Excerpts from "GrowLab - Activities for Growing Minds" — you will get some school copies at next workshop.

Overview of Guide

This guide contains four chapters, each with background information and sections of related activities. The "Activity Summary" matrix on page 22 outlines the activities in each chapter, including topics and science process skills covered, duration, and grade ranges. Reproducible worksheets are found in Appendices A and B.

Chapters

The activities in the four chapters represent a number of key life science concepts. The chapters are:

Plants Alive! Students investigate the miracle of life, from seed to plant. Explorations examine some important basic needs that must be met if plants are to thrive and grow. Students discover how plants' structures and responses to their environment help them meet these needs. Some activities focus on soil; others explore green plants' unique ability to make food.

Generation to Generation. Students observe plant life cycles and discover the structures and processes involved in plant reproduction. They consider the amazing adaptations that allow plants to create new generations both from flowers (sexually) and from plant parts (asexually).

The Diversity of Life. Students explore the tremendous diversity of life and how we make sense of this diversity. The chapter also focuses on how specific plant adaptations to different environmental conditions help create diversity.

Sharing the Global Garden. All of the elements in the "global garden" are interdependent. Students examine a few simple relationships that involve plants directly. They'll investigate how humans use plants, how our actions can affect them, and how we can lessen our negative impact in the global garden.

Background Information

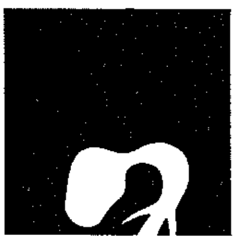
Comprehensive **background sections** precede related activities. The time and materials box at the beginning of each activity indicates where to find relevant background information. Key terms and vocabulary in the background are highlighted with **bold** type. We recommend giving new words meaning through concrete experiences. Vocabulary words will have more relevance when they are part of hands-on, inquiry-based explorations.

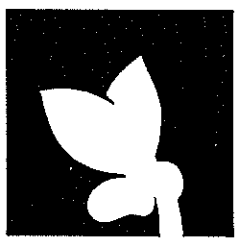
Additional resources to supplement the background information are listed in Appendix E. Always refer to *GrowLab: A Complete Guide to Gardening in the Classroom* for basic planting and plant care information.

Activities

The activities in this book are only a sampling of the types of lessons you can use to support life science concepts in an indoor gardening context. They are intended to model different approaches, reflecting a range of teaching styles, learning styles, and classroom conditions. Some activities are long-term projects, others can complement a thematic garden project, and others can be done in sequence as a series of science explorations. See the "Activity Summary," on page 22 and "Planning a Yearly Calendar," on page 16 for help in developing units and sequencing activities.

Suggested Grade Ranges. Symbols are given for each activity. These generally correlate with grade ranges: K–2; 3–5; 6–8. *Do not let the grade range indicated deter you from reading and using an activity*. Instead, adapt activities to meet your unique needs. For instance, if you or your students have had little experience with growing plants or with hands-on science, we recommend beginning with lower-level activities, adapting them where appropriate to your grade level. In some activities, you'll find sidebars suggesting adaptations for different grade ranges.


K–2


3–5


6–8

The Process of Science

For your students, learning about and "doing" science can range from watching a zinnia bloom to testing a cucumber plant's response to salt water. When allowed to explore in an atmosphere that promotes imagination and discovery, students will experience science as an essential and exciting part of their lives.

During this "age of information" your students have an extraordinary amount of information available at their keyboard fingertips. Science is more than the sum of those facts, terms, and definitions. It is using existing knowledge, our senses, reasoning, and communication skills to explore questions and solve new problems. Students at work in the indoor garden already use such skills as observing, measuring, and predicting.

How students use these skills varies with their developmental stage. Younger students rely largely on their senses to experience the world around them. Students' increasing use of science skills reflects their increasing ability to think abstractly. While younger students can carry out simple investigations to confirm or refute predictions, older students are able to design experiments, control variables, and quantify results.

Science Process Skills

			
observing	Smelling leaves of different plants.	Examining stomata with a hand lens.	Observing changes over time when stomata are clogged with petroleum jelly.
raising questions	"What will happen if I grow my plants in the dark?"	"How can I make my bean plant grow faster?"	"What makes a plant bend toward the light?"
predicting/hypothesizing	"The larger the seed, the bigger the plant."	"The warmer the water, the faster the seeds will germinate."	"Plants raised under red filters will have more flowers than plants raised under blue filters."
finding patterns and relationships	Sorting seeds by shape.	Developing a list of characteristics that make a fruit a fruit.	Noticing how soil temperature affects germination rates of different types of seeds.
designing/conducting investigations	Growing two plants in a closet and two in the GrowLab.	Experimenting to examine how different music affects plant growth.	Experimenting to determine how the amount of fertilizer applied affects growth rate.
inferring	"Plants must need water to grow."	"The beans probably didn't germinate because the soil was too wet."	"The beans probably didn't germinate in the wet soil because they didn't have enough oxygen."
communicating	Sharing drawings of bean sprout development.	Presenting a graph showing the effect of salt on the growth of ryegrass.	Debating the advantages and disadvantages of genetic engineering.

