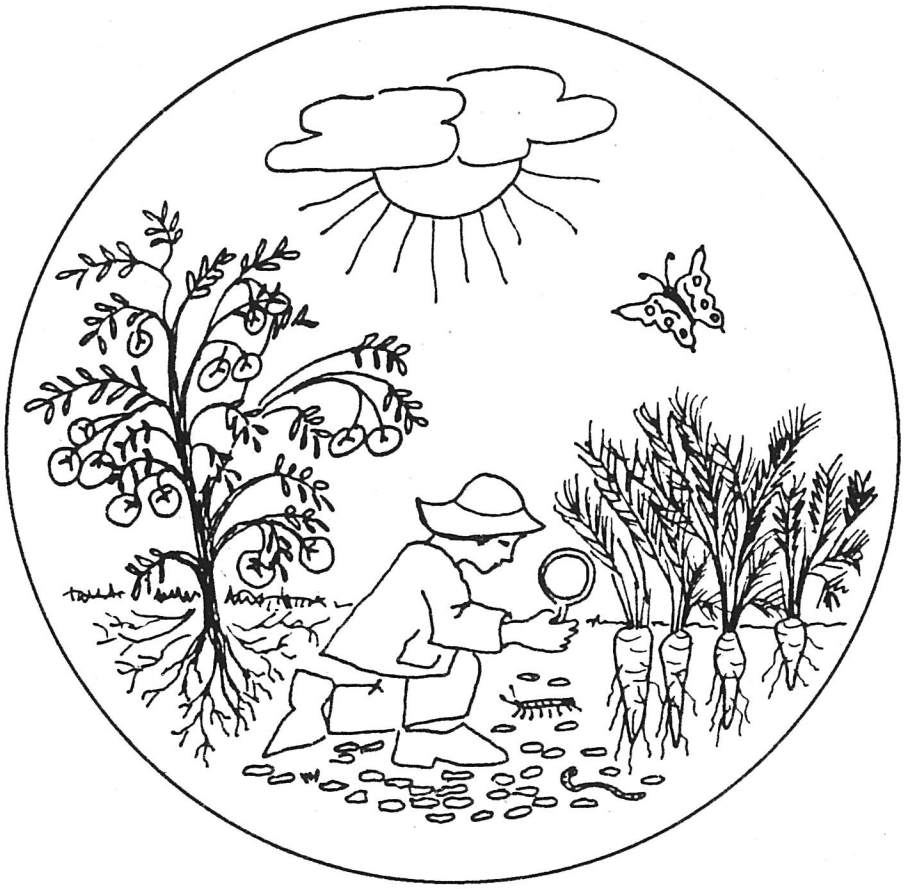
A Teacher's Manual

for

THE GREEN CLASSROOM

A GARDEN-BASED SCIENCE CURRICULUM



THE GREEN CLASSROOM PROGRAM

A Teacher's Guide to a Garden-based Science Curriculum

A Publication of The New Alchemy Institute
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ACKNOWLEDGMENTS

The Green Classroom program was orginally developed and initiated by Kim Knorr, a semester student at the New Alchemy Institute. Her early pioneering efforts paved the way for the entrance of the Green Classroom into the Falmouth School system. Today, every fourth grade class is involved in the project and all four elementary schools have a garden.

Special thanks go's to the following people who played a role in making this manual a reality: David Wills and his speedy red pen, Kay Brown for patiently formatting and reformatting, Joy Cooke for her early shaping of the curriculum, Pat Perry for her continued support, honest assessment of the program and for defining all of the vocabulary words, Amy Kaye for her wonderful drawings, the education department at New Alchemy for letting me hog the upstairs computer for 11 months, Kurt Teichert and David Sower for producing the needed computer graphics, and all of the fourth graders who unknowingly tested each of the lessons presented in this manual and encouraged me with their delight for gardening.

Welcome to The Green Classroom Program

The Green Classroom is a comprehensive environmental science curriculum which includes teacher directed skills and concepts, hands-on student experimentation, and the set-up and maintenance of a school garden.

