In-Touch Science: Plants & Engineering

A Cornell Cooperative Extension Publication

Acknowledgments

In-Touch Science: Plants and Engineering was developed as an interdisciplinary Cornell Cooperative Extension education program for children in grades 3 to 5. The project was funded by the National Science Foundation and Cornell University.

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Gratitude is expressed to all adults and agencies who implemented these materials. We salute their commitment to involving children in inquiry-based science and in improving educational opportunities for diverse audiences.

A special thank you is extended to the young people whose curiosity, enthusiasm, and sense of adventure convinced the authors that this program works.

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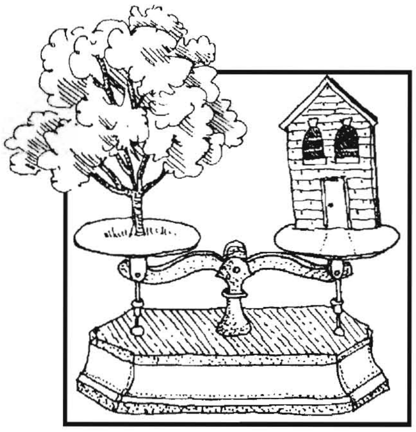

In-Touch Science: Plants & Engineering

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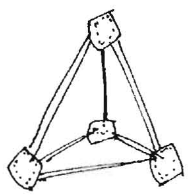
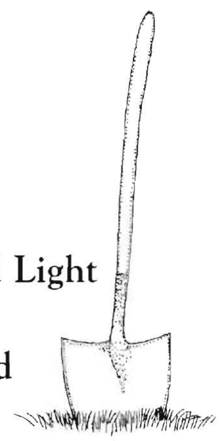




Introducing the Program

In-Touch Science is a hands-on science program developed by Cornell Cooperative Extension for children in grades 3 to 5 (aged eight to eleven). The program helps children

- communicate what they are observing and learning.
- understand the science connection between two fields of study.
- recognize those science concepts in daily experiences.

In-Touch Science emphasizes giving each child an opportunity to manipulate materials and equipment, test ideas, and explore what interests them in a relaxed learning environment. This works best with groups of five to ten children. A ratio of one adult to six children is ideal.

The ten activities in *In-Touch Science: Plants and Engineering* let children observe how one science concept relates to both plant science and engineering. This unit encourages youngsters to be more curious about their everyday encounters with plants and aspects of engineering.

The teaching style emphasizes interaction and communication among the children and between the children and the adult leader. Both adults and children are active participants. Together they experience the fun of discovery and share "I wonder..." statements that could lead to further science exploration.

In-Touch Science: Plants and Engineering was field-tested with more than 200 children from diverse socioeconomic backgrounds in 4-H clubs, school-age child care programs, scout groups, school fairs, and science clubs. It is also appropriate for use in summer camps, the Expanded Food and Nutrition Education Program (EFNEP), science and nature centers, and other community programs serving children and families. Although this program is intended to promote greater opportunities for children in nonclassroom settings, it has also been used successfully in school science classes.

Welcoming All Children

In-Touch Science welcomes all children. To that end, adult facilitators are encouraged to adapt materials and settings whenever those changes make sense for their audience. For example, if eyedroppers are too expensive you may want to teach the children to drop water by using their forefinger over the end of a plastic straw. Substitute supplies according to regional availability and ethnic preferences. Some suggestions are included in the Supplies and Preparation sections, but you will doubtlessly think of others.

Remember to try the activity with your "new" supplies, noting any changes in procedures and adapting the conversation questions accordingly.

You may have little choice of location. If possible, however, choose a setting that is comfortable for the children and is conducive to conversation. Do not allow the need for a water source or table space to dictate the site. Sometimes you can move everything outdoors and simply bring along a thermos of water and a plastic bag to cover your "table" on the ground. The goal is to provide a relaxed atmosphere that promotes exploration and interaction. You and the children in your group are the best judges of whether the *In-Touch Science* laboratory should be a cozy kitchen, your backyard, the local park, or the school gymnasium.

These activities are also designed to be within the capability of children who have special needs. Sometimes, the term "special needs" is equated with wheelchair accessibility, but in doing science activities such everyday things as allergies must also be considered. Specific information and handy hints are included with each activity to alert you to some of the special needs you may encounter. Please remember, however, that a comprehensive how-to list to address all situations is not possible.

Your common sense and your experience with children will often be the best guide. Many times you can ask the individual child what would be helpful, or ask the child's parent or teacher. Many of the hints will be applicable for several activities, so browsing through the manual may provide the answer you need.

What's in Each Session

The ten activities in *In-Touch Science: Plants and Engineering* are organized into five sessions of one to two hours each. Each session includes the same segments and flow of delivery:

Segment:	Focus (Plants)	Activity A	Transition	Focus (Engineering)	Activity B	Closure
Time (min.)	5	20	5	5	20	5

Start with Activity 1A and follow the sequence through Activity 5B. This sequence allows children to move from easy to difficult activities and provides consistent practice in applying one science concept to two different disciplines. Alternatively, each session can be broken into two sessions. In that case, remember to review at the second meeting what was done during the first so that the connecting science theme is still clear.

The activities require about thirty minutes each but could take more or less time depending on the children's skills, interest, and efficiency in organizing and cleaning up work areas. To ensure a fun, relaxed experience you may want to allow additional time, especially the first time you use the program.

As you read through each session, you will encounter these sections:

Mini-Poster. A one-page poster on colored card stock names the two activities and states the connecting science theme. Leaders should refer to this as needed to help the children understand how the two activities are linked.

Introduction. This page describes the plant and engineering activities and explains the common science concept.

Leader's Guide.
What's the point? explains what is expected of the participants, restates the main idea, and defines terms.
What's the plan? reminds you to become familiar with the activity and materials.
What's my role? emphasizes that you are a facilitator, a partner, a helper but *not* a lecturer. You set the tone and direction, then allow the children to wonder and try things at their own pace.

Plan Ahead. This section alerts you to advance preparation needs.

Special Hints. This box suggests adaptations that make the program more inclusive.

Science: Behind the Scenes. This section provides more detail about the underlying science concept. This extra dose of information may help you relax and enjoy the science experience. **Please do not use this material as a lecture, and avoid trying to convey everything you know to the children. Your genuine curiosity and a willingness to explore will inspire them far more than an armload of facts. If you**

want more background, browse your public or elementary school library or refer to the references (page 115).

Supplies and Preparation. Materials and equipment are listed along with suggestions for alternate supplies. Information is included about collecting supplies, preparing materials, and organizing workstations.

Focus. The Focus directs the group's attention to the general theme of the activity. This helps children relate what they know to what they will observe. Substitute other props or questions, but avoid telling the children too much about what you will be doing.

Activities. Each session has two activities: Activity A about plants and Activity B about engineering. The activity pages include step-by-step directions, sample questions to help stimulate conversation, safety precautions (in ***bold italics***), and a reminder to listen for "I wonder..." statements (page 10).

Each child and adult should have his or her own workstation with enough materials and space to work comfortably. Some materials and equipment will be shared and helping companions is encouraged, but each person should also be able to chase an idea or ponder an interesting thought. That may mean a step back, a fast move forward, or a long detour from what the group is doing.

Transition. Review aloud the "I wonder..." statements. This not only helps the children remember and share some of the great ideas that were expressed during the activity, but it also stimulates new ideas and projects. Ideally, the children will design a follow-up activity to answer an unresolved question.

If you are doing only one activity in a session, ask the children to clean up their workstations. If you are doing both activities, clean up from the first and create workstations for the second.

Closure. This is the time to think about how the two activities are linked. Compare the "I wonder..." statements from the two activities, looking for common elements. Refer to the poster to make certain the children understand how the two activities are related.

A Step Beyond. Questions that children expressed when these activities were tested have been developed into additional activities that expand or extend the experience. This activity-question-activity-question cycle demonstrates how the Learning Cycle (below) works and fosters an open-minded approach to learning and teaching. Ideas for more science activities and children's books related to this topic are included in the references (page 115).

A Way of Teaching and Learning

In-Touch Science uses the Learning Cycle, a teaching method that engages children in active investigative science. The Learning Cycle follows a sequence of exploration, concept introduction, and concept application as outlined in the box below. During concept application, new questions arise and the cycle starts again. Children are asked to look for many possible answers, not just one "correct" answer. An example of how it applies to *In-Touch Science: Plants and Engineering*, Activity 1A, "Lock It Up," is given in the second box at the top of page 8.

Learning Cycle Checklist

Exploration Phase

- Exploration is engaging.
- Ample time is provided for exploration.
- Exploration provides child-child and child-adult interaction.

Concept Introduction Phase

- The concept(s) introduced are an outgrowth of observation in the exploration phase.
- The concept(s) are named, and appropriate vocabulary is developed.

Concept Application Phase

- Children are given time to repeat observations with new materials.
- Children extend concept(s) to a new situation.
- Children are encouraged to wonder more about the experience, generating ideas for continued exploration and repetition of the cycle.

Adapted from Barman, C. R., and M. Kotar. "The Learning Cycle." *Science and Children* 27(7): 30–32. 1989.

Learning Cycle in "Lock It Up"

Exploration Phase

- Children look at the seeds and nuts in a cup.

Concept Introduction Phase

- Children talk about what is happening ("I wonder..." statements). The leader asks questions, makes observations, and introduces the concept of protection.

Concept Application Phase

- Children break open the various seeds, nuts, a grapefruit, and a coconut, discussing their experiences. They review "I wonder..." statements and suggest ideas they would like to test or they try A Step Beyond. One child wondered how a new forest could spring up right after a forest fire. Another wondered if you always found seeds in the same place on different plants.

Encouraging Conversation

Conversation between adults and children, and among children, is important in each phase of the Learning Cycle. The adult is both a participant and facilitator throughout the cycle.

Listen to the child's way of describing phenomena before introducing scientific language. One strategy is to focus your attention on what the children are doing. Help them communicate what they see, hear, smell, taste, and feel. Challenge them to make relationships among observations. Stating relationships indicates real understanding—in contrast to repeating memorized facts.

Each activity contains a shaded box, "Questions You Might Ask." The questions are intended as a guide, not a script. Take your cues from what the children say. Encourage them to talk to each other and not just to you. Avoid asking too many questions. Until they are comfortable following the procedures and manipulating supplies, some children will consider conversation a disruption rather than a natural part of the process. Respect each child's abilities, interests, and way of learning.

The sample questions promote conversation by using phrases that focus on the child's experience. Ask what the children saw, not why something happened. Ask how their results compared with their neighbor's, not which one was correct. Ask questions that can be answered with descriptions and comparisons, not "yes" or "no."

The following chart relates the wording of questions to specific science processes. Use it as an aid in designing child-centered questions. *In-Touch Science* units rely heavily on basic science processes; additional activities would lead to greater use of complex science processes.

Developing Science Process Skills by Experimenting and Talking with Children

Basic Science Processes	*Experimenting and Talking*
Observing	How would you describe...?
Using the senses to gather information	Tell me about...
Classifying	Which ones contain...?
Ordering or grouping observations	How are these alike? Different?
Communicating	Any expression of ideas or answers
Exchanging information	to questions
Questioning	I wonder why...?
Raising uncertainty	
Predicting	What do you think will happen?
Stating future cause-effect relationships	What if...?
Using Numbers	How many...?
Expressing with numbers rather than words	How long did it take to...?
Measuring	Fill four containers one-inch deep
Using instruments to quantify observations	Cover $^{1}/_{3}$ of the cookie sheet

Complex Science Processes	*Experimenting and Talking*
Interpreting Data	What happened before...? After?
Finding patterns or meaning among sets of data	Compare the samples.
Controlling Variables	What's our time limit?
Manipulating factors that could influence results	
Designing Experiments	Try testing "What would happen if...?"
Planning data-gathering procedures to test ideas	
Inferring	Try explaining, "Why?" by reasoning from gathered evidence
Proving explanations for events based on limited facts	Try answering, "This happens because..."

Twinkle, twinkle, little star,
How I wonder what you are.
—Rhymes for the Nursery, 1806
The Star, st. 1

Child of the pure, unclouded brow
And dreaming eyes of wonder!
—Through the Looking-Glass, 1872
Introduction, st. 1

For all knowledge and wonder
(which is the seed of knowledge)
is an impression of pleasure in itself.
—The Advancement of Learning, 1605

An "I wonder..." statement may

- be a simple observation about the materials: "This nut is hard."
- relate the activity to the child's prior experience: "My grandma gives me walnuts from her tree."
- express discovery: "I didn't know that the coconut on my cake comes from a seed."
- show growth: "It is strange that both soft and hard shells can protect things."
- relate the activity to another situation: "If shells can protect nuts from fire, are the nut trees the first to grow back after a forest fire?"

"I Wonder..." Statements

Because questioning and curiosity are key elements of the *In-Touch Science* program, the authors have adopted the phrase "I wonder..." to describe children's responses. These responses are used by the adult to direct, reinforce, and evaluate learning.

An "I wonder..." statement does not have to begin with the words "I wonder." It does not even have to be a statement. "I wonder..." statements are comments, ideas, questions, descriptions, concerns, theories, doubts—any expression that demonstrates that the children are thinking about what they are doing.

Throughout the sessions, children and leaders share, discuss, and collect "I wonder..." statements. These statements are important evidence that the children understand what they are doing, that they can see the connection between activities A and B, and that they can relate the science concepts to similar situations in their daily lives.

Most children have plenty to say, but it is not easy for a busy leader to hear or remember all of their ideas. With practice, most leaders can follow the children's conversation enough to redirect them when they stray from the topic and to help them summarize what they learned by referring to overheard "I wonder..." statements. Some leaders invite a helper to record "I wonder..." comments and read them back at the end of the activity or session. Others ask the children to write statements on cards, newsprint, or a chalkboard for review. Some groups have enjoyed tape-recording their ideas while others express in drawings what they learned or wondered about.

Organizing Supplies

The science experience will be more enjoyable if you have a plan for collecting, cleaning, storing, and restocking supplies. Each activity has a "Supplies and Preparation" page that lists the items needed, explains any preparation procedures, and suggests alternate materials. Supplies are easier to manage if they are assembled into a kit.

Supplies

The supplies recommended in this book have been used with many children and are known to work. Most can be found in your kitchen. All can be purchased at local food, drug, discount, garden, or office supply stores. Their selection was based on considerations of cost, availability, preparation time, ease of maintenance, and storage. You are encouraged to adapt the supply lists to suit your situation.

Reusable supplies are tools that can be used several times. Examples are lamps and thermometers. Sturdy plastic spoons, knives, and cups that might be considered disposable are intended to be reused. Sturdy resealable plastic bags may be reused depending on how well they withstand handling.

Consumable supplies include perishable and nonperishable items that are used only once. Examples are foods, paper, and paper towels. If you have storage space, you may want to buy nonperishable products in quantity.

Supply Kits

Because the self-discovery nature of this program is most effective with small groups, instructions for assembling supply kits are based on ten participants. The "Checklist for Assembling Supply Kits" on page 101 lists all of the supplies needed for doing the ten experiments with ten participants.

The "Checklist for Assembling Supply Kits to Loan" on page 103 excludes perishable items and groups other supplies so that you can quickly assemble a "basic" kit with only tools and reusable supplies or a "made-to-order" kit that fits your specific needs.

Hints for the Successful Use and Maintenance of Supply Kits:

- Identify one key person, such as a child who offers to help, teen, parent, or other volunteer, to monitor your kits.
- Purchase in quantity.
- Label items with name and quantity.
- Keep small items together with rubber bands or in bags or small boxes.
- Use a protective covering for sharp objects.
- Allow time to wash and dry reusable tools before they are repacked in the kit. If possible, include the children in the cleanup tasks.
- Choose a durable storage container with a tight-fitting lid such as the cardboard boxes used for packing reams of office paper.
- Tape a copy of the appropriate checklist inside the lid of the kit.

Monitoring Success

Adults who use the *In-Touch Science: Plants and Engineering* program will be giving children an opportunity to explore the science of plants and engineering through experimentation. This may be a new experience for you, and you may never have considered teaching children about these two disciplines together.

The aim of this program is for children to gain a greater appreciation for science and its role in their everyday encounters with plants and engineering. The ten activities introduce several concepts, any one of which probably needs to be explored more fully for children to achieve understanding. Yet children can begin to appreciate how similar science concepts relate.

Two indicators of program success are (1) the degree of the child's communication and (2) the complexity of the child's "I wonder..." statements. If the children are engaged by the activities, they should express their enthusiasm by talking, drawing, pantomiming, or in some way sharing what they are doing. The children's expressions should progress from "I've got sod like that in my yard," to "Could you prevent mud slides if you planted lots of grass?" Participants may also make comments about personal experiences or future plans such as "Oh, yeah, this is like what I saw on TV" or "I'm going to show my dad what happened."

The evaluation form on pages 111 and 112 is designed to collect both quantitative and qualitative data. Copy as needed, using a separate form for each session.

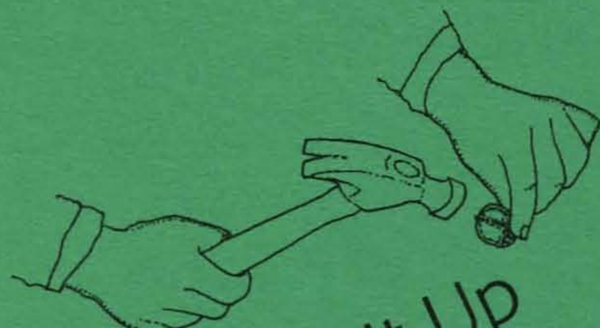
A Preprogram Activity

If you decide to use all the material sequentially with a group of children, you may want to introduce the program to them, especially if you haven't done many science experiences together. Before you start, it might be interesting to collect their ideas about science and their experiences with plants and engineering.