Chapter 3 - Diversity of Life

Key Concepts:

- Variations exist among the offspring of a species.
- Plants have adaptations enabling them to survive in many different environmental conditions and habitats; this has resulted in the great diversity of life.
- Humans develop systems to make sense of diversity.
- Humans take advantage of naturally occurring plant variations and manipulate plant genetics to meet our needs and preferences.
- Human actions can negatively affect the diversity of life on Earth.

Science Process Skills

Approximate grade ranges K–2	3–5	6–8	page	Activities	observing	raising questions	predicting/hypothesizing	finding patterns/relationships	designing/conducting investigations	inferring	communicating
				Diversity							
•	•		157	Title: **Plant Private Eyes*** Topic: Plant variation observations Duration: 1-2 days	•			•			•
•	•		160	Title: **Diverseedy**** Topic: Diversity among seeds Duration: 3 weeks	•	•	•	•	•		•
•	•		163	Title: **Lettuce Be Different**** Topic: Diversity within species Duration: 4 weeks	•	•		•			•
	•	•	166	Title: **Mystery Family Ties**** Topic: Plant family classification Duration: 8-10 weeks	•		•	•			•
	•	•	169	Title: **Order in the Class*** Topic: Classification systems Duration: 2 days	•	•		•			•
		•	173	Title: **Designer Crops**** Topic: Plant breeding Duration: 6-8 weeks	•	•	•				•
	•	•	183	Title: **Rainforest Stories**** Topic: Rainforest simulation Duration: variable	•	•	•			•	•
				Adaptations							
	•	•	191	Title: **Go Seeds Go!*** Topic: Seed dispersal adaptations Duration: 2 days	•	•			•		•
	•	•	194	Title: **Seed Busters*** Topic: Seed coat adaptations Duration: 1-2 weeks	•	•	•	•	•	•	•
	•	•	197	Title: **To Weed or Not to Weed?**** Topic: Adaptations for competition Duration: 2-3 weeks	•	•	•	•	•	•	•
	•	•	201	Title: **Turning Over a New Leaf*** Topic: Leaf adaptations Duration: 2-3 days	•	•	•	•	•	•	•

** = requires GrowLab use
* = does not require GrowLab use

Magic Beans and Giant Plants

Overview: After predicting what, other than magic, caused Jack's beanstalk to grow so tall, students design and conduct experiments to explore how different conditions affect plant growth.

This open-ended investigation of conditions for plant growth assumes some student knowledge of basic plant needs (light, water, etc.). It can be a springboard for more in-depth investigations of these factors.

Time:
Groundwork: 40 minutes
Exploration: 30 to 60 minutes setup; 4-plus weeks of observations

Materials:
- beans (pole beans such as limas or scarlet runners are best)
- *Jack and the Beanstalk* (optional)
- potting mix
- 4- or 6-inch pots
- "Problem Solving for Growing Minds" reproducible, page 283
- "Observation Journal" reproducible, page 286

Background: Page 39

Laying The Groundwork

Objective: To consider which specific conditions might affect plant growth.

1. Tell your students a version of *Jack and the Beanstalk.* Hand out some "magic" beans (see materials) and ask: *What do you think is the secret to growing tall bean plants?*

2. Explain that although magic *may* have influenced the growth of Jack's plants, scientists do know that other important factors contribute to plant growth.

As a class, generate a list of general factors (light, temperature, water, etc.) that students think green plants need to stay alive. Label it "All Green Plants Need." Next to each factor, ask students to predict what specific conditions they think might result in the tallest bean plants. Be sure to accept all student suggestions whether or not you think they're correct. For example:

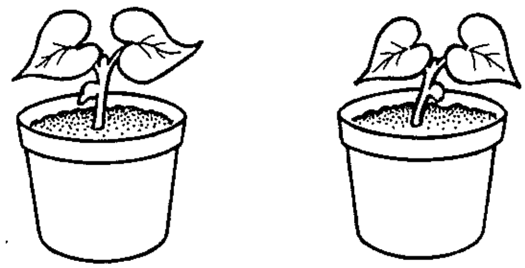
All green plants need	Predictions: Conditions for tallest bean plants
light	* sunlight better than fluorescent light * 24 hours of light better than 14 hours
water	* cold water better than hot water * water every day better than once/week
soil	* sandy soil better than clay soil * real soil better than soilless mix
nutrients	* more fertilizer better than less
other	* rock music better than classical * magnetism better than none

3. Ask your students how they might explore which of these conditions would help grow the tallest bean plants.

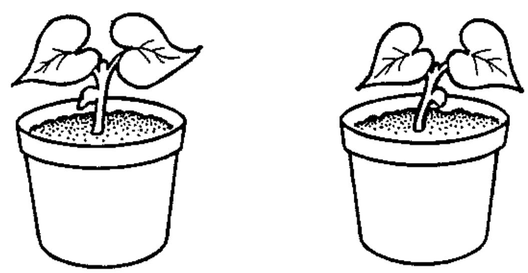
Exploration

Objective: To design and conduct experiments using a problem-solving process. To understand that different types of conditions influence the health and growth of living things.

