



Swimming Roots vs. Cloud Roots

KINDERGARTEN SCIENCE • NGSS K-LS1-1

Little Botanist:

Date:

Plant Buddy:

Task Statement: Observe and touch plant cuttings growing in water versus dangling in air, record changes in root and leaf appearance using sensory drawings, and demonstrate through physical movement how plants drink when swimming in water versus catching an air mist.

Station Check: How Does Each Plant Drink?



Cup A: Hydroponics (The Puddle)

Roots are soaking in blue water.

[Wet]

[Smooth]

[Swimming]

[Draw roots swimming in water]



Cup B: Aeroponics (The Cloud)

Roots hang in air and catch spray mist.

[Fuzzy]

[Hanging]

[Catching Drops]

[Draw roots hanging with mist dots]

Big Discovery: Growing With Zero Soil!

Are our plants growing healthy green leaves without dirt?

☐ YES! Water + Light = Happy Sprout  ☐ NO

Root Movement Game

1. Stand Tall

You are the plant stem and leafy head reaching for the sun!

2. Hydroponics Feet

Wiggle your toes continuously in a cool puddle drink!

3. Aeroponics Hands

Reach open root fingers wide to grab mist from the cloud!



Kindergarten Observational Assessment Rubric

NGSS K-LS1-1 ALIGNMENT

Teacher / Specialist Evaluation • Student: _____

Teacher Conference & Demonstration Checklist

Teacher Prompts during Station Walkthrough:

- “Point to the cup where roots are taking a bath. What is that called?” (Hydroponics / Water garden)
- “Show me what we do with the spray bottle in Cup B. Why do hanging roots need mist?” (They drink water drops)
- “Do plants need dirt from the yard to be happy, or just water and sunshine?” (Water, air, and light)

Observational Standards Rubric (Kindergarten Inquiry)

Inquiry Skill	Mastered (3)	Developing (2)	Emerging (1)
Sensory Differentiation Observing root environments	Clearly describes the physical difference between roots submerged in water vs. roots hanging in air.	Recognizes water presence in Cup A and mist in Cup B with teacher guidance.	Confuses water and air stations; does not observe root differences.
Visual Representation Sensory sketch accuracy	Draws swimming roots below water line for Cup A and distinct droplets/hanging roots for Cup B.	Draws roots in both cups but does not indicate water line or mist spray dots.	Scribbles or draws unrelated figures; needs hand-over-hand prompting.
Basic Needs Concept K-LS1-1 Survival	States verbally that plants drink water and soak up light, proving soil is not required for growth.	Agrees plants need water and light, but insists plants will eventually die without dirt.	Unable to identify what keeps the cuttings alive in the cups.
Kinesthetic Participation Roleplay modeling	Actively models puddle roots (wiggle feet) and mist-catching roots (wide root hands) appropriately.	Participates in physical modeling with peer imitation and teacher cues.	Does not participate in kinesthetic activity or confuses the physical movements.

Teacher Notes & Mastery Stamp

Individual Observations & Accommodations:

Status: ☐ Meeting Standards ☐ Approaching ☐ Needs Support

Teacher Signature: _____



Engineering Root Buffets: Hydro vs. Aero

GRADE 3 SCIENCE • NGSS 3-LS1-1 / 3-LS4-3

Lead Investigator: _____

Date: _____

Plant Variety: _____

Task Statement: Design and assemble mini-scale hydroponic and aeroponic growth chambers, measure and record daily root elongation and leaf growth over a 10-day period, and construct a Claim-Evidence-Reasoning (CER) explanation detailing how roots adapt differently when bathed in water versus suspended in mist.

Part 1: Root Architecture Sketches (Day 10 Check)

Hydroponic Roots (In Liquid Reservoir)

[Draw long, smooth aquatic roots]

Key Feature: Slender, straight roots adapted for standing water.

Aeroponic Roots (In Misty Air Chamber)

[Draw branched roots with fine root hairs]

Key Feature: Abundant, fuzzy root hairs catching humid air.

Part 2: 10-Day Controlled Fair Test Log

Observation	System A: Hydroponic Reservoir (Wick/Liquid)	System B: Aeroponic Mist Chamber
Day 3 Early Growth	Root Length (cm): ____ New Leaves: ____	Root Length (cm): ____ New Leaves: ____
Day 7 Root Branching	Root Length (cm): ____ Root Appearance: Smooth	Root Length (cm): ____ Root Appearance: Fuzzy hairs
Day 10 Final Check	Final Root Length: ____ cm Total Leaves: ____	Final Root Length: ____ cm Total Leaves: ____

Part 3: Scientific Fair-Test Controls

Changed (Independent):

Delivery method (Liquid soak vs. atomized mist)

Measured (Dependent):

Root length (cm) and root hair formation

Kept Same (Controlled):

Light spectrum, hours of light, fertilizer type



Grade 3 Scientific CER & Assessment Rubric

NGSS STANDARDS RUBRIC • 3-LS1-1 / 3-LS4-3

Evaluator: Teacher / Peer Assessment • Total Score: ____ / 16 Points

Scientific CER Explanation: Root Adaptations

Scientific Question: Which system produces more fuzzy root hairs, and why does that help the plant?