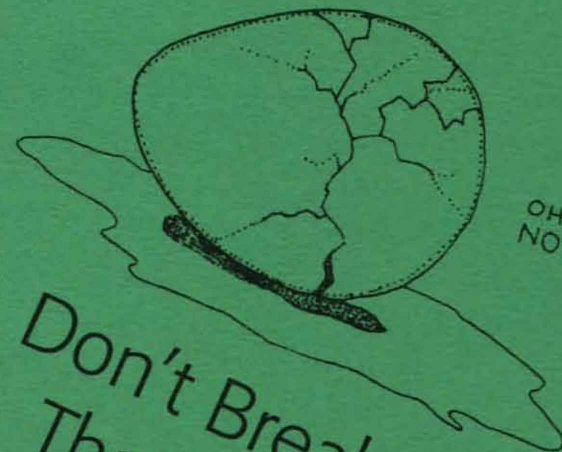
You could play a word game by saying, "If I say 'science,' what do you think of? Tell me about a time that you've experienced science. What did you do? Why do you think that's science?"

Or you might have the children draw a picture or collect magazine pictures of people doing science. The pictures could include people, objects, or activities. What are the children's perceptions of science?

You could conclude an introductory activity by saying, "Science is part of almost everything we do. Every day we make things, we eat, we play, and we ride or walk to school. Yet we rarely think of these routine activities as involving science. We will be doing a series of ten activities to find out more about the science of plants and engineering."

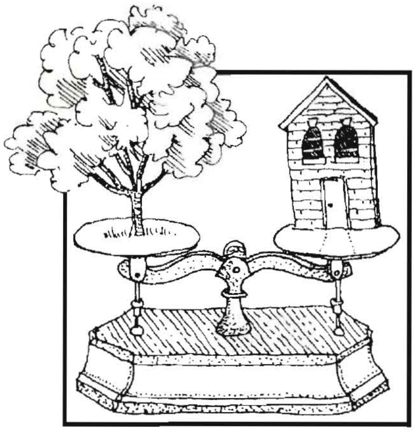


Lock It Up



Don't Break That Egg

Protection



Session 1

Protection

These two activities introduce the idea of protection. Protection is an important concept to both plants and humans, even though the items being protected as well as the ways in which they are protected are quite different.

Like people, plants use different materials, some soft and some hard, to protect against invasion or being eaten, from air that dries things out, or from fire. If we protect things, they last longer. We can examine a variety of materials and think of how they protect things.

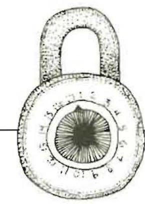
In Activity 1A, *Lock It Up*, children will examine fruits and their seeds to take note of their protective exteriors and to find out why such protection is necessary.

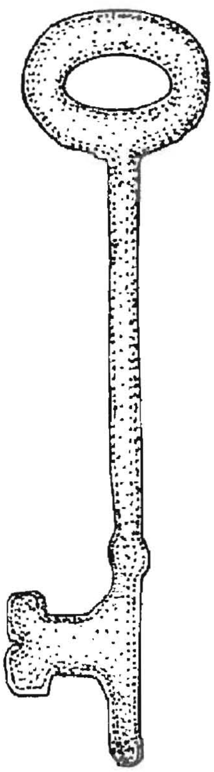
In Activity 1B, *Don't Break That Egg!*, children will protect a fragile item while discussing the methods that we use in our society to protect valuable objects. Observation, copying from nature, and imagination are useful when we search for a way to protect things.

Session at a Glance

Activity 1A

Lock It Up





Leader's Guide

What's the point?

Children examine fruits, nuts, and seeds. They have the opportunity to explore the many different strategies that fruits use to protect and enclose their seeds. *For additional information, read Science: Behind the Scenes (page 19).*

What's the plan?

1. Read the activity (page 21).
2. Gather the supplies (page 20).
3. Try the activity.
4. Note safety measures (in ***bold italics***) and special hints (below).

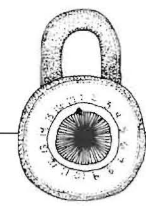
What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Special Hint

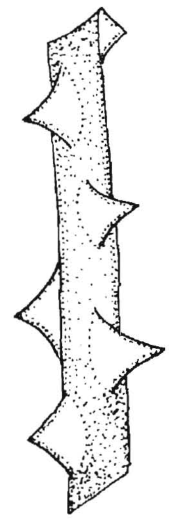
Make sure none of the children are allergic to nuts. This is a fairly common allergy, and a reaction can be triggered just by handling nuts.

Lock It Up



Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.



Plants are surprisingly creative in fending off hungry animals, harsh weather, and other adverse conditions. The rinds of oranges and grapefruits provide protection by preventing moisture loss; leaves may also be thick and waxy to hold in water. Plants such as cacti are often thorny to protect their soft, fleshy interiors. Some plants contain poisons to keep them from being eaten. The plant world has many, many protective adaptations. This activity takes a closer look at seeds that have tough, hard seed coats to protect the interiors from ravaging animals and insects.

For this activity it helps to know the botanical definitions of seeds and fruits. A seed is a matured fertilized egg. Each seed contains one young plant—called an embryo—enclosed by a seed coat. Different amounts of nutritive tissue are also present within the seed coat.

In all true flowering plants such as maples, pansies, and grasses the seed(s) is produced in an ovary. When this ovary is mature or ripe it is called the fruit. The fruit is really the seed-bearing part of the plant. And all flowering plants produce seeds that are enclosed by this matured ovary or fruit.

The ovary supplies food to the seeds-to-be and prevents the young seeds from drying or rotting, being eaten, or blowing away as they develop. Once the seeds mature, the surrounding fruit serves different purposes depending on the plant.

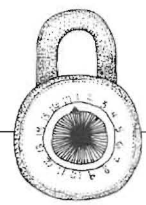
When the seeds are fully developed, some fruits open and release them. An example of this would be a pea pod that splits into two separate halves, releasing the mature peas inside. Some fruits are fleshy and sweet and remain intact when the seed is mature. These are our common fruits from the market, including tomatoes, oranges, and pears. These fruits, often brightly colored, attract animals and provide a food reward for swallowing and dispersing the seeds. Protected by their seed coat, the seeds move intact through the digestive systems of many animals.

A nut is what we call a fruit that is dry, doesn't break apart at maturity, and usually contains one seed. These tough, dry fruits protect the seed within and eventually rot away so water can enter and the seed can germinate. Examples are beechnuts, hazelnuts, and acorns.

It is fun to examine different fruits containing seeds and think about how the fruit helps the seed(s) survive.

Activity 1A

Lock It Up



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group. They will also be used for the activity.

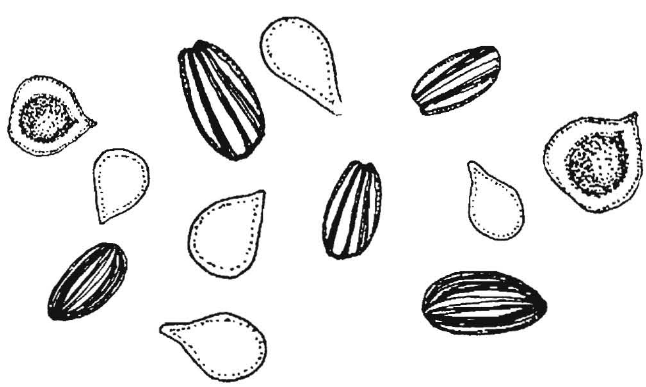
- ❑ bowl containing a variety of fruits, including nuts in their shells, fleshy fruits such as seeded grapes and apples, and any fruits that you can find outdoors

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

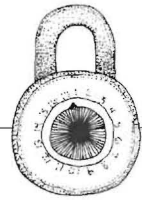
- ❑ handful of a variety of nuts such as English or black walnuts, sunflower seeds, peanuts, and almonds, all in their shells. In addition, try to include something unusual that children seldom have a chance to see, handle, or eat.
- ❑ small nutcracker
- ❑ protective plastic goggles[1]
- ❑ hammer
- ❑ large grapefruit with seeds (can be shared by group)
- ❑ large coconut (can be shared by group)
- ❑ thick plastic bag
- ❑ paper or plastic cup for each student
- ❑ Lysol

[1] Reminder: Before reusing, disinfect goggles in a solution of $1\frac{1}{4}$ oz. Lysol in 1 gallon of water. Rinse well and air-dry.



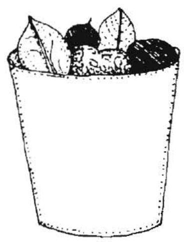
Activity 1A

Lock It Up



Focus

Place the bowl of mixed nuts and fruits on the table. Pass the nuts and fruits around. Say something like, "Tell me something about these. What are they? Where do they come from? Today let's try to find out more about them."



I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why some nuts are hard and some are soft.

why we eat only the inside of nuts and throw out the shell.

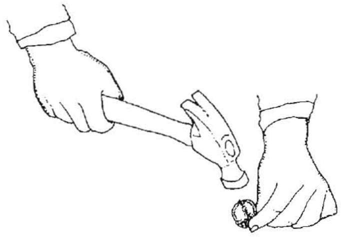
Activity

1. Choose a work surface that will not be damaged by the nuts or by hammering. A floor that will not be slippery when nutshells are scattered and is easy to vacuum or sweep up is also desirable.

2. Give each child a cup of nuts and seeds.

3. Challenge the children to break open each of the nuts with first one, then both of their bare hands.

4. Provide nutcrackers, or help children with hammers, and crack open the remaining nuts and seeds. Demonstrate how to use nutcrackers for children who haven't used them before. ***Have children wear clean protective goggles when breaking open the nuts with a hammer or nutcracker.*** Examine the shells that protect the seeds within. Taste one of the nuts ***(remember—some children are allergic to nuts)***.



5. Pass around the grapefruit and the coconut.

Conversation

Questions You Might Ask

Can you break open any seeds or nuts with your hands? Which ones break open?

Which ones are so hard that you can't break them open with your hands?

How thick are the shells of the nuts? What is the texture inside? Is it softer or harder than the shell?

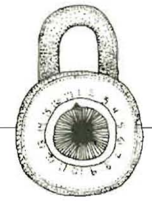
What properties do most of the fruits and seeds, regardless of the kind of plant, have in common?

What are the differences between the two protective coverings on the grapefruit seed and the coconut? What common traits do they share?

What role do you suppose the fleshy material inside the grapefruit plays?

Activity 1A

Lock It Up

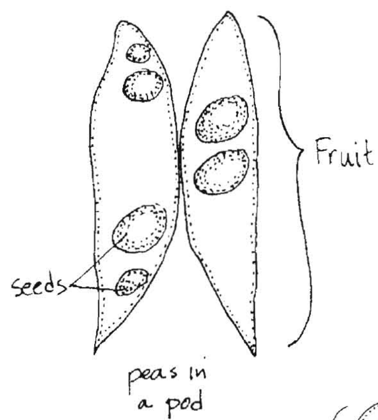


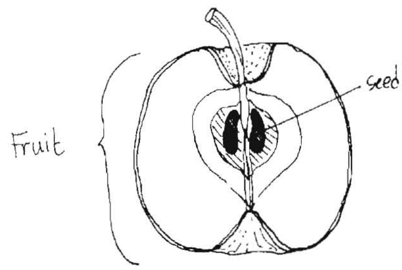
6. Peel and open the grapefruit, observe the structure of the sections, and notice that there are seeds inside that have a hard protective covering. Break open the seeds with a hammer and observe the internal portion.

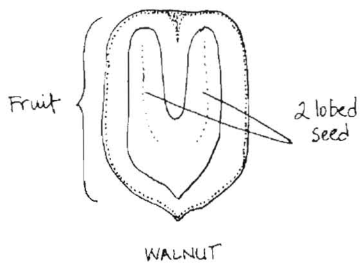
7. Put the coconut in a thick plastic bag and crack open the hard seed coat using the hammer. Taste the white meat inside and observe the flavor. The meat is the food storage tissue for the embryo.

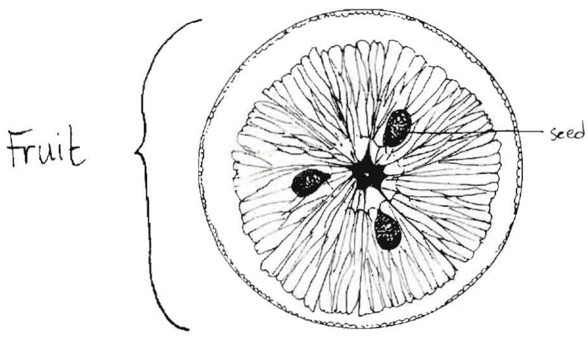
Transition or Closure

If you are doing only Activity 1A, review the "I wonder..." statements while eating the nuts and cleaning up the shells. Comment again on the protective nature of the tough exteriors. Then shift the children's attention to the engineering activity.









I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

which animals would love to eat these seeds.

what would happen to the fruits or seeds if they didn't have protective coverings.

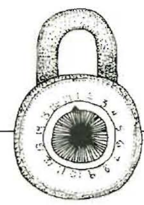
what kind of nutritive value seeds have.

what impact forces of nature—temperature changes, fire, flooding, drying—have on these protective coverings and the seeds inside.

what would happen to the seed if it wasn't protected from the forces of nature.

Activity 1A

Lock It Up



A Step Beyond

I wonder what other things plants do to protect themselves. I wonder why plants have different types of protection. I wonder what other plant parts are protected.

Take a walk through a meadow, forest, or even your backyard. Look for seeds that have protective coatings. Look at ways in which plants have made adaptations other than those used for protection. For example, maple seeds have adapted "wings" for floating far from the tree so that they do not grow in the dense shade of the mother tree.

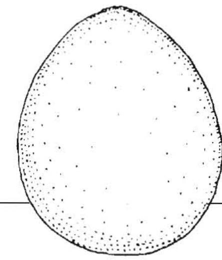
As you begin to look more closely at plants, you may notice that certain parts of plants—such as stems, trunks, and leaves—have very interesting adaptations. The bark might be really thick to protect the inside of the tree from ravaging animals; stems might be covered with thorns; or leaves might be hairy to keep insects from munching on them.

See if you can identify five unique protective devices found outdoors in the plant world. Use the following chart to record your findings:

Plant	Location of Plant	Plant Part	Protective Use

Activity 1B

Don't Break That Egg!



Leader's Guide

What's the point?

Children wrap eggs protectively and then drop them from a height. They learn that some materials protect a valuable object better than other materials do. They think about packing materials that we use every day to protect fragile and valuable things.

For additional information, read Science: Behind the Scenes (page 25).

What's the plan?

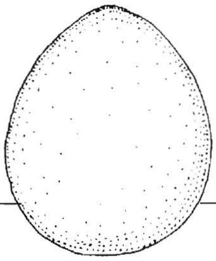
1. Read the activity (page 27).
2. Gather the supplies (page 26).
3. Do advance preparation (below) and try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

The more protective materials you gather, the better! Clean out closets or raid a pantry to find old pieces of cloth, packing "peanuts," and other materials. (See Supplies and Preparation, page 26.)



Activity 1B

Don't Break That Egg!

Science: Behind the Scenes

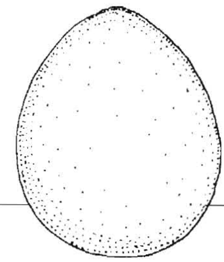
Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Many things that people design can be found in nature. Even when we think we're designing something new and special, we often find that nature has done the same thing. Eggs are very successfully designed to be strong, allow air to pass through to the developing baby bird, and enable the baby to peck its way out when it hatches.

Think of some manufactured materials and structures that are based on nature's designs. As you saw in the plant science activity, plants have many protective strategies, many of which have been paralleled by people as they design protective devices. Cork is designed by nature, and styrofoam is designed by people; these are examples of this functional similarity. Polyester and cotton fabrics can be so similar that we have difficulty telling them apart. Plants use a waxy coating to prevent moisture loss; people have created plastic coatings to do the same thing.

Activity 1B

Don't Break That Egg!



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

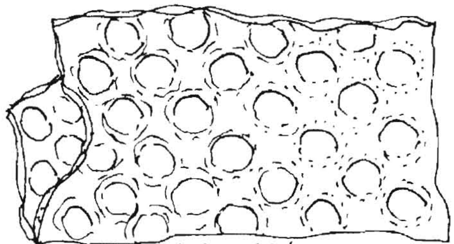
- ❑ 1 dozen eggs in an egg carton

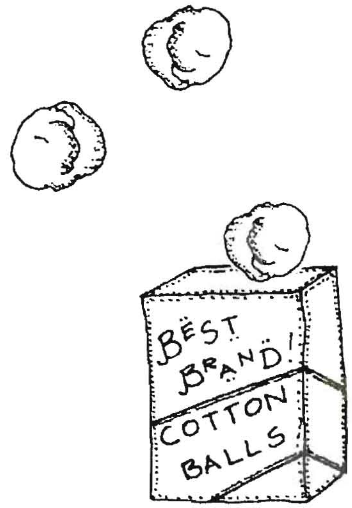
Activity Supplies

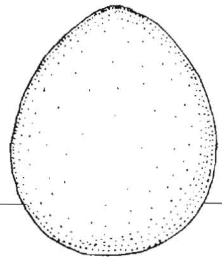
Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ magic marker for writing child's name on package
- ❑ raw egg
- ❑ a variety of wrapping and packing materials[1]
- ❑ anything else you can think of that might be useful for wrapping such as tape, string, and other fasteners
- ❑ scissors

[1] bubble wrap, dried grasses, feathers/fur, packing "peanuts," popped corn, pieces of cloth, paper such as paper towels, wrapping paper or paper bags, cotton balls/lamb's wool, dried beans/seeds, and other "everyday" packing materials that you have. Don't forget "hard" packing materials such as margarine and yogurt containers and small boxes.







Activity 1B

Don't Break That Egg!

Focus

Examine the eggs in the carton. Say something like, "How are the eggs packed? How do cartons protect the eggs from breaking?"

Activity

1. Put out a large assortment of wrapping and packing materials. Include a variety of hard and soft, crushable and absorbent, large and small materials.

2. Cut materials into small, individual-sized pieces if this was not done earlier. Some possible materials are listed, but use whatever you have available.