With the Green Classroom, students are engaged in an activity-based science project that continues through the school year. Lessons in social studies, art, mathematics and language arts are integrated into the curriculum. In addition to specific lessons, the Green Classroom focuses on group cooperation and problem solving skills. It fosters a deep respect for the earth while providing the experience for its care.

The manual has been developed to provide the teacher with 1) the information needed to start and maintain a school garden 2) detailed lesson plans to teach the concepts, and 3) a variety of optional activities to enhance the key lessons.

The New Alchemy Institute will continue to be supportive of your Green Classroom program. If you need any further assistance call or write for information on teacher workshops and consultation sessions.

Happy Gardening!

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Green Classroom Calendar At a Glance

SEPTEMBER
Garden Activities: Form a garden committee. Generate support and funds for your project. Prepare your garden site. Get cover crop seed and/or leaf mulch. Borrow any tools that you need.
Lessons: Introduction/garden journals. Seasonal changes in the garden. Soil exploration. Putting the garden to bed.

OCTOBER
Garden Activities: Build a compost bin. Gather compost material.
Lessons: Soil formation. Soil types and influence on plant growth. Composting and the nutrient cycle.

NOVEMBER
Garden Activities: Take a rest—The garden is sleeping.
Lesson: History of gardening and native foods.

DECEMBER
Garden Activities: Order seed catalogues.
Lesson: Food system in the United States.

JANUARY
Garden Activities: Order seeds. Plan your indoor growing center and purchase equipment.
Lessons: Ordering Seeds. Seed study. Germination experiments.

FEBRUARY
Garden Activities: Set up your indoor growing center. Determine garden layout. Purchase or collect all garden tools needed.
Lessons: The structure and function of plants. Starting seeds indoors/plant growth experiments.

MARCH
Garden Activities: Continue to start seeds indoors. Test you garden soil. Purchase necessary soil amendments. Build a cold frame.
Lessons: Interdependencies in the garden environment. Habits and habitats.

APRIL
Garden Activities: Add necessary soil amendments. Rototill the garden. Prepare the garden beds. Harden off seedlings. Transplant and direct seed the cool weather plants.
Lessons: Soil Fertility. Preparing garden beds. Hardening-off, transplanting and direct seeding.

MAY
Garden Activities: Mulch and weed the garden. Continue to plant.
Lessons: Garden maintenance. Insect hunt. Insect research reports.

JUNE
Garden Activities: Continue garden maintenance. Make and send invitations to Harvest Party. Harvest your garden. Make plans for the summer. Evaluate the year.
Lesson: Harvest Party; research report presentations, good food and fun.

Starting The Green Classroom Project

From the very beginning it is important to develop a garden site that invites and nurtures a sense of ownership from all involved. The garden area can grow to be a special place of pride and delight if it has been well planned. The more people involved with the project the better, for involvement lends itself to caring and generates support. As the project develops, include other teachers, school administrators, students and people from the community whenever possible.

Form a Garden Committee

Form a garden committee with all of the teachers involved in the project. This is an essential step in securing a successful gardening project in your school. All of the teachers involved must share the responsibilities of developing and maintaining the school garden. One teacher cannot do it alone. In the beginning, the committee will have to meet frequently. Once you get the ball rolling it may only be necessary to meet once a week during lunch. Schools that have experienced great success in gardening have also planned periodic lunch meetings with the principal. Coordinating efforts and good communication between teachers and administrators can only strengthen your gardening program.

In September, begin to coordinate classroom time in the garden and allocate garden responsibilities between teachers and volunteers for this month. For extra support, consider establishing a Community Advisory Committee for your garden program.

A Community Advisory Committee consisting of parents and other interested people (like parents, 4-H leaders, cooperative extension personnel, gardening center managers, garden club members, Rotary Club members, etc.) could become the backbone of the garden project. The main responsibility of this group is to mobilize community resources. Schools involved with the Life Lab gardening project centered in Santa Cruz, California have had great success with Community Advisory Committees. The committees organize community work days to get the garden project underway. Tasks such as building compost bins and tool sheds, rototilling the garden or double-digging beds have all been accomplished through the efforts of the committees. A Community Advisory Committee could also take on the responsibility of getting press coverage for your project and seeking donations from local businesses.