1. Challenge small groups of students to choose one of the predictions for growing the tallest bean plants generated in the Groundwork. To test predictions, have each group design an experiment, lasting up to four weeks. Use the Problem Solving for Growing Minds process, page 10, to help guide and later record investigations. A sample setup:



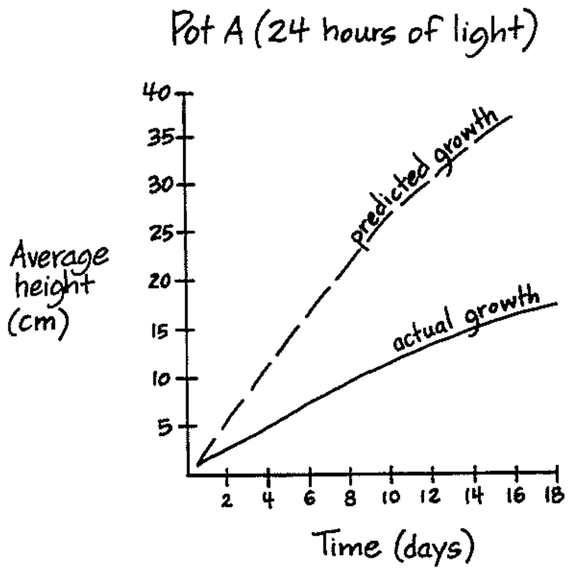
Group A
(24 hours of light)



Group B (control)
(14 hours of light)

2. Before groups set up experiments, have each present its design for review by the class. Have students explain why they predict their particular conditions will improve plant growth. For example, "We think twenty-four hours of light will make the beans grow taller in four weeks, because we know they need light to make food. So the more light, the more food, and the taller the plant."

3. Have each group decide how they'll gather their data. Suggest that at the end of each week students graph the daily growth rate of their plant and predict, based on the growth rate, how tall their plant will be by the end of the next week. On the graph, illustrate both predictions and actual growth rate results.



4. After four weeks of experimenting, have each group present a three-minute "news conference" to the class highlighting its findings. Suggest a title such as: "Grade ____ Scientists Find That _______ May Have Contributed to Jack's Mammoth Beanstalk." Have students use creative summary charts and graphs to present data. See "Create-a-Chart", page 287, for suggestions.

Encourage other class members to review the findings and ask questions about the nature of the experiment, conclusions, etc. For example: "Why did you plant X number of seeds in each pot? How did you treat each of your groups? What might you do differently if you were to repeat the experiment? How do you know it wasn't ____ that affected your plants?"

5. Combine results from different experiments on a class chart. Refer to the chart in discussing the questions in Making Connections, below.

	Group ___	Group ___	...
Question/Hypothesis			
Experimental findings			
Comments/New questions			

Making Connections

Possible discussion questions:

- *Were there growing conditions that the tallest plants seemed to have in common? What seemed to contribute most to the height of bean plants?*
- *Did any of your findings surprise you? Which ones?*

Taller is Not Necessarily Better

Although growing tall plants rapidly is an exciting focus, it's important to recognize that plant height does not necessarily reflect plant health. If lights are kept too high, for instance, or a plant is kept under warmer than optimal conditions, it may grow tall and spindly. A plant in this condition is actually less healthy than a shorter, stocky plant. Tall plants may have less leaf area and thus less food-making ability than smaller plants with more and/or larger leaves.

• *Did the tallest plants seem to be the healthiest plants? Explain your response. Do you think bigger is necessarily better? Why or why not?* (See the sidebar, "Taller is Not Necessarily Better".)

• *How did the data from the whole group help give us a better understanding of conditions for good bean plant growth?*

• *Do you think your findings about best conditions for growth can apply to all plants? Why or why not? Consider needs of a cactus, for example, compared with a lily pad.*

• *Although humans need food, are certain types or quantities better for our health and growth? How do you think this compares with plants?*

• *What other questions about conditions for plant growth do you have? Which could you set up an experiment to test?*

Branching Out

• Devise an experiment to grow the smallest bean plant that will produce flowers.

• Replant beans harvested from your stalks. (Wait to replant seeds until pods have dried, about four weeks after the beans are ripe.) Notice whether the seeds from the biggest plants produce bigger offspring.

• Create an instrument that will let a plant draw a record of its own growth.

• Calculate the average heights and total height of all plants used in the experiments.

• Prepare recipes using different types of beans.

• Rewrite or act out a new version of *Jack and the Beanstalk* using some of the new information gained from your exploration. Post these "techno-tales" around the room.

• Discuss how experiments like yours could contribute to addressing the world's food problems.