3. Give each child a raw egg (you can substitute hard-boiled eggs if messiness is an issue).

4. Invite each child to wrap the egg in a protective package that will survive being dropped. As a group, choose a location from which you will drop the eggs. Some suggestions are down a stairwell, out a second-floor window, or from a ladder, porch, desk, or table. ***(Of course, use caution in areas with significant height!)***

5. Set a size limitation to the finished package if you wish to.

6. Give the children a time limit and remind them periodically how much time they have left.

7. Make sure that the children write their names on their creations.

8. You (the adult) stand on a desk, on a ladder, or from wherever you have decided to drop the egg, or choose one child to do this. (Because children's height varies, the eggs would drop from a different distance if each child dropped his or her own egg.)

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how people in other parts of the world keep eggs from breaking.

if eggs would be stronger if they were a different shape.

Conversation

Questions You Might Ask

How do you think milk is protected from spoiling in the summer heat?

How can your parents protect ice cream from melting on the way home from the grocery store?

How can you keep your books dry when you're walking to school in the rain?

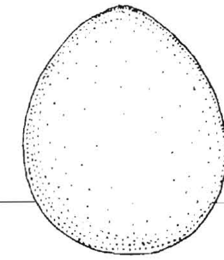
Why do people put glass over paintings and photographs?

How do people protect themselves from getting hurt? Do different parts of our bodies need different kinds of protection?

When someone washes the kitchen floor, why do they put "wax" on it?

Why do people paint their houses?

Don't Break That Egg!



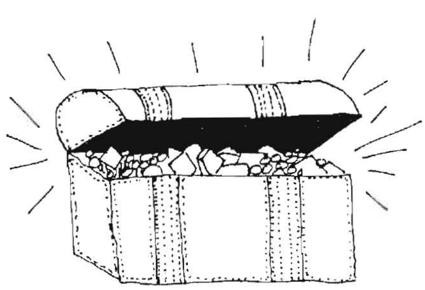
9. One by one, drop the children's wrapped eggs.

10. Have the children unwrap their eggs over a sink or washable surface and talk about the results.

Closure: Connecting Plants and Engineering

If you are doing only Activity 2B, review the "I wonder..." statements. Note that protection isn't something that just engineers and designers think about. Every culture has devised ways of protecting things. Children in your group may be able to talk about their cultures and others they have experienced. Or they may be able to bring in examples or ideas of the ways that their family, relatives, or neighbors protect valuable possessions.

If you are doing Activities 1A and 1B together, review the "I wonder..." statements for both. Reflect on the similarity in the protective nature of the hard seed coats and the protective coverings over the eggs.



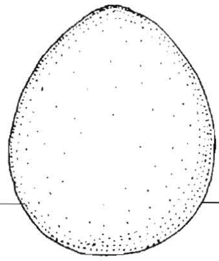
I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

if there would be any way to protect a wrapped egg from breaking if it were dropped from 100 feet in the air.

why and how some birds' eggs are stronger or weaker than others.

how I would design an egg if I could be a "better-egg-designer."



Activity 1B

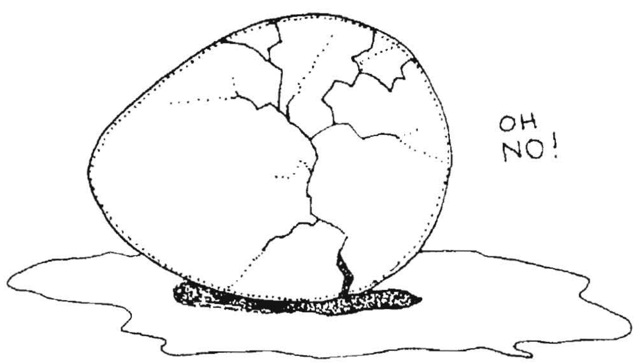
Don’t Break That Egg!

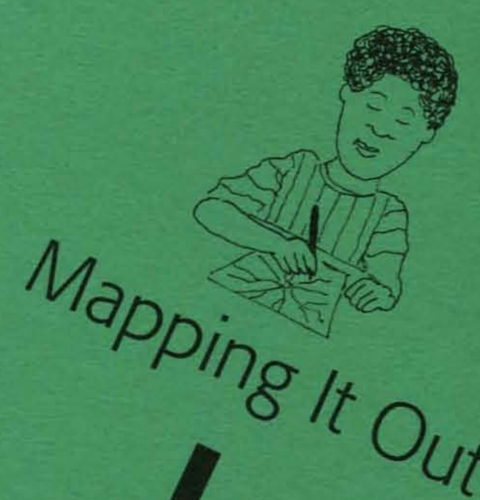
A Step Beyond

I wonder if my protective package would protect my head.

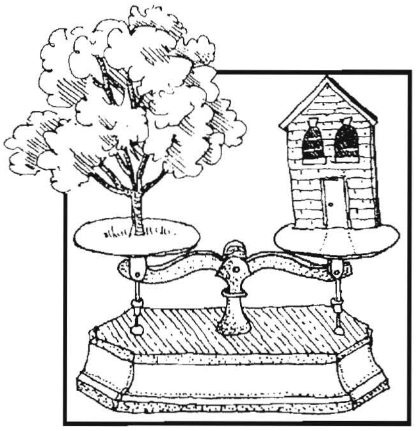
Different kinds of materials can offer different kinds of protection. In the egg drop, you chose some hard things and some soft things. Why did you choose different materials?

Pass around a motorcycle helmet, football helmet, or bicycle helmet and consider what it is made of. Why is it made of those materials? What does it feel like on the outside? What does it feel like on the inside? Helmets are hard on the outside. Why are they hard? Does it keep the rain out? These items are hard so they can protect your head from sharp edges that might poke or scrape you.





Transportation



Session 2

Transportation

These two activities explore how we get things from one place to another and encourage children to be more curious about transportation systems in the world around us.

Plants and animals have transport systems to move food to where it is needed. Whether it is engineers planning a road system between farm and processing plant and then to people's homes, or the way plants bring water from their roots to their leaves and flowers, the rules are the same: get from here to there as quickly and easily as possible.

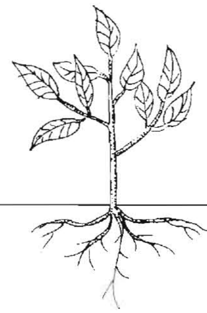
In Activity 2A, *Pulling Up Color,* children will examine the uptake of colored water in plant stems.

In Activity 2B, *Mapping It Out,* children will examine roadways to see the network that provides goods to stores and allows for various types of transportation.

Session at a Glance

Activity 2A

Pulling Up Color



Leader's Guide

What's the point?

Children observe that plants have elaborate systems of transportation for water and nutrients. Older children may be interested in some of the terminology for the process involved with the transport of food and water.

For additional information, read Science: Behind the Scenes (page 35).

What's the plan?

1. Read the activity (page 37).
2. Gather the supplies (page 36).
3. Do advance preparation (below) and try the activity.

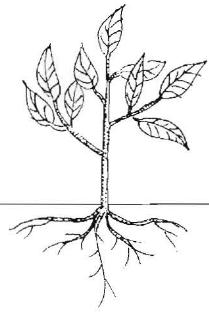
What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Plan Ahead

It can take several hours before the color is visible at the top of the celery stems or in the daisy petals. The time varies with age of the plant tissue, amount of light, and other factors. To ensure success, do the following:

- Cut one daisy stem and one celery stalk and place them in the colored water the day before you do the activity with the children. Use these examples as evidence that colored water, given enough time, will move all the way up the stems.
- Set up Activity 2A (steps 1 through 7) and then do Activity 2B or something else for at least half an hour. This allows time for the colored water to move. Allow more time for daisy petals than for celery stems.



Activity 2A

Pulling Up Color

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

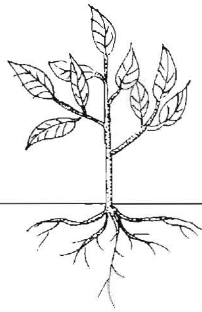
The "roadways" inside plants are sophisticated and intricate; these pathways move moisture and nutrients to all parts of the plants. Water and dissolved minerals move upward through stems against gravity. This happens through a combination of factors: pressure, adhesion, cohesion, and transpiration. Without an intricate transportation system, all plants would have to lie along the ground!

Here's how it works. The roots of a plant absorb water from the soil. As water enters the roots, it pushes water already within the plant upward into the stem. The water molecules within the pathways stick, or cohere, to each other. They also adhere to the sides of the column. This cohesion and adhesion keep the column of water together. At the end of the column, on the surfaces of the leaves, water is lost to the air through transpiration. Transpiration is caused by evaporation of water through openings in the leaf.

Because of this elaborate system, water can move upward as quickly as 30 inches per minute. Scientists working with trees can hear, through special devices, when the column of water breaks. This breakage is referred to as cavitation.

Activity 2A

Pulling Up Color



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

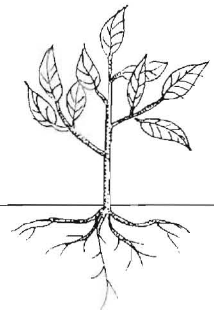
- ❑ stalks of celery and daisies (the latter if available)

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper or plastic tablecloth
- ❑ small container (juice glasses or yogurt cups work well)
- ❑ pitcher of lukewarm water
- ❑ eyedropper
- ❑ vegetable food coloring (use several colors if available)
- ❑ sharp knife
- ❑ celery stem[1]
- ❑ daisy or daisy mum, if available[2]
- ❑ direct sunlight or desk lamp

[1] Keep refrigerated, or cut at the base and place in water.
[2] Flowers must be young and fresh.



Activity 2A

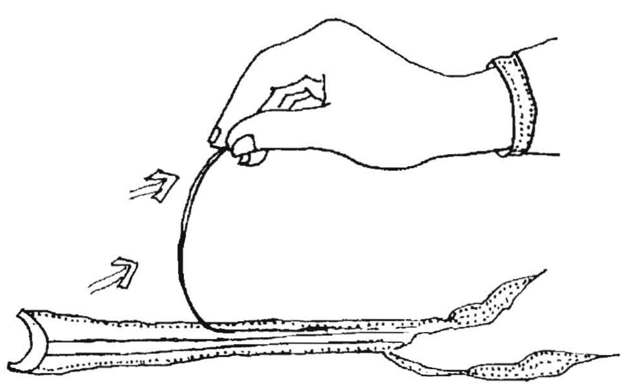
Pulling Up Color

Focus

Show the celery and daisies. Say something like, "How do you suppose a stalk or stem gets the nutrients and water to all parts of the plant? Let's find out."

Activity

1. Work on a surface covered with newspaper or a plastic tablecloth. Have a pitcher of water available.
2. Have children fill their container about 1 inch deep (about $^1/_3$ cup) with water.
3. Each child should add at least 20 drops of food coloring to their container. If available, try using a variety of food colorings.
4. Cut the bottom end of all four celery and daisy stems, so that each has a fresh cross-section cut.
5. Have children place one celery stem and one daisy stem, cut side down, in each container.
6. Place containers in direct light from bright sunlight or a desk lamp.
7. Let children know that you'll return to this activity after completing Activity 2B.
8. When you return, make cross-section cuts along the celery stems at various points. Have the children look for evidence that the colored water is moving up the stems. Count the "strings," or vascular bundles, in the cross section.

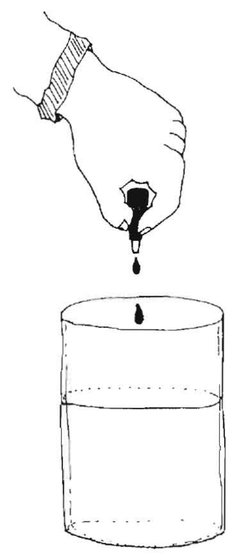


I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

what those strings inside the celery stem are for.

if anything would change if we did this activity in the dark.



Conversation

Questions You Might Ask

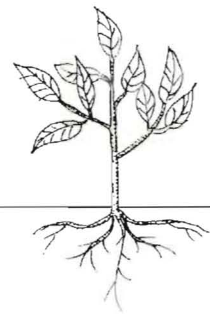
What do you suppose is going to happen with these stems?

What do you think would happen if we broke a stem? (You might want to try it.)

What would happen if we left the celery and daisies lying out of water the night before?

Activity 2A

Pulling Up Color



Transition or Closure

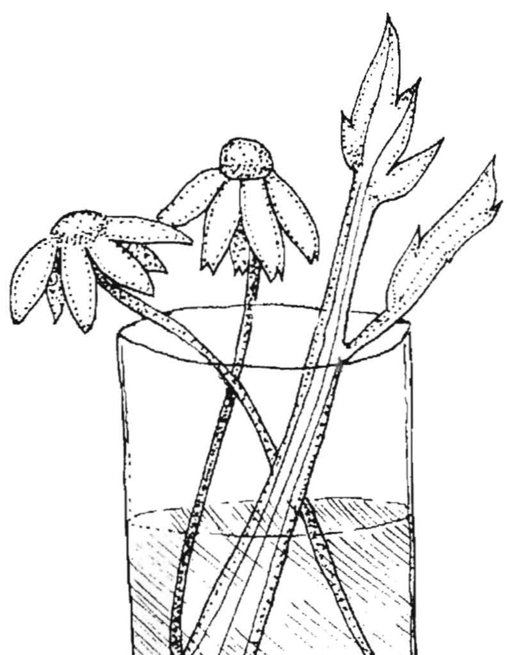
If you did only Activity 2A, review the "I wonder..." statements and clean up. If you are doing Activities 2A and 2B together, summarize the plant activity and move to Closure: Connecting Plants and Engineering, page 44.

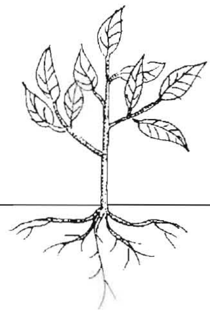
I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

whether other plant stems have these stringy "tubes" for carrying water and nutrients.

what happens if the stems break or get crushed.





Activity 2A

Pulling Up Color

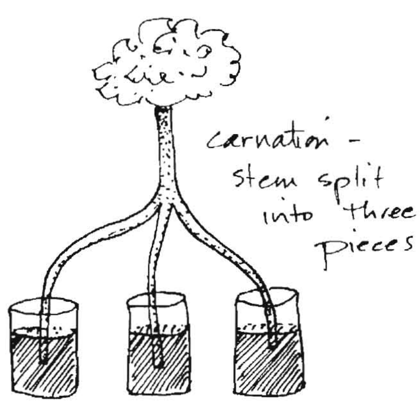
A Step Beyond

I wonder if the stem could pull up different colors of water from three glasses if we split the stem in pieces.

Fill three glasses halfway with water. Place food coloring of a different color in each glass. Take a large, fresh celery stem, and with a sharp knife cut the base of the stem into three sections. Split the stem upward far enough to place each of the three sections into the three individual glasses.

What do you think will happen? Try it with white carnations for flamboyant results. Can you think of other plants that might be interesting to try this with?

What would happen if a celery stem was turned upside down and placed in colored water? Would the water still travel to the other end? Encourage the children to explore the effect of gravity on the ability of a plant to transport water and dissolved minerals to all of its parts. Set up an experiment in which individual plants are maintained in different positions. For example, place one plant upright, another at an angle, and a third one upside down. Have the children keep track of how long it takes each plant to take up the colored solutions. Does the position affect how fast and how much colored water each plant can take up? Have the children calculate how long it takes each plant to transport the colored water, and measure the distances the colored water traveled in each plant.



Activity 2B

Mapping It Out

Leader's Guide

What's the point?

Children use road maps to understand how we design efficient transport systems. Maps help them see that there are reasons behind our systems of roads—that roads are built to connect places that are important to us.

For additional information, read Science: Behind the Scenes (page 41).

What's the plan?

1. Read the activity (page 43).
2. Gather the supplies (page 42).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 2B

Mapping It Out

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Roads are paths that let people, animals, and goods travel from place to place. They often tell us about the history of towns and cities. Many roads began as paths or trails for animals or early people. The paths were not always the shortest way between two places because they had to avoid trees and rocks and sometimes find ways to cross water. Modern engineers don't have to worry about trees and rocks because we have equipment to clear the trees and push rocks out of the way. Engineers can decide whether to go over, around, under, or through natural obstacles like hills or swamps.

In ancient times roads were used to link houses and villages. Trade grew and became important on these roads between villages and between distant places. One of the oldest roads that we know about is the Royal Road of Persia, built between 1400 and 500 B.C. It was about 1,600 miles long.

The ancient Romans built roads on a large scale. Their roads were so well built that parts of them are still in use today. They built more than 53,000 miles of paved roads, starting with a base of stone blocks topped by small stones and cement and then pebbles. The road surface was made of large slabs of fitted-together stones. The whole construction was 3 to 6 feet thick and the roads were straight. Roman engineers actually cut across hills and through swamps and built bridges over creeks.

More than a thousand years ago, the Incas built a fine road system in South America. Some of the Incan roads wind through mountain passes in the Andes Mountains so steep that they are built in steps. This was all right because the roads were used by llamas and human runners and not by wheeled vehicles. The Incan highways that connected the coastal plains to the high mountain plateaus were more than 2,000 miles long and 20 feet wide. They were made on top of high earthen embankments and were built of stones and hard mortar.

Today, of course, huge machinery is used to build roads, but the ancient people who built the Roman and Incan roads used only animals and human power to accomplish their amazing road-building feats.

Activity 2B

Mapping It Out

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ map of your local area or large piece of white paper
- ❑ pencil or marker

Activity Supplies

Activity supplies are listed for individuals; multiply as needed.

- ❑ copy of Indianapolis map (page 47)
- ❑ magic marker
- ❑ copy of Manhattan map (page 49)
- ❑ large cabbage leaf
- ❑ crayon
- ❑ white paper (copier paper works fine)

Activity 2B

Mapping It Out

Focus

Pass around a map of your local area or with the help of the children sketch one on a large piece of paper. Ask the children where they live (or go to school, to shop, or to any other community landmarks) and trace the path from that point to where you are meeting.