The following suggestions are from *The Youth Gardening Book* by the National Association of Gardening.

Some schools have benefited greatly by starting "Adopt-a-Garden" partnerships with local businesses. Businesses will benefit from the partnership by directly affecting the quality of the public schools, investing in future leaders and enhancing their own image within the community. In exchange, the school garden highlights the sponsoring business in various ways. Many have prominent plaques identifying the sponsoring organization. Your town may already have such a program. To find out if one exists contact your chamber of commerce or office of education.

Generate Support for Your Garden Project

Getting some good "PR" can help you get the money you need. The more good publicity you get the easier it becomes to approach potential supporters and ask for donations to help your project. Call the local newspaper or radio stations and inform them about your project. Remember, you are doing something unique here. A school garden is

newsworthy. Everything is an event in a school garden! Here are a few events that will capture media attention:

dedication/ground breaking ceremony
announcement of your project 's beginning
planting ceremonies
plant sell
picture session or open house when the garden looks good
harvest festival featuring a fresh salad from the garden
feature story on science projects generated from the program

Invite local officials to tour your project and coordinate the event with some press coverage. Encourage young gardeners to join you and tell about their gardening experiences. Write an occasional letter to the editor of the local paper, or ask someone who supports your efforts to write one. Ask parents to contribute their comments about the program in writing. Make a video of your garden project and show it at a school board meeting. If you have surplus vegetables, find a group that needs them and donate the food. If you do this regularly, it is a good story for the media.

Choose a Garden Site.
You do not have to have prime agricultural soil for a successful school garden. Most any site with at least six inches of topsoil is a good potential garden area. An area that has a good crop of weeds or a sod cover usually means garden vegetables will do well. Here are a few suggestions that will help you choose a site that will increase your chances of a fruitful garden.

Less slope is best
Place your garden on reasonably level ground. Steep slopes are less fertile and will increase chances of water runoff and soil erosion. Choose a site with a slope less than 20 degrees.

Good drainage
If the soil has a good crumbly texture it will usually drain well. Look for puddling after a rain. Vegetables will not grow well in saturated muddy soils.

Water is essential
The closer your garden is to a water source the better. Ask the custodians to locate all water spigots for you. A shorter hose to your site will save you money.

Six hours of sunlight a day
Your garden will need at least six hours of full sunlight each day. A southern exposure is ideal. Check the site at different times during the day to see how the sun hits it. A little bit of shade is all right and at times very welcome.

Consider your future needs
Will the area you have chosen accommodate your future garden plans? You may want to build a tool shed, a compost bin, a coldframe or a greenhouse near by. Picnic tables or benches often come in handy. The garden will expand as more classes take part in the program. Start small but always allow room for big dreams.

Minimize the risk of vandalism
Unfortunately, vandalism happens. There are things you can do to minimize the risks involved. Locate the garden away from main thoroughfares and as close to the school building as possible. Put up a sign near the garden letting people know what you are

doing and why. Involve as many people in the garden project as possible. Potential vandals can become protectors of the garden if they have a vested interest in the project. You may want to put up a fence although many people believe fences provide a greater challenge to conquer. If a fence is installed plant climbing roses around it. Scotch thistles discourage trespassers also.

Decide on Garden Approach

You will have to decide if you want a communal garden or individual class plots. If the garden is communal, children share the work of cultivating, planting and harvesting. A communal garden plot encourages group participation and cooperation and insures that every child receives something from the harvest. The size of a communal plot depends on the space available and the number of children who are gardening, but there should be room for everyone to work at the same time, without being crowded.

Individual plots do not have to be spacious, but should be large enough for each child to plant a few favorite vegetables. Individual plots can be used to compare different varieties and to allow for the special needs of individual children. Plants that require a lot of room like corn or squash can be planted in another area of the garden, leaving the hardy space savers like radishes, beets, chard and leafy lettuce for the individual plot.

Determine Garden Size

There is no magic formula for determining the size of your school garden, but there are a few things to consider. The garden has to be large enough for your class to work in. Garden beds must be at least three feet wide to allow plenty of growing area. Kids have a hard time reaching the middle of the bed if it is much wider. Walkways between beds should be at least three feet wide. The walkways need to be roomy enough for kids to kneel down and work in and to push a wheelbarrow through.