1. Claim (State which system grew more root hairs):

2. Evidence (Cite your measured data and observations from Day 3, 7, and 10):

3. Reasoning (Explain scientifically using the words *oxygen* and *water droplets*):

Standards-Based Assessment Rubric (NGSS 3-LS1-1 & 3-LS4-3)

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Emerging (1)
Chamber Design & Setup	Assembles both hydro and aero chambers correctly; ensures steady water feed and safe root suspension.	Assembles both systems with minimal assistance; chambers operate reliably throughout lab.	Chambers have minor structural issues (e.g., wick dries out or mist hole leaks).	Fails to construct working chambers; plants dislodged or unwatered.
Controlled Data Logging	Meticulous daily tracking of root length (cm), leaf counts, and qualitative root hair density.	Data recorded for all key check days (3, 7, 10); minor measurement errors.	Inconsistent data logging; skips days or leaves units off root measurements.	Data table mostly blank; demonstrates lack of observation.
Comparative Morphology	Accurately contrasts aquatic root morphology with fine aerial root hair branching in sketches and notes.	Sketches show clear differences in root texture and branching between systems.	Sketches look identical for both systems; fails to note root hair formation.	Sketches missing or inaccurate; no distinction between systems.
CER Scientific Argument	Presents a clear claim backed by quantitative metrics and explains oxygen diffusion into root cells.	Clear claim supported by observation; explains that misted roots need oxygen to absorb food.	Claim stated but lacks supporting data; weak or vague reasoning.	Inaccurate claim or fails to answer the scientific question.

Grading Scale: 15–16: Advanced | 12–14: Proficient | 8–11: Developing | <8: Intervention

Teacher Signature: _____



Agriscience Lab: Water Efficiency & Biomass

GRADE 5 SCIENCE • NGSS 5-LS1-1 / 5-LS2-1

Senior Scientist: _____

Research Group: _____

Trial Period: _____

Task Statement: Quantify the water consumption efficiency (mL of water used per gram of biomass gained) between deep-water hydroponics and aeroponics, analyze the role of root oxygenation on nutrient uptake, and draft an agriscience proposal evaluating vertical farm and space mission applications.

1. Scientific Theory & Biomass Hypothesis

Core Concept (NGSS 5-LS1-1): Plants build structural matter predominantly from air (CO_2) and water (H_2O), not soil minerals!

Research Hypothesis: If a crop is grown in an aeroponic chamber rather than deep-water hydroponics, then its **Water Efficiency Index (WEI)** will be _____ because atomized droplet delivery:

2. Quantitative 14-Day Resource Budget

Track starting/ending plant fresh mass (g) and total volume of nutrient water added (mL).

System Metric	Deep Water Hydroponics (DWC)	Automated Aeroponic Chamber
Initial Fresh Mass (M_i)	_____ g	_____ g
Final Fresh Mass (M_f - Day 14)	_____ g	_____ g
Net Biomass Gained ($\Delta M = M_f - M_i$)	_____ g	_____ g
Total Water Consumed (V)	_____ mL	_____ mL
Water Efficiency Index ($WEI = V / \Delta M$)	_____ mL / g	_____ mL / g

3. Physiological Root Zone Analysis

Bulk Liquid Diffusion (Hydroponics):

Roots are surrounded by liquid. Dissolved oxygen (DO) drops rapidly without vigorous air bubblers, limiting cellular respiration in the root tips.

Atomized Micro-Droplets (Aeroponics):

Mist droplets coat root hairs while 100% of surrounding air provides gaseous oxygen, maximizing ATP energy production for rapid active transport of minerals.



Grade 5 Agriscience Synthesis & Evaluation Rubric

NGSS STANDARDS ALIGNMENT: 5-LS1-1 & 5-LS2-1

Investigator: _____ • Evaluation Date: _____

Engineering Synthesis & Mission Proposal

- 1. Resource Conservation Index:** Compare your calculated WEI values. Which system produced the greatest crop biomass with the least water input?
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- 2. Matter Origin Explanation (5-LS1-1):** How does this experiment disprove the misconception that plants consume soil to gain mass?
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- 3. Space Habitat Application:** Would you recommend hydroponics or aeroponics for a lunar base with limited rocket payload weight? Justify using lab data:
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Standards-Based Evaluation Rubric (4-Point Analytic Scale)

Performance Indicator	4 - Advanced	3 - Proficient	2 - Basic	1 - Below Standard
Quantitative Efficiency Calculation Math / WEI Processing	Flawless calculation of ΔM and WEI with proper units (mL/g); thoroughly interprets numerical efficiency ratios.	Accurate calculations with minor rounding discrepancies; correctly identifies the more water-efficient system.	Mathematical errors in biomass subtraction or division; missing units on calculated data.	Calculations incomplete or omitted; unable to determine water efficiency index.
Matter & Energy Modeling 5-LS1-1 Disciplinary Core	Clearly explains how air (CO_2) and water create plant mass, proving soil is not the primary source of organic material.	Explains that plants gain weight from water and carbon dioxide from air without needing soil.	Mentions plants use water, but struggles to explain where dry biomass originates without soil.	Retains misconception that plants must eat dirt or fertilizer particles to gain mass.
Root Physiology & Oxygenation 5-LS2-1 Environmental Matter	Details the biochemical necessity of root oxygenation and contrasts bulk liquid barriers with misted gas diffusion.	Explains that aeroponic mist allows roots to absorb oxygen directly from the surrounding air.	Mentions roots need air, but confuses root respiration with leaf photosynthesis.	Demonstrates no understanding of root oxygen requirements in soilless systems.
Engineering Proposal & Agronomy SEP: Constructing Arguments	Synthesizes quantitative lab data into a compelling recommendation for spaceflight or arid vertical farming.	Recommends a system supported by lab data; discusses water savings and system maintenance.	Proposes a system based on personal preference rather than recorded efficiency data.	Fails to provide an agriscience recommendation or justification.

Total Score: ____ / 16 Points | **Proficiency:** [] Exceeding [] Meeting [] Approaching

Evaluator Signature: _____