Activity

1. Each child selects the map that has Indianapolis in the center. Note that food from the factory has to be transported from Indianapolis to each of the circled towns.
2. One by one, read the towns' names aloud as each child traces the fastest route from Indianapolis to the town. Use the word "hub" in reference to Indianapolis.
3. When the children have drawn all the lines from the hub to the outlying towns, ask them what shape the colored lines look like to them. Can they imagine that it looks like a flower?
4. The children fold their maps in half with Indianapolis on the fold. Keep the maps.
5. Each child looks at the grid map of Manhattan. Explain that pizza delivery drivers transport pizzas from where they are made to customers whose houses are marked.
6. Each child traces the fastest route that each pizza driver can take to get to the customers.
7. When the children have drawn all the routes, ask them what the shape looks like to them. Keep the maps.
8. Give each child a large cabbage leaf, a crayon, and a piece of white paper. Place the paper over the cabbage leaf and then scribble back and forth on the paper. (This is called a leaf rubbing.) Hold this rubbing up and compare it, side by side, to the folded map of Indianapolis. The children should notice that the veins in the leaf make heavier lines on the paper, so that the tracing looks like one of their road maps.
9. Return to Step 8, Activity 2A.

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

why they decided to build the road (or path or street) that goes in front of where we're meeting.

Conversation

Questions You Might Ask

How have people developed ways of getting across ice?

Why do you think that engineers build bridges over some rivers but dig tunnels under other rivers?

How many animals can you think of that have been used to transport people or goods?

Are all roads built the same? Think of problems you'd face building a road in the desert or in the Arctic.

Why do you think some roads are straight and some are curved and twisty?

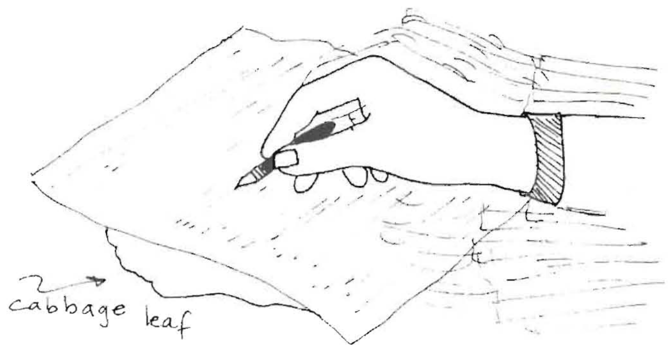
Why do we still need roads if we have airplanes?

Activity 2B

Mapping It Out

Closure: Connecting Plants and Engineering

If you are doing only Activity 2B, review the "I wonder..." statements. If you are doing Activities 2A and 2B, review the "I wonder..." statements for both. Ask the children to think about how the routes on their maps are like the plant activity they completed. The points of comparison are the daisylike radial pattern that the roads make as people transport food from Indianapolis to the towns, and the way the plant is transporting water from its center to its petals. The children should see the similarities between the cabbage leaf rubbing and the routes on the folded map. Finally, the children will see that transporting pizza in Manhattan from the pizza shop to the customers is similar to the way the celery transported colored water from its base up the stem.



I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

why we have to make so many turns and travel around so many curves to get somewhere.

why we can't always travel in straight lines.

if animals have their own roads to get from one place to another.

what roads will look like in 100 years.

if there will even be roads in 100 years.

Activity 2B

Mapping It Out

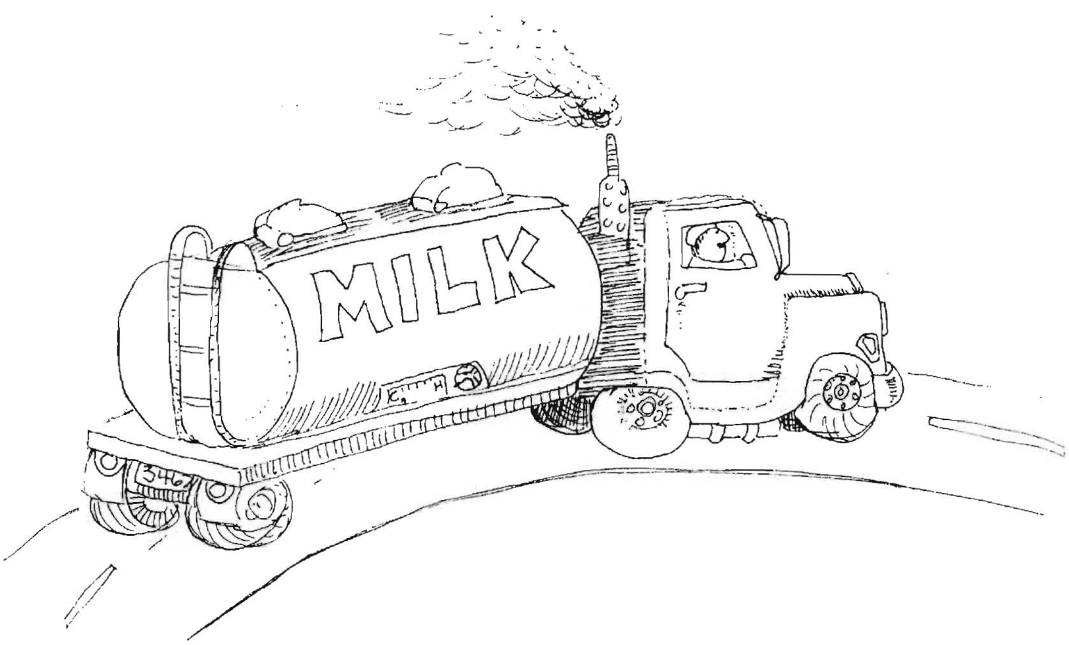
A Step Beyond

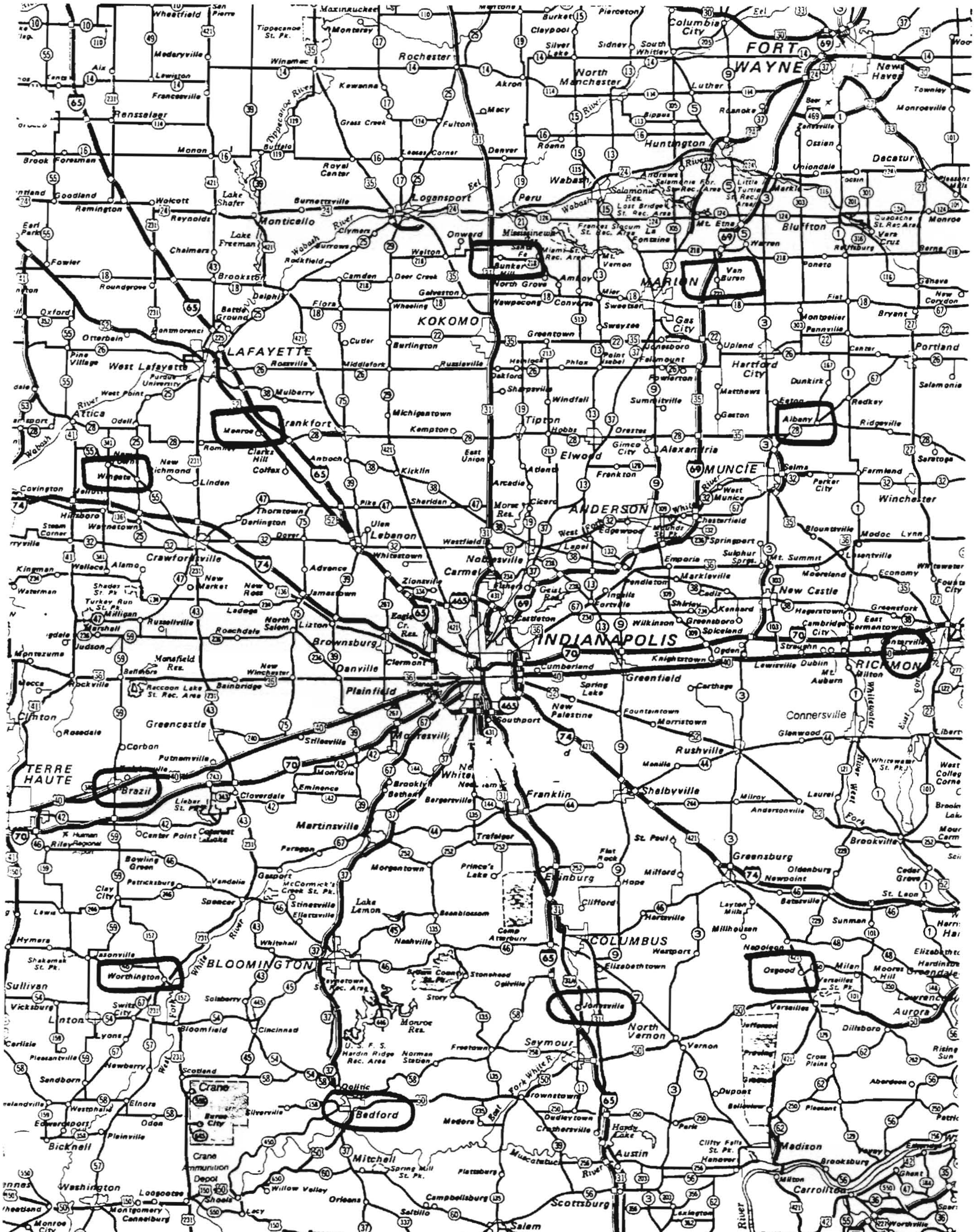
I wonder how we would design a new local highway.

Have the children design a new local highway. Using a large sheet of newsprint or construction paper, have children imagine obstacles (natural and manufactured) that must be avoided or removed. Talk about recent road- or street-building projects in your area. Why were they built? What points are they connecting? How would they look different if we weren't dependent on automobiles?

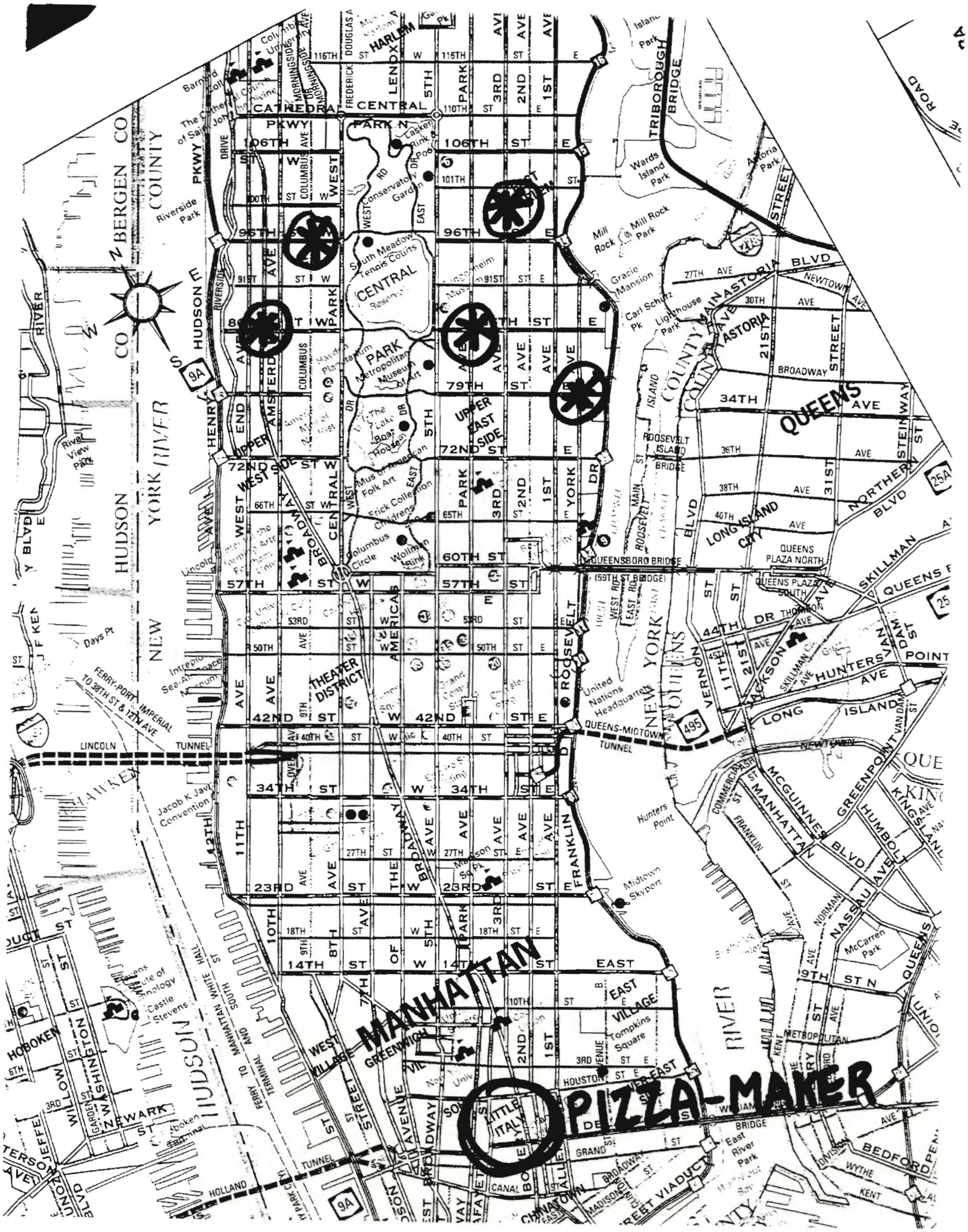
I wonder what is the most efficient (cheapest and fastest) way to transport the food we eat.

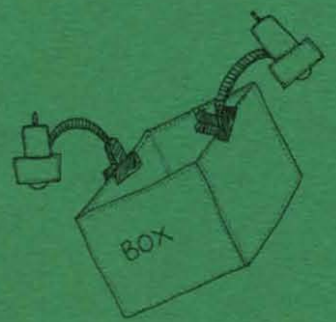
Have the children select a food item. In the case of fruits and vegetables, ask the produce clerk at the local supermarket where these products were grown. If possible, find out how they were shipped. Can you come up with a way to transport this product that is more efficient? Discuss the idea of growing and purchasing products locally to increase transport efficiency as well as reduce the amount of fuel we use to move these goods from one place to the other. Visit a local farmers' market to see where these goods were grown.



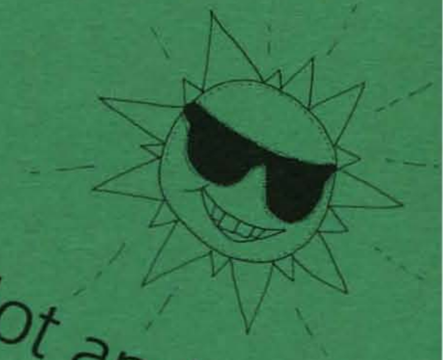


FORT WAYNE
Rochester
North Manchester
Huntington
Logansport
Peru
Wabash
Monticello
Marion
KOKOMO
LAFAYETTE
West Lafayette
Frankfort
MUNCIE
ANDERSON
Noblesville
Lebanon
Crawfordsville
INDIANAPOLIS
Greenfield
RICHMOND
Connersville
Rushville
Shelbyville
Greencastle
TERRE HAUTE
Brazil
Martinsville
BLOOMINGTON
COLUMBUS
Greensburg
Worthington
Bedford
Seymour
Madison
Scottsburg
Salem


PIZZA-MAKER
MANHATTAN
QUEENS
HARLEM
UPPER WEST SIDE
UPPER EAST SIDE
THEATER DISTRICT
CENTRAL PARK
LITTLE ITALY
CHINATOWN
EAST VILLAGE
GREENWICH VILLAGE
WEST VILLAGE
ASTORIA
LONG ISLAND CITY
HOBOKEN
HUDSON RIVER
BERGEN CO
HUDSON CO
NEW YORK COUNTY
TRIBOROUGH BRIDGE
QUEENSBORO BRIDGE
QUEENS-MIDTOWN TUNNEL
LINCOLN TUNNEL
HOLLAND TUNNEL
United Nations Headquarters
Midtown Skyport
Gracie Mansion
Wards Island Park
Roosevelt Island
Tompkins Square
Riverside Park
Metropolitan Museum of Art
Columbus Circle

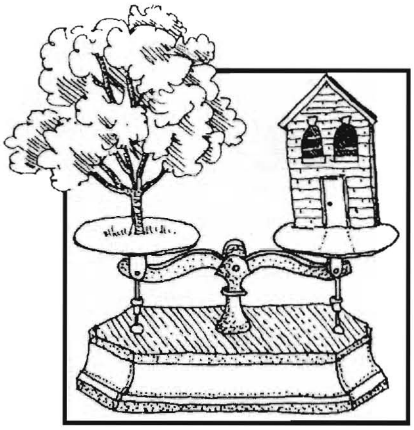


Here Comes the Sun



Hot and Cold, Dark and Light

Warming and Cooling



Session 3

Warming and Cooling

These two activities explore the heat generated by sunlight, how plants have a cooling effect, and how colors have an impact on heat absorption. Heat from the sun keeps the earth warm and keeps people warm as well. The earth is always losing some heat to outer space, yet it keeps some heat because it has a blanket of air that holds in some of the warmth.

In Activity 3A, *Here Comes the Sun*, children will shine light on enclosed containers and examine the difference between containers that have plants and those that do not.

In Activity 3B, *Hot and Cold, Dark and Light*, children will explore the differences in the color of building materials and how they affect home heating.

Session at a Glance

Activity 3A

Here Comes the Sun

Leader's Guide

What's the point?

Children observe the cooling effect that plants have on an enclosed system and make comparisons to the effect that plants have on our own environments. Carbon dioxide is a gas that is produced when we breathe, burn wood or coal, heat our house, or drive cars and trucks. Carbon dioxide holds the earth's heat in the atmosphere. During the day, living plants use carbon dioxide.

For additional information, read Science: Behind the Scenes (page 55).

What's the plan?