For comparison here are a few garden dimensions used by operating school gardens. The Life Lab schools have used two beds per each class of 30; each bed is 3.5' X 25' with three foot walkways. This area of 180 square feet works out right for them.

The New Alchemy Children's Garden is 40' X 60' and is large enough for eight classes of 25 students each. The East Falmouth Garden is 10' X 63'. This garden accommodates four classes of 25 students each.

Material from this section was adapted from *The Youth Gardening Book* by the National Gardening Association, 180 Flynn Ave., Burlington, Vermont 05401.

SEPTEMBER

NOW IS THE TIME TO CONSIDER...

1. Arranging a field trip to New Alchemy or a local produce farm. See Optional Activities for Lesson 1.

2. Getting cover crop seed and/or leaf mulch to put the garden to bed. See Lesson 3: Putting the Garden to Bed.

3. Preparing the garden site.
   Mark off the garden with stakes and string then have it rototilled. Rototilling may only be necessary for the first year of your garden project. Some school grounds are so compacted and covered with grass or weeds that rototilling is essential in the fall if you are planning to enrich the soil with a cover crop. As your garden soil becomes more enriched, it may not be necessary to use a rototiller. Try to find a parent or another member of the community to provide this service for you. If you are loaded with energy and have some extra time, the garden can be turned over by hand— a rewarding but labor-intensive job.

4. Requesting PTO funding for tools and equipment or seek other funding sources or donations from your local community. You may be able to tap into Title Two or Chapter Two money. In the fall, gardening grants are available from the National Gardening Association. Each year 100 exemplary youth garden groups and programs are awarded $600 worth of equipment, supplies and tools through this grant program. For more information contact: The National Gardening Grants, CD 180 Flynn Avenue, Burlington, VT 05401, (802) 863-1308. Grant application deadlines are in November.

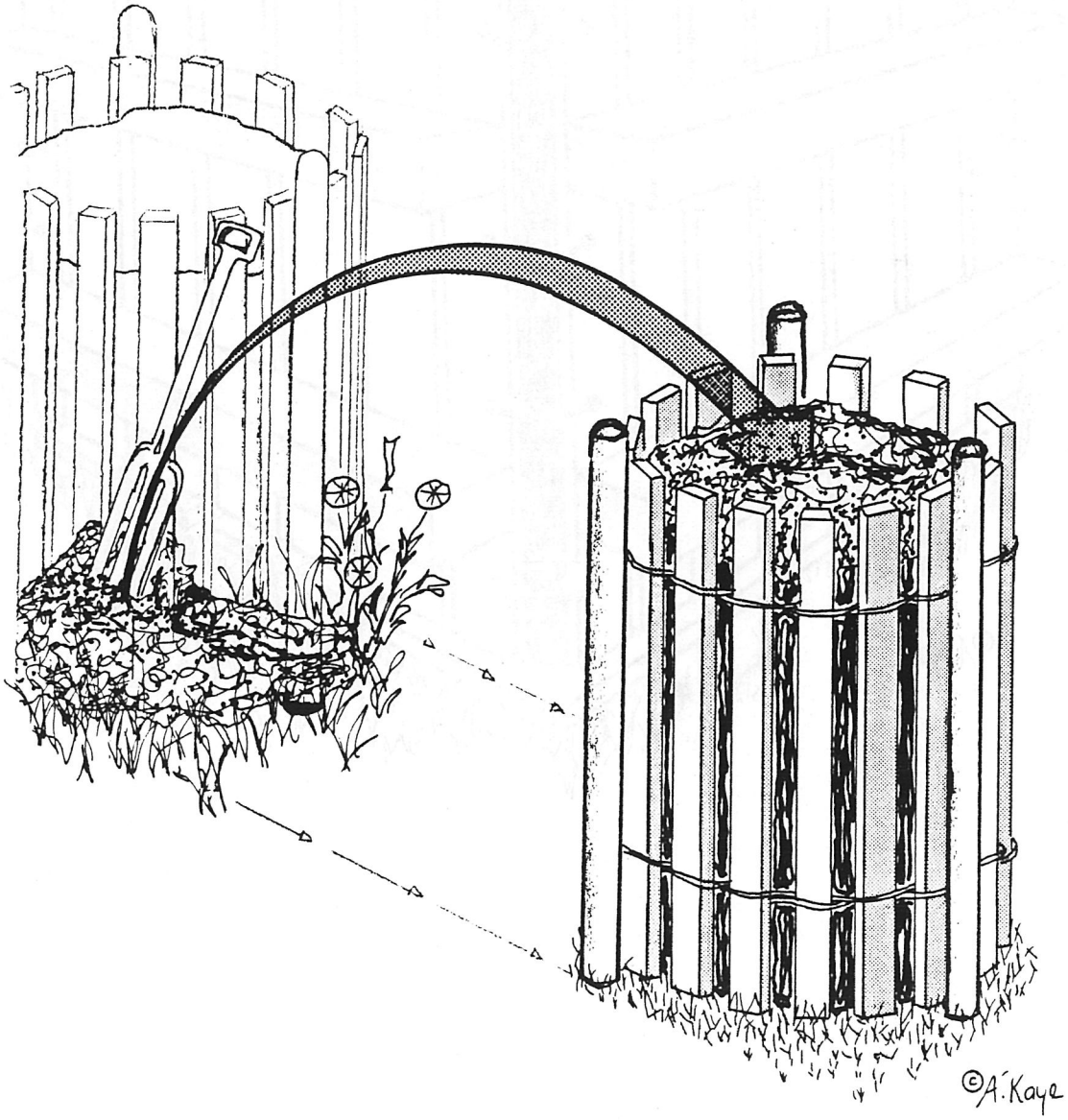
5. Writing a letter to parents explaining the project and asking for gifts of extra tools, time, services and other supplies or needed equipment . See the "Supply List for a School Garden" at the back of the manual.

