	6.0	1.4	15s ON / 5m OFF	Silky root hairs	Nutrient baseline stable
Oct 16, 09:00	5.9	1.5	20s ON / 4m OFF	Dense lateral nets	Topped 1L pure water

Design Variable Hypothesis: How does increasing the OFF timer from 5 min to 15 min affect root hair surface area? Formulate and defend your hypothesis.

Harvest Analysis & Comprehensive Project Rubrics



Dr. Madsen & Sammy

Culminating Harvest Day: Students weigh clean biomass, calculate fresh edible yields, and conduct sensory evaluations on laboratory-grown romaine, kale, and basil crops.

"By measuring both fresh biomass weight and water input, our students learn the power of sustainable farming!" – Dr. Grella & Dr. Madsen



Dr. Grella's Harvest

K–8 Engineering & Scientific Inquiry Rubric

Evaluation Criteria	4 – Exemplary	3 – Proficient	2 – Developing	1 – Beginning
Scientific Experimental Process	Constructs clear testable hypothesis; strictly isolates control and experimental variables.	Identifies control vs. variable; records accurate procedural steps.	Experiments with minor variable confounds; procedural steps incomplete.	Performs procedures without identifying variables or clear rationale.
Data Collection & Mathematical Rigor	Daily metric logs with zero gaps; calculates growth rates, averages, and standard deviation/units.	Logs regular metric measurements (mm/mL); computes accurate total differences.	Intermittent logs; missing units or occasional arithmetic miscalculations.	Incomplete data logs; qualitative notes only without numeric measurements.
System Operation & Maintenance	Mastery of pH, EC calibration, rockwool seating, and pump safety protocols.	Safely monitors pump function and records fluid level accurately.	Requires frequent instructor prompts to record pH or clean net pots.	Improper handling of equipment or neglect of solution reservoirs.
Synthesis, Analysis & Reading	Connects reading concepts (transpiration, nutrient uptake) directly to empirical lab findings.	Accurately answers reading comprehension questions using lab evidence.	Summarizes text but struggles to relate theory to physical tower observations.	Minimal engagement with text; lacks evidence-based conclusions.

Scoring Summary & Teacher Feedback

Total Score: ____ / 16 Points | Performance Level: [] Exceeds
[] Meets
Instructor Signature: _____ Date: _____

Classroom Extension: Salad Celebration!

Rinse freshly harvested hydroponic greens with cool potable water. Pair with local vinaigrette to celebrate student scientific achievement!