1. Read the activity (page 57).
2. Gather the supplies (page 56).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 3A

Here Comes the Sun

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Light is actually made up of millions of "particles" called photons. These photons are sort of like tiny Ping Pong balls shot outward from the sun. They contain energy; if they are not absorbed, they are reflected. This is why a white room appears light—the photons are being reflected, whereas in a black room, more of the photons are absorbed. This absorption of photons is also what causes heat to build up.

Plants have a cooling effect on the earth. In addition to absorbing photons, they play another critical role. During photosynthesis, plants use carbon dioxide, which is a gas. Humans and animals give off carbon dioxide when they breathe. A buildup of carbon dioxide causes increasing warmth. Unfortunately, cars, trucks, and factories also give off carbon dioxide. As rainforests are burned, additional carbon dioxide is given off into the atmosphere; this is double trouble because it also results in fewer plants. If carbon dioxide were to continue to build up, the world would become much warmer. The changing atmosphere would cause immense changes in the weather such as increased storms, droughts, and floods. This increased buildup of carbon dioxide has many, many scientists concerned that global warming is, in fact, likely.

The greenhouse effect and global warming are not the same thing. The greenhouse effect is the process that causes the surface of the earth to be warmer than it would have been in the absence of an atmosphere. Global warming is the name given to an expected increase in the magnitude of the greenhouse effect, resulting in the surface of the earth becoming hotter than it is now.

Activity 3A

Here Comes the Sun

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ houseplant
- ❑ empty 2- or 3-liter bottle

Activity Supplies

Activity supplies can be shared by the group.

- ❑ 2 gooseneck desk lamps with clamps
- ❑ 2 100-watt bulbs (one for each lamp)
- ❑ medium to large-sized empty box
- ❑ scissors
- ❑ 4 empty 2- or 3-liter clear plastic soda bottles (one for each pot)
- ❑ 2 small potted plants (4- to 6-inch pots), well watered[1]
- ❑ 2 similar-sized pots with no plant but filled with wet soil
- ❑ 4 thermometers

[1] best are leafy plants that are 6 to 8 inches tall such as coleus, chrysanthemum, kalanchoe, ivy, fern, corn plant, zebra plant, dracaena, aluminum plant, bean, tomato

Activity 3A

Here Comes the Sun

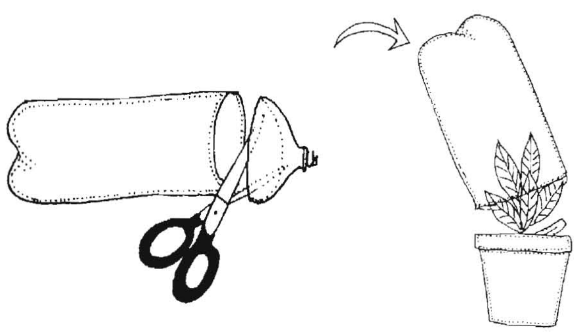
Focus

Hold up an empty 2- or 3-liter bottle and a small houseplant. Say, "Let's pretend that this empty container is a greenhouse and that sunlight is shining through the window. What do you think will happen in the 'greenhouse' that contains a plant, compared with the 'greenhouse' that doesn't? Let's find out."

Activity

1. Screw a bulb into each lamp. Place the empty box in the center of the table and clamp one lamp to one side of the box, facing out, and one to the other side, also facing out; position the lamps so that they face downward about 24 inches above the surface of the table.

2. Cut off the top of the plastic bottles and turn upside down to make a terrarium cover.



3. Turn on each lamp and feel the warmth of the light it produces by holding your hand about 12 inches from the lamp. Hold your hand the same distance away, but cover your hand with the plastic bottle bottom. How warm does your hand feel now? (The warmth in the container is an example of the "greenhouse effect.")

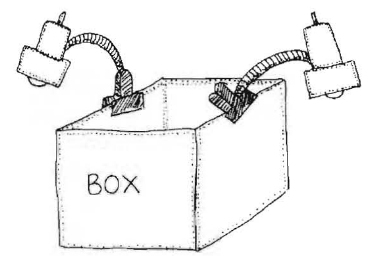
4. Lay the thermometer along the soil surface. Place the plastic bottle bottom over the pot of wet soil and put it under one lamp. Watch the thermometer for a change in

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

what effect plants have on temperature.

what happens if the heat that builds up in an enclosed space doesn't escape.



Conversation

Questions You Might Ask

Why is your hand warmer inside the bottle than outside it?

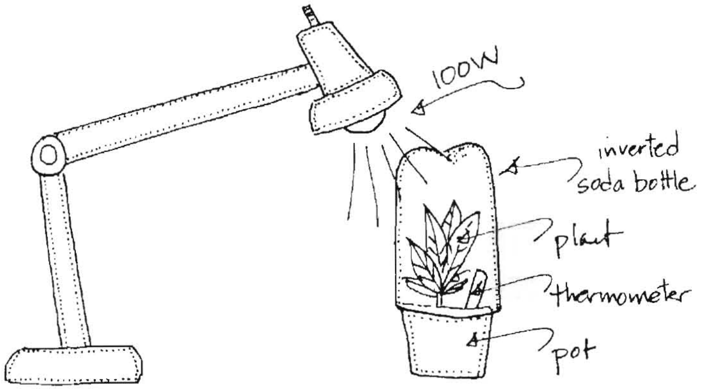
Can you understand how the bottle acts like a blanket, keeping the energy of the light inside the container?

Does the temperature inside the bottle increase or decrease without plants?

Plants reduce the carbon dioxide in the air and help to keep the earth from getting too hot. What do you think would happen if many of the plants in the world were cut down?

What changes did you see in the bottle?

temperature.[1] What happens to the temperature after 2 minutes, after 4 minutes? (a 20°F change over 5 minutes is possible.)



5. Lift the plastic cover off the pot. Put your hand into the bottle. How warm is it in there? How warm is the soil to touch? (Both the soil and the air in the bottle will be very warm.) What does the plastic look like? (Moisture may have collected on the side.)

6. Place the plastic cover over one of the potted plants. Be careful to slide the leaves and stems of the plant up into the plastic bottle. Once the plastic cover is on, slide the thermometer in along the soil surface. Move each plant with a plastic cover under a lamp and watch for a change in temperature. What happens to the temperature after 2 minutes, after 4 minutes?

7. Lift the plastic cover off the pot. Put your hand into the bottle. How warm is it in there? How warm is the soil to touch? (The soil is cold and wet, the air in the bottle is slightly warm and wet.) What does the plastic look like? (It is covered with water droplets.)

8. Repeat this activity with a different plant, and with another pot of soil, to compare. Use the other thermometers. Are the results the same?

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[1] Some children will find it hard to wait. You may want to have them spend this time making a list of the things they expect may happen.

Transition or Closure

If you are doing only Activity 3A, review the "I wonder..." statements. If you are doing Activities 3A and 3B together, summarize the plant activity and shift the children's attention to the engineering activity.

Activity 3A

Here Comes the Sun

A Step Beyond

I wonder how plants make the earth a healthy place to live. I wonder what I can do to help plants grow.

In addition to reducing the amount of carbon dioxide that is released into the atmosphere (by not driving a car excessively, or taking a bus whenever possible), humans can help reduce global warming through any efforts that ensure the growth and survival of plants, particularly forests. Much has been written in the news to point out the need to save the rainforests. While this is indeed critical, children sometimes have a difficult time relating to a place so far away. Young people appreciate the cooling quality of a park on a hot summer day and enjoy huge old shade trees as cool respites. Challenge them to come up with ways to enhance tree growth in your own community. If you live in a city, explore avenues for planting street trees or clean up a vacant lot and plant a garden. If you live in the suburbs or in the country, there may be areas in danger of development. Oftentimes, wetlands are made into shopping malls, and old-growth forests are cut to make way for housing. See what you can do in your own community to "save" wild areas. Explore all of the delicate points of view that can divide people over these issues.

Activity 3B

Hot and Cold, Dark and Light

Leader's Guide

What's the point?

Children make pretend houses out of milk cartons using different colors of construction paper and aluminum foil to help them understand how sunlight can help us heat our homes. The children learn that a house equipped with passive solar heating is designed to take advantage of the sun's energy. For example, sun shining in the south-facing windows of a house heats air that circulates throughout the house. Sometimes engineers design collection units in homes that capture and store the sun's heat in water or stones. When we design homes that use passive solar heat in the winter, we have to plan that the house will not be overheated in the summer. This activity will show the children some of the factors that must be taken into consideration when using passive solar heat.

For additional information, read Science: Behind the Scenes (page 61).

What's the plan?

1. Read the activity (page 63).
2. Gather the supplies (page 62).
3. Try the activity.
4. Note safety measures (in ***bold italics***).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 3B

Hot and Cold, Dark and Light

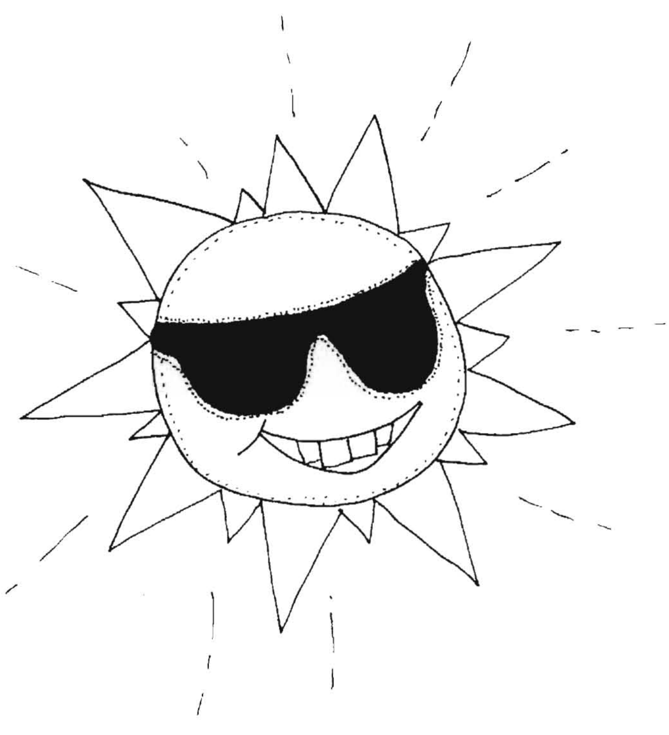
Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Let's talk for a minute about the sun, because the activities we perform imitate the way the sun's energy warms us.

The sun is a medium-sized star—a huge, hot ball of gas—one star among billions in our galaxy. The sun is about 93 million miles away from earth. Its diameter is 864,000 miles (more than 100 times the size of the earth).

The sun makes its own heat and light (thus producing our heat and light). The sun's high heat at its center (millions of degrees) causes its hydrogen atoms to move at incredibly high speeds—so fast that they smash together. The atomic nuclei (the centers of the atoms) of the hydrogen atoms fuse together in groups of four, forming a heavier atom called helium (that's the gas that we use to fill balloons). When the atoms crash together, part of the atom is converted into energy. It is this energy that provides us with the heat and light that sustain all life on earth.



Activity 3B

Hot and Cold, Dark and Light

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group. They may be used again in the activity.

- ❑ sheet of black construction paper
- ❑ sheet of white construction paper
- ❑ sheet of aluminum foil

Activity Supplies

Activity supplies can be shared by small groups.

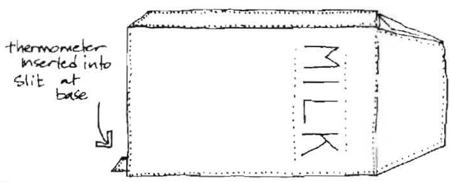
- ❑ 4 empty school lunch–size milk cartons
- ❑ 8 $^1/_2$" x 11" sheet of black construction paper (used in Focus)
- ❑ 6-inch square of aluminum foil (used in Focus)
- ❑ 8 $^1/_2$" x 11" sheet of white paper (used in Focus)
- ❑ graph paper worksheet
- ❑ 4 thermometers (group can share)
- ❑ 2 gooseneck desk lamps with 100-watt bulbs (used in Activity 3A)

Activity 3B

Hot and Cold, Dark and Light

Focus

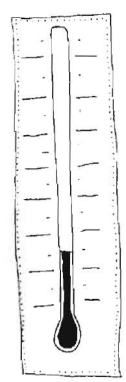
Place the three materials down in front of the children. You might ask, "What's different about these materials?"



Activity

1. Lay the milk cartons on their side and cut a slit in the bottom of each for the thermometer to fit in as shown.

2. Cover each of the milk cartons with one of the "roof" sheets (white paper, black paper, aluminum foil). Leave the fourth carton uncovered as a "control" or "comparison" to see how the temperature changes without a particular type of roof. Each milk carton is a "house" and we will check the temperature to see how warm or cool the roof keeps the house when the "sun" shines on it.



3. Slip a thermometer inside each "house" so that the bulb is inside the house but the thermometer's numbers are readable.

4. Place the houses under the desk lamps that you used in Activity 3A. Make sure that each house is the same distance from the lamp.

5. Record the temperature in each house.

6. Carefully check the temperature of each house every 5 minutes and write the temperatures on the data sheet.

7. While you are waiting, have each child trace an outline of his or her hand on a piece of white paper and on a piece of black paper. Cut out the two hand shapes.

I wonder ...

Keep track of "I wonder...." statements you and the children express while doing the activity. Children might wonder

if plants and animals use colors to warm themselves.

what building materials we use to keep our homes warm.

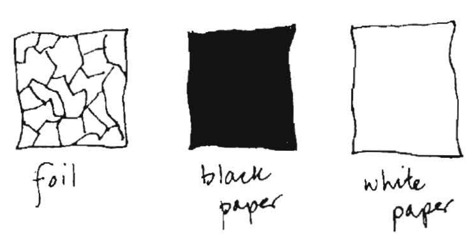
Conversation

Questions You Might Ask

If you lived in a cold climate, what color roof might you put on your house?

If you lived in the tropics, what color roof might you use if you wanted to keep your house cooler?

What other situations can you think of where a white, black, or reflective surface would be useful?



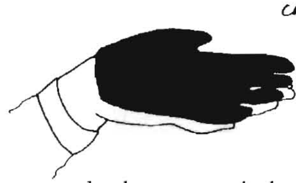
Activity 3B

Hot and Cold, Dark and Light

8. One at a time, have each child place his or her hands—palms up—under the light, ***making sure that their hands are kept a safe distance from the bulb (at least 8 inches away).*** Tell the child to close his or her eyes tightly.

9. Lay the two cutouts on the child's palms as shown, without telling the child which color paper you're putting on which palm. Have them tell you which hand feels hotter and guess what color the paper is.

Lay flat piece of "hand-shaped" construction paper on children's hands



10. After 15 minutes, return to the houses and plot the temperatures on the graph paper. Which roof keeps a house warmest? Which roof keeps a house coolest?

Closure: Connecting Plants and Engineering

If you are doing only Activity 3B, review the "I wonder..." Statements. Ask, "What did you enjoy about these activities?" Why is it important for us to pay attention to the way our sun heats natural and manufactured features on our planet?" If you are doing Activities 3A and 3B, review the lists of "I wonder..." statements from both. Ask, "Thinking back to the plant portion of this activity, how would we use trees to keep our homes cool?"

I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

what would happen if we put windows on top of our houses.

if other colors reflect or absorb heat.

what would happen if you put a mirror on your roof.

what people do in space to keep spaceships warm.

Activity 3B

Hot and Cold, Dark and Light

A Step Beyond

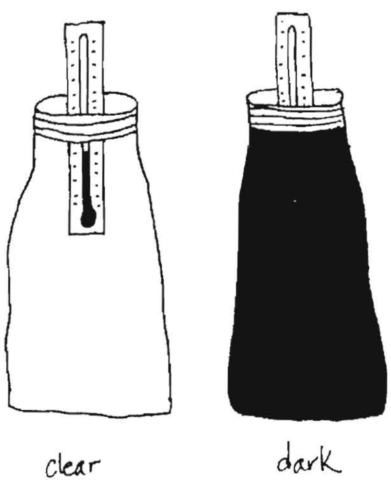
I wonder if we can collect solar energy. I wonder how long we can store energy from the sun.

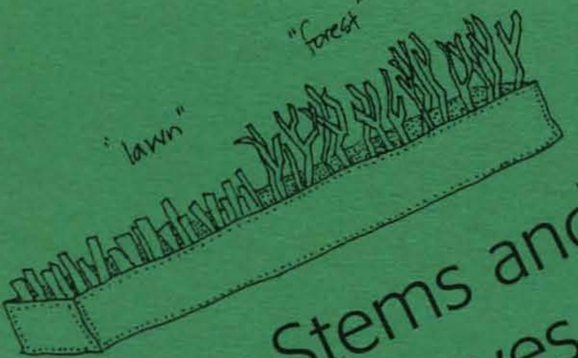
This activity will show you how to save the sun's energy more efficiently. A sunny day is best, although a lamp will work as a substitute.

Take two fruit juice bottles (with necks big enough to insert a thermometer) and fill them with water. Add enough blue food coloring to one of the bottles to make the water very dark. The other bottle should be filled with plain water.

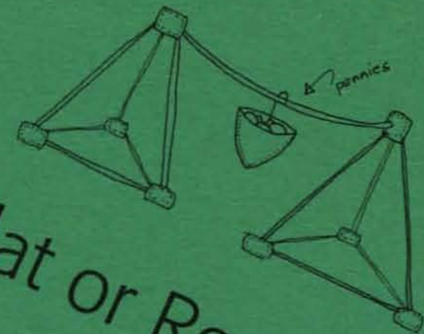
Insert a thermometer into the neck of each bottle. Use modeling clay to hold the thermometer in place, making a tight plug in the bottle-neck with the clay. The thermometer bulbs should reach down the same depth into the water in the bottles.

Measure the temperature in both bottles. They should be the same. Put both bottles in a sunny spot and observe the change in temperature every 10 minutes for 30 minutes. Why do you think the temperature is higher in one of the bottles?