6. Building a compost bin
   Compost not only enriches your garden soil but the process is magical and provides an excellent opportunity to teach lessons on the nutrient cycle, recycling and decomposition. A container for your compost is not necessary for the decomposition process, but they do make composting a neater and easier task. Following are two easy-to-build compost bins. Whatever type of bin you build, keep in mind that it must be at least 3' by 3' with a height of three feet in order for the compost pile to be self-insulating. For an excellent explanation of composting see: "Composting, A thrilling Experience For Youngsters — an insert following Lesson 3 for October: Composting and the Nutrient Cycle.

Two Easy-to-Build Compost Bins

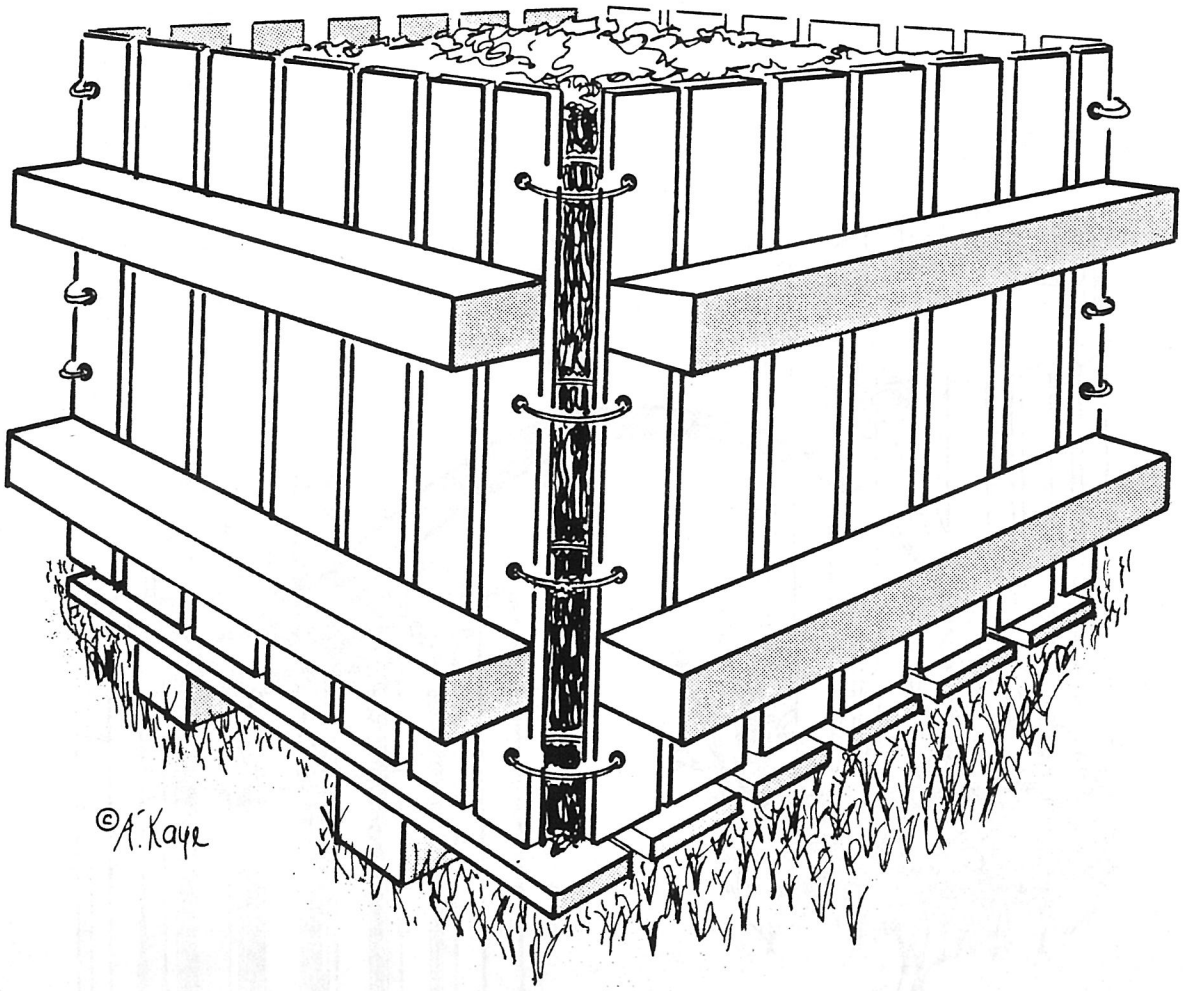
Snow Fence Bin

Use 11 feet of snow fence to make a circular bin that is three feet across and four feet high. To stabilize this light-weight bin, tie or wire the fence to stakes made of metal pipe or conduit. The bin must be taken down to turn the compost. Set up the bin a few feet away and turn the compost into it.



Wooden Pallet Bin