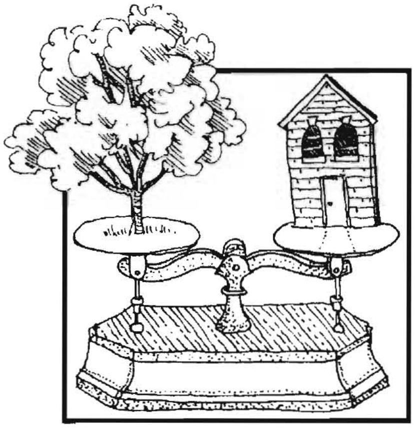


Strong Stems and Broad Leaves



Flat or Round

Structure



Session 4
Structure

These two activities show that some shapes are stronger than others. The shapes of plant parts are important; in some cases, the rigidity inherent in their shape keeps plants standing up, as with tree trunks. Other plant parts, such as leaves, may be flat, and that shape serves a different role. Just as with plants, the shape of a building or bridge is important. Shapes of building materials may ensure that structures remain rigid and erect or flex when necessary. Which has more strength and rigidity, something that is flat or round? Which shape is more flexible? Children can learn about the importance of "shape" by engineering their own structures or by observing plant parts engineered by nature.

In Activity 4A, *Strong Stems and Broad Leaves,* children will simulate plant parts with newspaper to see how flat and cylindrical plant parts contrast. They will also create a "lawn" and a "forest" to compare the strengths of plant stem shapes.

In Activity 4B, *Flat or Round—A Penny Overload,* children construct "bridges" from flat and round pasta to compare these shapes for strength and flexibility.

Session at a Glance

- Leader's Guide, pages 70, 76
- Science: Behind the Scenes, pages 71, 77
- Supplies and Preparation, pages 72, 78
- Focus, pages 73, 79
- Activity, pages 73, 79
- Transition or Closure, pages 74, 80
- A Step Beyond, pages 75, 81

Activity 4A

Strong Stems and Broad Leaves

Leader's Guide

What's the point?

Children observe that the shapes of plant parts can affect the degree to which they are flexible or rigid. They do this by modeling plant parts and by observing live plant tissue. This activity introduces the concept that different plant shapes have evolved to serve very different purposes. Some of these differences can be observed by looking at their different shapes.

For additional information, read Science: Behind the Scenes (page 71).

What's the plan?

1. Read the activity (page 73).
2. Gather the supplies (page 72).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Strong Stems and Broad Leaves

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

When plant parts are flat, they tend to bend much more easily than when they are cylindrical. This is a function of the role that the parts play within the plant. When wind or other forces push against round shapes, the cylindrical parts do not bend as easily as flat ones do. Notice that many plant stems are shaped like a circle, triangle, or square in cross section, particularly those that are tall. Many grass plants have broad, flat leaves, and some have flattened stems. Grass plants, such as corn, have evolved to withstand windswept plains and open fields.

Flat leaves may flap in the breezes, but they also need to maximize the amount of sunlight that they can capture. Rigidity and strength are not as important for leaves as maximizing space and facing upward to capture sunlight. Tree trunks tend to be round, strong, and rigid, but again, they play a different role. The leaves of quaking aspens and other poplars have flattened petioles (the stalks that connect the leaf to the stem of the plant). You can see their leaves shimmering in a breeze more easily than leaves that have more rounded petioles.

Plants use a competitive strategy to live, and they have evolved different ways of directing their energy into various plant parts. Some plants may invest a great deal of energy in stem tissue that will help the plant stand tall. If the plant can grow taller than other plants, it can get more sunlight, photosynthesize more, and increase its chances of survival. Other plants have evolved to invest their energy into being less tall but having huge, broad, flat leaves. They grow in the shade, in the understory of other plants, but height isn't as critical because they have a larger area in which to maximize photosynthesis.

Activity 4A

Strong Stems and Broad Leaves

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

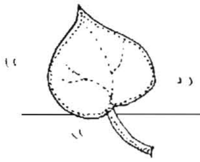
- ❑ stack of newspapers (also used in the activity)

Activity Supplies

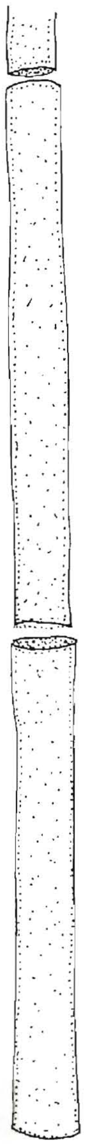
Activity supplies are listed for individuals unless otherwise noted; multiply as needed.

- ❑ newspaper
- ❑ marker or pencil
- ❑ scissors
- ❑ clear, lightweight tape
- ❑ clay or play dough (group can share)
- ❑ 9" x 13" baking sheet (group can share)
- ❑ sturdy houseplants[1]
- ❑ tweezers (optional)

[1] In the winter, use a plant with sturdy stems, such as a chrysanthemum, that you don't mind taking apart. In the growing season, any plant with sturdy stems and flat leaves will do.



Strong Stems and Broad Leaves



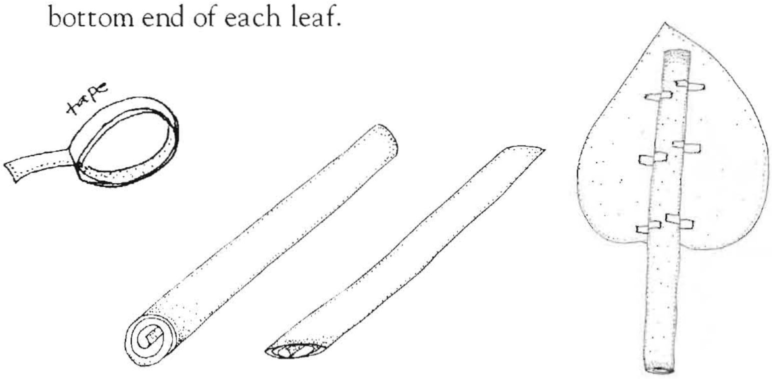
Focus

Lay out the newspapers on the table. Say something like, "What shapes do leaves come in? What about stems? Let's copy some of these shapes with this newspaper."

Activity

1. Draw and cut out giant-sized leaf shapes from large sections of newspaper.

2. Make the leaf petioles by rolling up whole sheets of newspaper and taping in place. Petioles are the stalks that connect the leaf blade to the stem of the plant. Ask the children to flatten half of the newspaper rolls. Now you have flattened petioles and round petioles that have equal amounts of newspaper material. Tape the petioles to the leaves, so that about 12" of the petiole protrudes from the bottom end of each leaf.



3. Lift leaves by the end of the petiole. Wave the leaves up and down in a fanning motion. What happens? Are there differences between round and flattened petioles?

4. This time, create tall "tree trunks" out of newspaper rolls. Half of the children make round trunks and the other half make flat ones. Roll a newspaper into a 1- to 2-in. diameter tube and tape it. Roll another and tape it to the first one, creating a long, thin tube.

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

what other plant parts we can make with this newspaper.

Conversation

Questions You Might Ask

What happens to the newspaper leaves when you fan them? How do the petiole shapes influence what happens?

Which petiole shape is more rigid and appears to have more strength?

Which stems, those in the lawn or those in the forest, are more flexible?

Which would hold up better if you walked on them?

What would happen in an ice storm?

How far can you bend the "grass" before it breaks? What about the stems that are simulating trees in the forest? How far can you bend them before they break?

So, in the case of flexibility, which is better, flat or round?

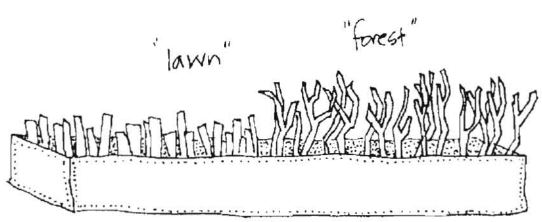
When is a round shape best? When is it best to have a flat shape?

Activity 4A

Strong Stems and Broad Leaves

5. Continue to do this, making tall structures that are either flat or round. Which "tree trunk" stands more easily? If you poke them at the center, which collapses more easily? Which one is "better?" (It's interesting that most children assume, since the flattened shapes collapse, that the round shape must be "better." This is a nice lead-in into the next part of the experiment.)

6. Press the play dough into the baking sheet. On one half, using parts from the live plant, you will simulate a forest, and on the other half you will create a lawn. For the lawn, gently remove the leaves and press them into the play dough. If leaves are large, cut them into strips so they appear more like grass. Tweezers may help you gently insert them into the play dough. For the forest, break off pieces of stems, with some leaves still attached, and insert them by the stem into the dough, or "forest," side of the cookie sheet. Continue until you have a "lawn" and a "forest." Have children gently press down on each section with the palms of their hands to think about how each section feels with respect to flexibility or rigidity.



7. Just for fun, as a wrap-up, ask the children what they can do with their newspaper "trunks." Play baseball? Build a structure?

Transition or Closure

If you are doing only Activity 4A, review the "I wonder..." statements. If you are doing 4A and 4B together, summarize the plant activity and turn the children's attention to the engineering activity.

I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

which plant shapes have more strength.

which shapes are more flexible.

which shapes can be found in nature. flat? round? are there others?

Strong Stems and Broad Leaves

A Step Beyond

I wonder which plants have round and flat parts. I wonder what other shapes can be found.

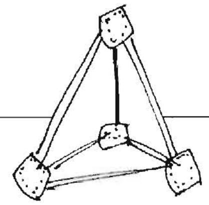
Go on a plant scavenger hunt. Take a walk and find flat and round plant parts. Do the flat parts tend to be leaves? Are the round parts always stems? What are the exceptions? What other shapes are found in the plant world? Can you think of any plant parts that are triangular? Can you locate any square parts (the mint family has square stems). What properties do you think are inherent to these shapes?

I wonder how we take advantage of special plant parts to make or do certain things.

In some cultures, banana leaves are used as hand fans. The flat shape of the leaf lends itself to directing air to a certain location. The round stems of bamboo are ideal for crafting exceptionally strong furniture and even for building scaffolding used to construct buildings. What are some other plant shapes that we take advantage of?

Activity 4B

Flat or Round



Leader's Guide

What's the point?

Children make a connection between the shape and strength of a material. They also learn about repeating an activity several times to arrive at an average "result."

This activity uses the inherent shapes of structures to understand an important part of scientific research—repeated measurements. We use science to make predictions about things, but doing an experiment one time can't tell us that it will always turn out the same way. For example, if we wanted to know whether lima bean plants are taller than green bean plants, we wouldn't plant one of each kind because the single lima bean seed we planted might not be an "average" seed. So we would plant several of each kind and keep track of their height and then compare the averages of each of the groups of plants.

For additional information, read Science: Behind the Scenes (page 77).

What's the plan?

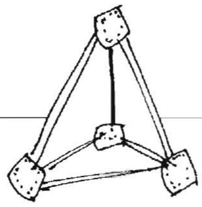
1. Read the activity (page 79).
2. Gather the supplies (page 78).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 4B

Flat or Round



Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

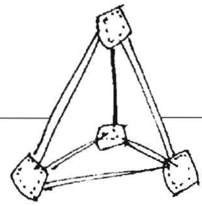
Human beings build structures. Since we moved out of caves, we've been building dwellings, bridges, and towers. How do we decide what materials to use? We try different materials that are available. So if we live in China we build with bamboo, and if we live in the far North we build with packed snow and bones from whales. But the impulse is the same—we select the best materials available to build the structures we need.

How do we select the best materials? Trial and error, experimentation, and research are all ways in which we decide how to build and what materials to use. Expense is often a consideration, as is the weight of the structure. Should we build it out of stone? Out of wood? Out of plastic? Or steel? It is often a complicated decision that has many considerations.

In this activity, the children look at the simple difference of shape to learn about strength. But materials are important as well. Sometimes we have to use materials because of strength, weight, cost, or other factors, but by considering shape as well as materials we can build better structures with the materials available.

Activity 4B

Flat or Round



Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 1 piece of linguine and 1 piece of spaghetti for each child

Activity Supplies

Activity supplies are listed for individuals unless otherwise noted; multiply as needed

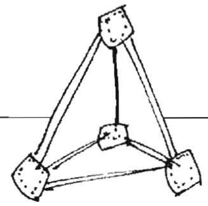
- ❑ 8 marshmallows[1]
- ❑ 18 pieces of raw spaghetti (circular in cross section)[2]
- ❑ 4 pieces of raw linguine (flattened in cross section). The spaghetti and linguine should be about the same size in diameter.
- ❑ paper clip
- ❑ envelope corner cut to make a hanging "basket"
- ❑ approximately 40 pennies
- ❑ white paper
- ❑ calculator

[1] Plan to have extra marshmallows on hand because children will invariably eat them.

[2] ***Make sure the children do not eat the raw pasta. Shards may cut their mouths.***

Activity 4B

Flat or Round



Focus

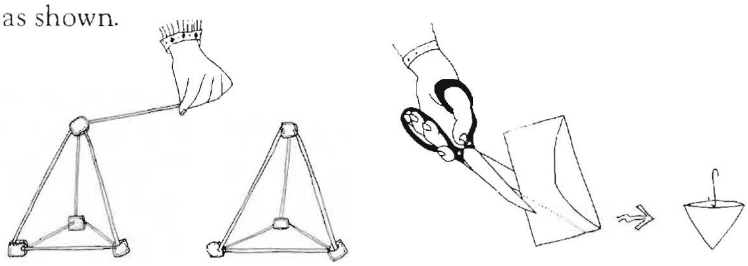
Give each child a piece of spaghetti and a piece of linguine. Have one child at a time slowly bend the two pieces of pasta. Which piece breaks first? Ask, "How are the two pieces different? Why do you think one kind of pasta seems to be the one to break first?"

Activity

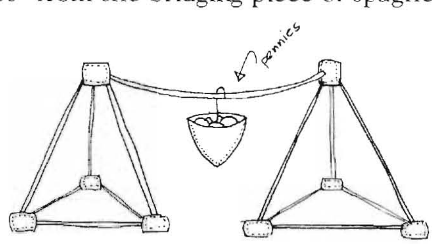
1. Give each child 8 marshmallows and the 18 pieces of spaghetti. Don't give the linguine to the children at this time because they may confuse the two shapes of pasta.

2. Have each child make two pyramids out of the spaghetti and marshmallows as shown in the diagram. Each structure should be solidly constructed. If a piece of spaghetti breaks during construction, replace it with a whole piece so that each structure is of the same size and shape.

3. Connect the two pyramids with a single piece of spaghetti as shown.



4. Using the paper clip as a hanger, hang the envelope "basket" from the bridging piece of spaghetti.



5. Have each child place pennies in the "basket." Make sure the children put the pennies in one at a time.

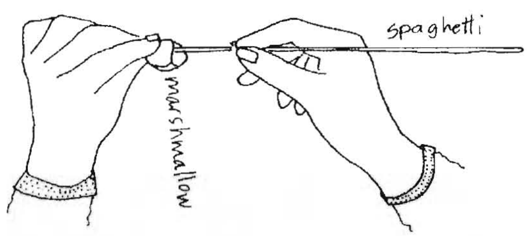
I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

how bridges are built or how they are designed.

why each piece of spaghetti doesn't break at exactly the same time.

why it is important to know how strong a material is when I'm building something.



Conversation

Questions You Might Ask

Can you think of times when it's better for a material to be more flexible?

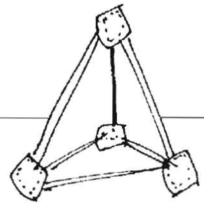
When is it better for a material to be stiffer?

Why is it important to take repeated measurements?

Suppose you want to see how much the average ten-year-old child weighs. What will happen if you select just one child to weigh? What is a better way to do it? How many children do you think you should weigh?

Activity 4B

Flat or Round



6. When the bridging piece of pasta breaks, write down the number of pennies that the spaghetti held up without breaking. Each number is an "observation."

7. Have one or two children write down all the numbers of pennies on a worksheet.

8. Have each child repeat the spaghetti experiment three times.

9. Calculate the average number of pennies that the bridging spaghetti can hold by adding all the children's numbers and dividing by the number of observations.

10. Collect any unused spaghetti and give each child four pieces of linguine. Repeat the experiment three times using linguine as the bridging pasta.

11. Again, have one or two children write down all the numbers of pennies on a worksheet and calculate the average number of pennies that the bridging linguine can hold by adding all the children's numbers and dividing by the number of observations.

12. Build any additional structures for fun and eat the leftover marshmallows.

Closure: Connecting Plants and Engineering

If you did only Activity 4B, review the "I wonder..." statements. If you did Activities 4A and 4B, talk with the children about how the two experiences helped them think about structure in both the natural environment and the manufactured environment. Review the "I wonder..." statements for both activities. Say, "Often when scientists do experiments, they come up with lots of new ideas or questions. Which one is the most interesting to you? How could you find out more about it?"

I wonder ...

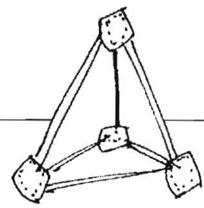
Keep listening for "I wonder..." statements after the activity. Children might wonder

how geodesic domes are built.

what practical things I can think of making where flexibility is really important.

Activity 4B

Flat or Round



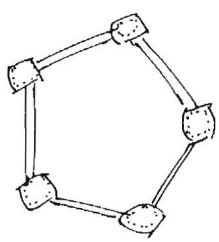
A Step Beyond

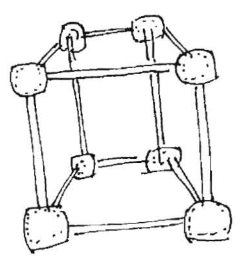
I wonder what shapes are strong and are used for building.

Children can do many other activities with shapes that involve comparing strength and flexibility. Talk about the pyramid that the children built. Why is it sturdy? What is special about a triangle? Try building other shapes using marshmallows and spaghetti. What happens if you build a cube? Is it as sturdy as the pyramid? Many enjoyable activities can be done with marshmallows and spaghetti. If you give them time, the children will enjoy building many complex shapes and constructions with pyramids, cubes, and other fanciful shapes.

If you want to do more experiments with repeated measurements, an enjoyable activity is to give each child a bag (or same-size scoopful) of M & M candies.[1] Have each child count how many of each color M & M they have and the total in their bag. Record each child's numbers and calculate the average number of each color and the average number of total candies. Is each bag the same? Why not?

[1] Remember that some children are allergic to chocolate. You can use a non-chocolate candy like Skittles as a replacement.

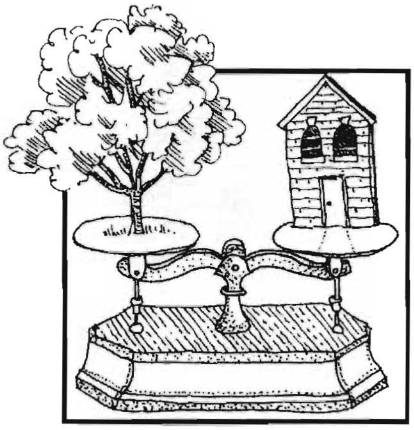




Hold It Together
with Turf

Chocolate Mud
Slides

Erosion



Session 5

Erosion

These two activities introduce erosion, the wearing away of soil by wind, water, or ice. Erosion is an important concern with respect to our environment; approaching erosion from the perspective of both plants and engineering will help children better understand its significance.

In Activity 5A, *Hold It Together with Turf,* children will examine the impact of erosion on bare soil versus an area with plants and will examine the effect that fibrous plant roots—such as grass—have on reducing the impact of erosion.

In Activity 5B, *Chocolate Mud Slides,* children will simulate a sod-free bank of soil and will construct devices to reduce the impact of erosion.

Session at a Glance

Activity 5A

Hold It Together with Turf

Leader's Guide

What's the point?

Children examine the impact of erosion on bare soil, compared with an area containing plants that have a dense, fibrous root system. They also make comparisons to erosion that they can see daily along roadsides, sidewalks, and banks. Erosion has become a serious issue for farmers and nonfarmers alike. Repeated cultivation, overgrazing, and neglecting to grow cover crops have all led to an alarming loss of topsoil, particularly in the midwestern and western states. People are realizing this and seeking alternative practices. Another example of erosion can be seen in the delicate ecosystems along shorelines and runoff into waterways. Many people love to live and vacation at the ocean's edge. Condominiums and cottages have confronted estuaries, marshes, and our coasts. The result? The shoreline is receding as the ocean water nibbles away at exposed beaches once held in place by sea grasses and other plants.

For additional information, read Science: Behind the Scenes (page 87).

What's the plan?

1. Read the activity (page 89).
2. Gather the supplies (page 88).
3. Try the activity.

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Activity 5A

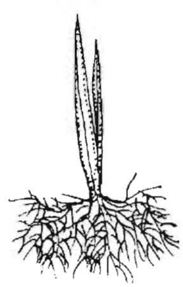
Hold It Together with Turf

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

When wind blows across bare soil, or when water flows down a hill, the wind or water slowly wears away the land, just as erasing rubs away the markings from a pencil. Barriers of many types are used to prevent, or at least reduce, erosion. The thick, fibrous root systems of some plants, such as crown vetch and grasses, are particularly effective. The roots act as a net, holding the soil tightly in place. Roots are very proficient anchors.

This activity focuses on erosion caused by water, but wind is a powerful force for erosion as well. Back in the era of the great Dust Bowl, settlers farmed the Great Plains, which had previously been protected with a covering of prairie grasses and other plants. It was plowed under and replaced with corn and wheat. These annual crops were planted each year. Constant tilling left the soil barren and with very little protective cover. With few plant roots to hold the soil in place, the Great Plains were susceptible to erosion. Repeated windstorms swept the prairie, and it is estimated that more than 300 million tons of soil were blown away. The effects of the dust clouds formed during the Dust Bowl were noticed as far away as the East Coast.



fibrous

taproot

Activity 5A

Hold It Together with Turf

Supplies and Preparation

Focus Supplies

The focus items can be shared by the group.

- ❑ piece of grass sod, cut to fit the cake pan
- ❑ cake pan, about 9" x 13"

Activity Supplies

Supplies can be shared by small groups.

- ❑ rectangular cake pan, about 9" x 13"
- ❑ newspapers or a plastic tablecloth to catch the runoff soil
- ❑ large plastic sheet, shower curtain, or plastic tablecloth
- ❑ soil to fill the pan
- ❑ book, pudding box, or other object of same height
- ❑ measuring cup
- ❑ bowl of water
- ❑ 2 flower pots: one filled with soil, the other with a plant

Activity 5A

Hold It Together with Turf

Focus

Cut and remove a piece of sod from a lawn. Even if the grass is brown and this activity takes place in the winter, spring, or fall, the fibrous roots of the grass will be visible (unless the ground is frozen and you cannot remove the sod). Be sure that the piece fits very snugly in one of the pans and that there are no air spaces between the edges and the piece of sod.

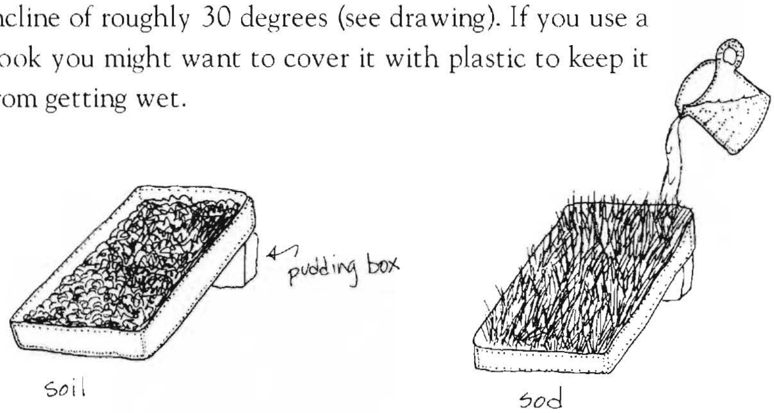
Place the pan with grass sod on the table. Say something like, "Do you think the grass in this pan will have an effect on the soil underneath it, if we wet it down? Let's find out."

Activity

1. Fill the other cake pan with soil.

2. Lay the newspapers or tablecloth on a surface that you don't mind getting dirty.

3. Rest one end of each pan on a book, pudding box, or other object of the same height, so that the pans are on a slight incline of roughly 30 degrees (see drawing). If you use a book you might want to cover it with plastic to keep it from getting wet.



4. Beginning with the pan that contains just the soil, have the children slowly pour water—one cupful at a time—into the high end of the pan. Count how many cupfuls it takes before the soil begins to move visibly and run out of the pan.

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

what other plants might be effective for erosion control.

how people take advantage of plants for erosion control.

where plants are placed to prevent erosion.

Conversation

Questions You Might Ask

Do you think it was easy or difficult to cut and remove the sod? Why?

How many cups of water does it take before the soil begins to wash down the pan?

How many cups of water does it take before the soil is completely washed away?

Does the soil do very well at resisting the water? What about the sod?

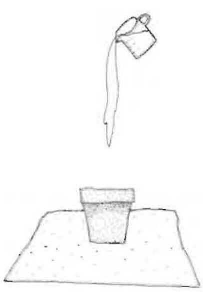
Activity 5A

Hold It Together with Turf

5. Repeat the activity with the pan that contains the sod. Be sure the children pour the water over the surface of the sod from the high end of the pan. Count how many cupfuls it takes to make the soil run out of the pan.

6. Remove individual grass plants from the sod and examine their root systems. How would you describe the root systems?

7. Place the two flower pots—the one that contains a plant and the one that is filled only with soil—on the plastic sheet. This is best done outside or in a room that is easy to clean up.



8. Stand above the planted pot, and with a cup of water held at about head height, *slowly* pour water down over the plant.

9. Repeat, pouring water into the pot that contains only soil. Compare the impact of the water droplets on the surfaces of the two pots. Does the plant help to cushion the impact of the "rain"?

Transition or Closure

If you are doing only Activity 5A, review the "I wonder..." statements. If you are doing Activities 5A and 5B together, make sure the children wash their hands before turning to the chocolate pudding activity.

I wonder . . .

Keep listening for "I wonder..." statements after the activity. Children might wonder

what happens to bare soil when it rains.

why there are mud slides in California.

where the soil that erodes from farmland ends up.

what erosion prevention mechanisms are used to preserve fish habitat.

Activity 5A

Hold It Together with Turf

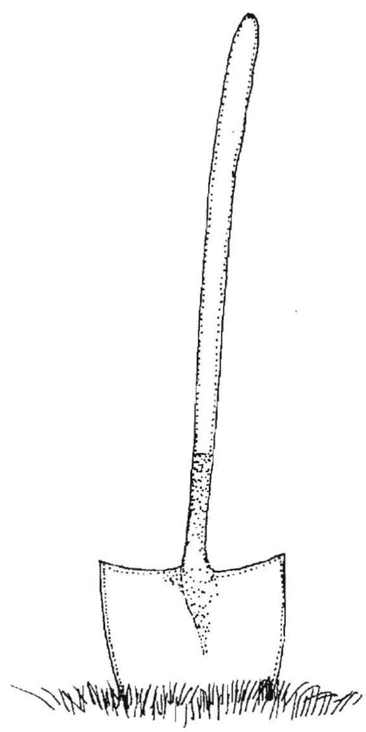
A Step Beyond

I wonder how farmers control erosion. I wonder if soil erosion affects aquatic life.

If you are in or near a rural area, talk with local farmers to see what practices they employ to prevent on-farm erosion. How do they control erosion so that fertilizers and pesticides do not reach streams and other bodies of water?

Walk around in your neighborhood, the school grounds, or a nearby park. Can you locate areas that have been eroded?

Some aquatic life such as sport fish depend on good water quality to carry out their life cycles. Erosion tends to cloud up the water they live in. This can drastically alter the living environment. Visit a stream or river that allows people to sport fish. Think of additional ways to protect aquatic habitats.



Activity 5B

Chocolate Mud Slides

Leader's Guide

What's the point?

Children enjoy causing and preventing erosion by digging diversion ditches, baffles, and using other engineering methods to stop running water from eroding a hillside. This experiment gives children an opportunity to learn about the effects of running water on the land and to try to stop or slow down erosion. "Eroding" chocolate pudding makes a mess as it slides downhill. But the children love it.

For additional information, read Science: Behind the Scenes (page 93).

What's the plan?

1. Read the activity (page 95).
2. Gather the supplies (page 94).
3. Try the activity.
4. Note special hints (below).

What's my role?

- Guide the children through the activity by doing the procedures with them.
- Encourage conversation about what they are doing and observing. Use the conversation questions as a guide, not a script to be followed.
- Listen for and summarize "I wonder..." statements the children make during the activity. (See "I wonder..." statements, page 10, Monitoring Success, page 13, and Evaluation Form, page 111.)
- Help the children relate this activity to their daily experiences.

Special Hint

This activity uses chocolate pudding that is made with milk. ***Be aware that some of the children in your group may be allergic to chocolate or to milk.*** Chocolate pudding was selected because it looks more like soil. Butterscotch or vanilla pudding mix can be substituted.

Activity 5B

Chocolate Mud Slides

Science: Behind the Scenes

Do not use this material as a lecture. It is intended to increase your background knowledge and comfort level with the subject. Allow the children to explore.

Running water erodes the land in many ways. Erosion is part of our natural world. Whenever it rains, water washes over the land, picking up loose soil and carrying it away. Water runs downhill in rivulets and in streams and rivers, carrying soil, pebbles, and small rocks. Entire mountains erode away over hundreds of millions of years. This has happened since our planet was formed.

But it is no comfort to people to think "geologically" when they are looking at their house sliding downhill in a mud slide. Engineers spend a lot of time and effort working to prevent erosion on hillsides and to prevent houses and roads from being washed away by heavy rain or runoff from melted snow.

Erosion has been a very important factor where large cities have developed. It is also very important in farming and growing enough food. Depending on where you live, you can talk to the children about erosion in your own area. Have the children ask their parents if they remember times when roads, hillsides, beaches, dunes, or homes washed away or were flooded out.

Activity 5B

Chocolate Mud Slides

Supplies and Preparation

Focus Supplies

Focus items can be shared by the group.

- ❑ 2 packages instant chocolate pudding
- ❑ 1 or 2 large bowls
- ❑ rubber spatula or large spoon
- ❑ 2 large cookie sheets with rims[1]
- ❑ 1 quart cold milk
- ❑ measuring cup
- ❑ whisk or electric mixer

Activity Supplies

Activity supplies are listed for the group.

- ❑ spray bottle (or clean dish detergent or household cleanser bottle)
- ❑ newspapers or a plastic tablecloth to catch the pudding as it runs off
- ❑ plastic wrap
- ❑ 6 short pencils, or crayons, or short straight sticks
- ❑ spoons and plates

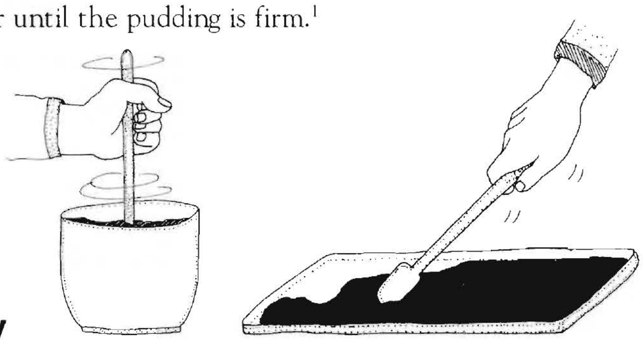
[1] This activity requires one cookie sheet, but we are allowing an extra package of pudding mix and two extra cups of milk for a second "batch" of pudding for the children to eat.

Activity 5B
Chocolate Mud Slides

Focus

Prepare two packages of pudding in separate bowls (or if you only have one large bowl, make one package of pudding at a time). Save the empty pudding boxes.

While the pudding is still liquid, pour each bowlful into a cookie sheet, spreading the pudding evenly in the pan with the spatula. Set both sheets aside on a flat surface for at least five minutes or until the pudding is firm.[1]

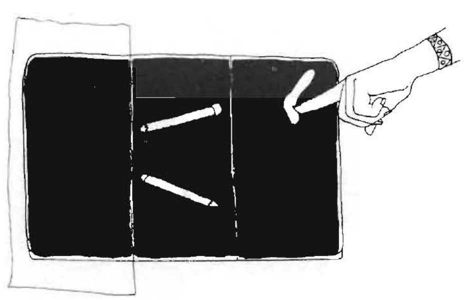


Activity

1. Fill the spray bottle with cold water. Lay the newspapers or plastic tablecloth on a surface you don't mind getting dirty. This is a good activity to do outside.

2. Cover one-third of the cookie sheet with plastic wrap.

3. On another third of the cookie sheet, arrange the pencils, crayons, or sticks in a pattern as shown in the illustration.



4. On the final third of the cookie sheet dig a "ditch" down the "hill" with fingers.

[1]The second pan is for eating. You may want to let the children know that, and you may even want to begin the activity by eating the pudding. You know your group best!

I wonder ...

Keep track of "I wonder..." statements you and the children express while doing the activity. Children might wonder

if a ravine or gorge is the cause or result of erosion. Why?

why people sometimes build their houses on steep hills.

if all soils erode at the same rate.

Conversation

Questions You Might Ask

What happened to the "soil" that was protected by a covering? What happened to the soil that was unprotected but had a ditch running downhill?

What happened when you built baffles (the pencils) to make the water run more slowly downhill?

What color was the water that ran over the bare "soil?"

What color was the water that ran over the plastic covering?

What are some other ways that engineers design erosion prevention devices?

What would happen if nobody paid attention to preventing erosion?

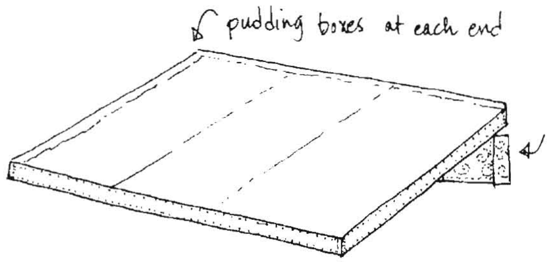
Do different kinds of soil present different erosion problems?

What else besides rain can cause erosion?

Activity 5B

Chocolate Mud Slides

5. Prop one end of the cookie sheet on the empty pudding boxes as shown.



6. Have the children take turns gently squirting water from the spray bottle along the top edge of the cookie sheet so that the water runs down the "hill."

7. Keep squirting the water until you have caused significant erosion and "slippage."

8. Clean up the activity and give the children the second pan of chocolate pudding to share; portion it out to them.

Closure: Connecting Plants and Engineering

If you are doing only Activity 5B, review the "I wonder..." statements. Ask, "Why is it important to know how to stop the effects of erosion?" If you are doing Activities 5A and 5B, review the "I wonder..." statements from both. Say, "Often when scientists do experiments they come up with lots of new ideas and questions. Which one is the most interesting to you? How could you find out more about it?"

I wonder ...

Keep listening for "I wonder..." statements after the activity. Children might wonder

what would happen if we really could stop all erosion.

if you plant a garden on a hill, which direction the rows should go. Why?

Activity 5B

Chocolate Mud Slides

A Step Beyond

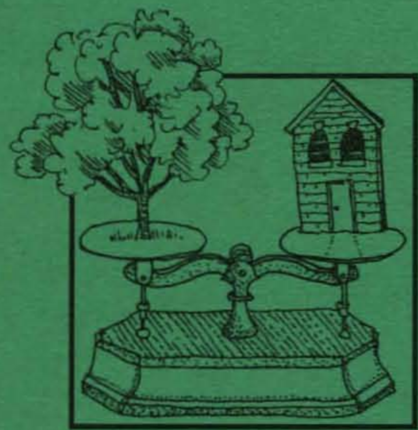
I wonder what human activities cause erosion.