Four wooden pallets tied together at the corner forming a box makes an easy-to make durable bin. You could put a fifth wooden pallet on the bottom to allow air to circulate from below the pile. Make two of these bins side-by side. Turn the compost from the first bin into the second to increase the rate of decomposition. Wooden pallets are often thrown away and are your's for the finding. Check grocery stores, garden centers, department stores, newspaper offices,etc. for a readily available supply.



Tool Care and Use

Tools are the most expensive and essential equipment you will have for your garden project. Proper care and handling from the beginning will ensure many years of safe use.

Before the first garden activity requiring tools, go over the following rules on proper handling of tools with your students.

1. Never run with a tool in your hand.

2. Always carry a tool close to your body with the sharp edge pointing down and the handle up.

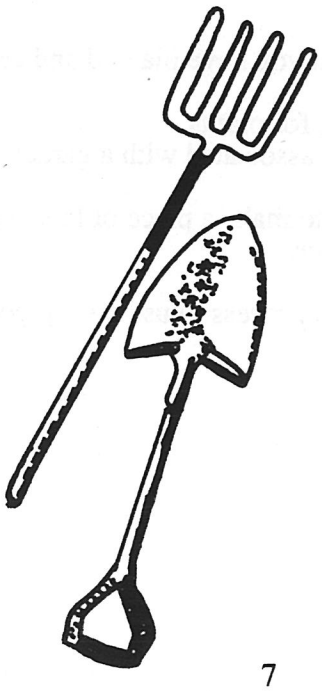
3. Be aware of your space when using a tool. Check to see if anyone is near you. Remember you will need plenty of clear space when using a rake, hoe, shovel or pitch fork. Do not lift or swing tools above your knees.