A simple follow-up is to repeat the activity using different techniques. For example, you might want to lay down graham crackers or cookie squares to mimic sidewalks or roadways. Use your imagination.

In the week following the activity, challenge the children to find a newspaper clipping or magazine article that talks about erosion or mud slides. Look for signs of erosion as you walk or drive around your neighborhood. Have the children bring this information to the next session.

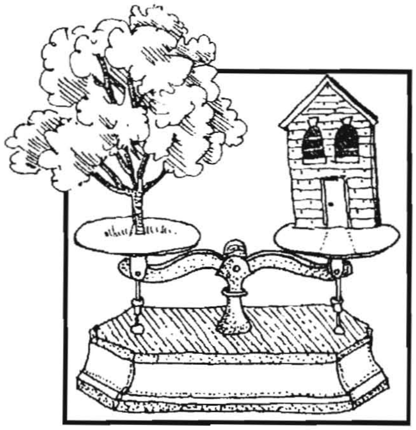
Erosion can be caused by natural processes such as rain or wind. But not all erosion is caused by nature. How do people cause erosion? Often we don't even realize the damage that we are causing, and sometimes we can change our behavior to decrease our negative impacts on the earth. Encourage the children to come up with a list of activities that cause erosion, the damage that is caused, as well as alternate ways we can decrease the amount of erosion that we cause. Use the chart below to record this information.

Human Activity Creating Erosion	Damage Caused	Alternative Behavior



In-Touch Science: Plants & Engineering

Resources and Management



In-Touch Science: Plants & Engineering

Checklist for Assembling Supply Kits

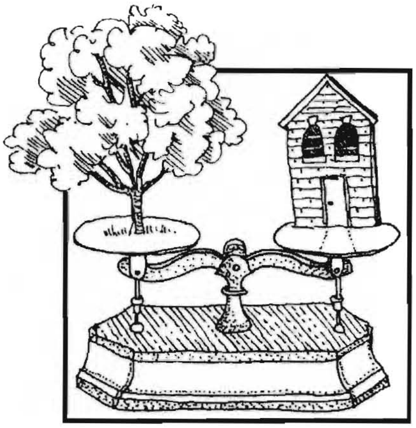
The supplies listed at right are needed to assemble one ten-person supply kit. Supplies are grouped as Tools, Food, Plant Materials, Supplies to Purchase, and Supplies to Gather. The "quantity" column indicates amounts needed for ten participants to complete all ten activities. The "activities" column indicates when the items are used.

To keep small items organized, you may want to place them in resealable bags or envelopes labeled with item name, quantity, and activity number. For safety, place sharp implements in a box or other container.

To make shopping easier, foods are listed together, but perishable items (such as milk, eggs, and plant materials) should be purchased when needed for the specific activity.

Item	*Quantity*	*Activities*
Tools		
❑ goggles (borrow if possible)	10	1A
❑ small nutcrackers	5–10	1A
❑ hammer	1	1A
❑ sharp knife	1	2A
❑ scissors	10	4A
❑ tweezers (optional)	5–10	4A
❑ calculator	1	4B
Food		
❑ variety of fruits (include nuts in their shell, fleshy fruits like apples, and any other fruits you can find)	10 cups	1A
❑ large grapefruit with seeds	1	1A
❑ large coconut	1	1A
❑ eggs	1 dozen	1B
❑ celery	1 bunch	2A
❑ cabbage	1 large head	2B
❑ marshmallows	at least 80	4B
❑ spaghetti	$^1/_2$ lb.	4B
❑ linguine	$^1/_2$ lb.	4B
❑ instant chocolate pudding mix	2 pkgs.	5B
❑ milk	1 quart	5B
Plant Materials		
❑ daisies or daisy mums	4–10	2A
❑ small potted houseplant	2	3A, 5A
❑ sturdy houseplant	1	4A
❑ grass sod	9" x 13"	5A
Supplies to Purchase		
❑ thick plastic bag	1	1A
❑ magic markers	10	1B, 2B
❑ vegetable food coloring	1	2A
❑ thermometers, small	4	3A, 3B
❑ black construction paper	10 sheets	3B
❑ white construction paper	10 sheets	3B

Item	Quantity	Activities
❑ aluminum foil (6" squares)	10 pieces	3B
❑ spoons and plates	10 each	5B
❑ paper or plastic cups	10	1A
Supplies to Gather		
❑ plastic tablecloth (for protection)	1	2A, 5A, 5B
❑ wrapping materials (see activity)		1B
❑ packing materials (see activity)		1B
❑ juice glasses or yogurt containers	10	2A
❑ newspapers	as needed	2A, 4A, 5B
❑ water, warm		5A, 5B
❑ water, lukewarm		2A
❑ Manhattan maps (from manual)	10	2B
❑ Indianapolis maps (from manual)	10	2B
❑ map of your local area *or* large piece of white paper	1	2B
❑ crayons	10	2B, 5B
❑ white paper	10	2B
❑ empty box	1 medium	3A
❑ flower pots, small	2	3A
❑ soda bottles, 2- or 3-liter	4	3A
❑ gooseneck desk lamps with clamps	2	3A, 3B
❑ regular desk lamp	1	2A
❑ 100-watt bulbs	2	3A, 3B
❑ school lunch milk cartons	4–8	3B
❑ graph paper	20 sheets	3B, 4B
❑ clear, lightweight tape		4A
❑ clay or play dough		4A
❑ 9" x 13" baking pan	2	4A, 5A
❑ paper clips	10	4B
❑ #10 business envelopes	10	4B
❑ pennies	400	4B
❑ 1-cup measuring cup	1	5A
❑ flowerpot with soil	1	5A
❑ short pencils	6	5B
❑ spray bottle	1–2	5B
❑ plastic wrap	5" x 12"	5B
❑ large cookie sheet with rim	2	5B



In-Touch Science: Plants & Engineering

Checklist for Assembling Supply Kits to Loan

Wash and Repack. Indicate if any are missing.

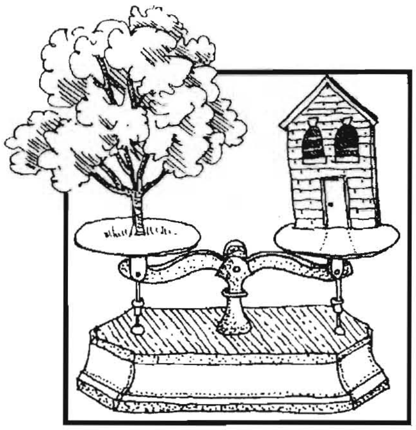
Item labeled in bags or boxes	*Quantity*
Reusable Tools and Supplies	
❑ paper or plastic cups	10
❑ goggles	10
❑ small nutcrackers	5–10
❑ hammer	1
❑ sharp knife	1
❑ scissors	10
❑ tweezers (optional)	5–10
❑ calculator	1
❑ juice glasses or yogurt containers	10
❑ crayons	10
❑ 1-cup measuring cup	1
❑ thermometers, small	4
❑ squirt bottle	1–2
❑ flower pots, small	2
❑ spoons	10
❑ plates	10

Replace as Consumed

Item labeled in bags or boxes	*Quantity*
❑ spaghetti	1/2 lb.
❑ linguine	1/2 lb.
❑ instant chocolate pudding mix	2 pkgs.
❑ thick plastic bags	1
❑ magic markers	10
❑ vegetable food coloring	1
❑ black construction paper	10 sheets
❑ white construction paper	10 sheets
❑ aluminum foil (6" squares)	10 pieces
❑ graph paper	20 sheets
❑ white paper	10 sheets
❑ clear, lightweight tape	1 roll
❑ clay or play dough	

Supplies Not Provided

Item
❑ perishable food items
❑ plastic tablecloth
❑ wrapping materials
❑ packing materials
❑ newspapers
❑ water, warm
❑ water, cold
❑ empty carton
❑ soda bottles, 2- or 3-liter
❑ desk lamps with clamps
❑ 100-watt bulbs
❑ school lunch–sized milk cartons
❑ 9" x 13" baking pan
❑ paper clips
❑ regular envelopes
❑ pennies
❑ flowerpot with soil
❑ short pencils
❑ plastic wrap
❑ cookie sheet with rim



In-Touch Science: Plants & Engineering

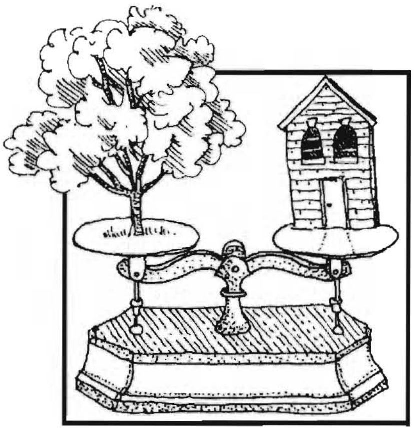
Guide to Ordering Supplies

Supplies used in *In-Touch Science: Plants and Engineering* can be purchased at food, garden, discount, or office supply stores. The following or similar mail order sources may be useful if you are assembling several supply kits or have difficulty finding supplies.

Central Restaurant Supply
642 North Salina St.
Syracuse, NY 13208
800-244-6848
Knives, cookie sheets, thermometers, nutcrackers, measuring cups

Delta Education
Hands-on Science K–8 Catalog
P.O. Box 3000
Nashua, NH 03061-3000
800-442-5444
Goggles

Nasco
901 Janesville Ave.
Fort Atkinson, WI 53538-0901
800-558-9595
Knives, cookie sheets, thermometers, scissors, calculators, measuring cups



In-Touch Science: Plants & Engineering

Parent Letter

You may want to introduce *In-Touch Science* to the parents of the children in your group. This is especially helpful if your group has not previously worked on science projects or if you want to encourage parent volunteers. Complete the form below and duplicate as needed.

____________________ (Agency name)

____________________ (Agency address)

____________________ (Date of letter)

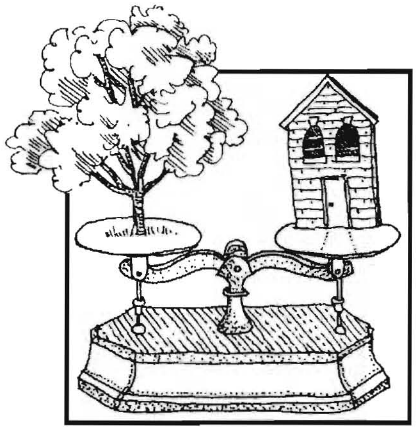
Dear Parent/Guardian:

The ___________________________ (name of your group) will be exploring and having fun with *In-Touch Science* on _________________________ (program dates). *In-Touch Science* is a hands-on science program that encourages children to examine everyday items, to talk about their observations, and to connect what they learn to what they do in daily life. Your children will occasionally bring home something they made. More often, you will need to ask them to tell you what they did. The program was developed by Cornell University with funding from the National Science Foundation.

Signed:________________________

Position:________________________

Agency:________________________



In-Touch Science: Plants & Engineering

Model Release

You may want to take photographs for local publicity or to share with Cornell University as part of the national *In-Touch Science* evaluation. In either case, you need to obtain permission to use these images. Adults can sign individual model release forms; parent/legal guardians should sign for children under 18 years of age. Complete the form below and reproduce as needed.

Model Release

Please check all that apply:

___ ______________________________(your agency)

___ In-Touch Science Team and Cornell Media and Technology Services, Cornell University, 239 Martha Van Rensselaer Hall, Ithaca, NY 14853-4401

The agencies indicated above are hereby granted the right to record and use any images (including, but not limited to, videotape, photographs, film, and audiotape) in which I, my child or children have participated as part of *In-Touch Science*[1]. I further understand that this authorization shall extend to their grantees, lessees, or licensees in perpetuity.

Model's Name (please print):______________________________

Model's Signature (if model is adult):______________________________

Parent/Guardian Signature (if model is a minor):______________________________

Home Address:______________________________

Telephone:______________________________

Email:______________________________

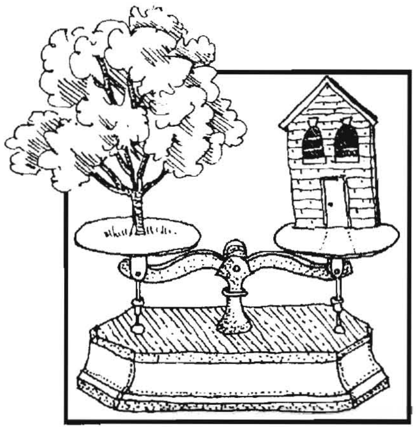
Date Signed:______________________________

Location and Description of Event:______________________________

____

Date of Event:______________________________

[1]*In-Touch Science* is a hands on science program for youth. Centered at Cornell University and funded by the National Science Foundation, it emphasizes exploration, conversation, and application to everyday experiences.



In-Touch Science: Plants & Engineering

Evaluation Form

Copy as needed, using separate forms for each session.

Sessions and Activities

❑ 30-minute session with one activity
❑ 60-minute session with two activities
❑ Other ______________________

❑ Session 1	1A Lock It Up • 1B Don't Break That Egg!
❑ Session 2	2A Pulling Up Color • 2B Mapping It Out
❑ Session 3	3A Here Comes the Sun • 3B Hot and Cold, Dark and Light
❑ Session 4	4A Strong Stems and Broad Leaves • 4B Flat or Round—A Penny Overload
❑ Session 5	5A Hold It Together with Turf • 5B Chocolate Mud Slides

Participation

Number of participants:

Children ________

Adults ________

Description of children:

Age(s) ________
Ethnic group(s) ______________________
Gender ______________________
Additional information ______________________

Description of adults:

Age(s) ________
Ethnic group(s) ______________________
Gender ______________________
Position ______________________
Education ______________________
Teaching Experience ______________________

Setting

School-age child care program
4-H club
EFNEP
Parenting program
Other ______________________
Community youth program
Camp
Museum

Children's Interest and Conversation

Level of interest	(low)	1	2	3	4	5	(high)
Amount of conversation among children	(low)	1	2	3	4	5	(high)
Amount of conversation with you	(low)	1	2	3	4	5	(high)

Children's Ideas and Comments

List sample *"I wonder..."* statements:

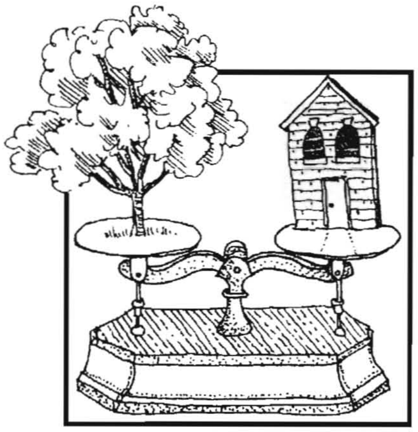
Other comments:

Adults' Ideas and Comments

Prior knowledge of this session's topic	(low)	1	2	3	4	5	(high)
Comfort level using this teaching approach	(low)	1	2	3	4	5	(high)
Age appropriateness of materials/procedures	(low)	1	2	3	4	5	(high)
Difficulty managing noise and disruptions	(low)	1	2	3	4	5	(high)
Level of support (site, parents, volunteers)	(low)	1	2	3	4	5	(high)
Amount of time for preparation/cleanup	(low)	1	2	3	4	5	(high)
Would you use this activity again?	Yes	No					

Other comments:

Return to
Extension Staff
Cornell University
Department of Textiles and Apparel
204 MVR Hall
Ithaca, NY 14853-4401



In-Touch Science: Plants & Engineering

Glossary

adaptation
A modification that has evolved over time

adhere
To cling or stick fast

adhesion
A molecular force of attraction that holds unlike bodies together

carbon dioxide
A gas made up of one carbon and two oxygen molecules, often referred to as CO_2

cohere
To stick together

cohesion
The molecular force between molecules that causes them to unite

erosion
The wearing away of land surfaces through the detachment or transport of soil, through wind, water, and other forces

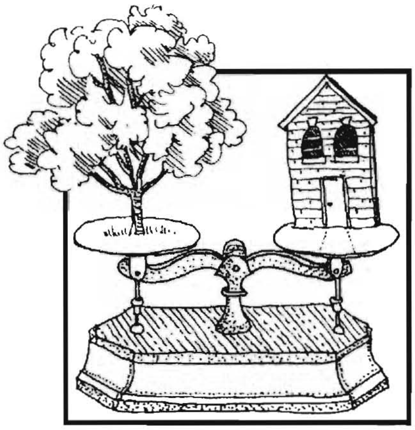
petiole
The slender stalk by which a leaf is attached to a stem; often called a leaf stalk

photon
A unit of electromagnetic radiation

photosynthesis
The process through which plants produce sugars from light energy. Occurs in green parts of a plant.

sod
A section of ground covered with grass

transpiration
The process of giving off water



In-Touch Science: Plants & Engineering

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The teaching style of the **In-Touch Science** program emphasizes the fun of manipulating supplies and engaging in the scientific process of discovery. Together, adults and children will share "I wonder . . ." statements that can lead to even more interest in science and exploration.

In-Touch Science: Plants and Engineering

The ten activities in this 116-page manual show children how each of five science concepts relates to plant science and engineering. For example, Session 1 examines protective materials and strategies. Children learn how plants protect themselves from drought, fire, and insects. They explore engineering ideas as they construct containers to protect fragile or valuable items.

The **In-Touch Science** publications were developed by Cornell Cooperative Extension educators at Cornell University in response to the need for youth to develop science literacy emphasizing learning science by *doing* science.

These hands-on projects and activities engage children at an early, and naturally inquisitive, age.

In-Touch Science is for children in grades 3 to 5 (aged 8 to 11). The program helps children

- communicate what they observe and learn.
- understand the science connection between two fields of study.
- recognize science concepts in daily experiences.

Each **In-Touch Science** unit has children manipulating materials and equipment, testing ideas, and exploring what interests them in a relaxed learning environment. It works best with groups of five to ten children.

In-Touch Science is useful to science centers, 4-H clubs, school-age child-care programs, summer camps, home schoolers, the Expanded Food and Nutrition Education program, scouts, and other community programs. It can be easily adapted for use in school science programs.

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