4. Keep the tools out of pathways and other places where someone might trip or fall. Sharp edges should always be left pointing toward the ground.

Take time to practice the proper handling of tools. Role play a child using a tool in the proper and the incorrect way. Have the students tell you if what you are doing is right or wrong.

Cleaning Tools

Always clean your tools before putting them away. Use a wooden box full of sand and motor oil. Have the students push the blade of the tool in and out of the sand a few times. Then wipe the tools off with an oily rag or use a stiff wire brush to remove any remaining dirt. Your tools will be more likely to resist rust if this is done after each use. Learning to take care of equipment is a valuable lesson on responsibility. We always end a work session 15 minutes early to allow for clean up.



September

Lesson 1: How Does Your Garden Grow?
Introduction and the Fall Season

Time Frame
35 minutes

Objectives
To introduce students to the Green Classroom.
To discuss reasons for gardening.
To compare gardening experiences.

Materials Needed
Large sheet of poster paper or newsprint, colored marker, one journal for each student, a big delicious looking vegetable. Optional: pictures of vegetables or flowers to decorate covers of journals.

Procedure
Introduce the gardening project by bringing in a typical garden vegetable and explaining that by the end of the school year they will be growing vegetables like this in their own school garden. Encourage your students to share past gardening experience with the others in the class by asking: Who has ever gardened before? What did you grow? What was your favorite thing about gardening? Who taught you to garden? etc.

On the black board generate two lists with your students. One entitled **What We Know About Gardening,** the other **What We Want to Know About Gardening.** Have the students copy the list in their journals. As the students learn more about gardening they can subtract items from the What We Want To Know list and add them to the What We Know list. As the year progresses refer to the list to see how much has been learned.

Lead a discussion on the reasons for gardening by asking: Why in the world would anybody want to garden? Try to include the following reasons:

Gardening is fun.
It makes you feel good when things that you have planted and cared for grow into healthy plants.
We can learn about growing and caring for plants.
We can learn about the animals that are associated with a garden.
We can grow our own fresh food.
As gardeners, we have the opportunity to make a piece of land a beautiful and delicious environment filled with life and color.

Be sure to take pictures of the entire garden process to use during your orientation lesson in years to come.

An Introduction to Garden Journals.

Journals are an important part of this program and should be used as an overall science/observation/record-keeping tool, and as a place to express feelings and reflect on activities. Students will be asked to make entries in their journals following class and garden lessons. They should also use them to store information and record data pertaining to optional activities. There are many opportunities to use journals for expressive writing and to work on specific objectives in the language arts curriculum. Some specific suggestions for journal entries will be given after each session. Be sure that every entry is dated.

Journals should be something that the students feel are their own. They should be allowed freedom in what they write. To encourage this, you may choose not to mark or grade the journals. You can emphasize specific skills through the directions you give for individual entries. Students can begin to evaluate and improve their writing by reading each other's journals or by discussing what they have written with you in a non-judgmental way.

Journal Suggestions

1. Hand out the journals and explain how they will be used throughout the garden project. Have students personalize their journals by decorating the covers with drawings, collages (use old seed catalogs) or any other appropriate medium.

2. Have students write sentences about the initial presentation. Tell them that they can write about things they learned, how they feel about being part of the program, what they think it is going to be like, etc.

3. Have the students record the two lists generated on the black board during today's lesson.

Visit A Local Produce Farm

Arrange a guided field trip to the New Alchemy Institute or a local produce farm. Talk with the staff at the farm to find out about the types of food that can be grown locally and the methods used. Brainstorm a list of questions to ask the farm staff before you go on your trip. When you return to the classroom check the What We Want to Know About Gardening list to see if an item can be added to the What We Know About Gardening list.

Gardening Through Fiction

Read a gardening story to the class. The following books are highly recommended.

The Beetle Bush, by Beverly Keller, 1976. Coward, McCann and Geoghegan, Inc. Grades 1 - 4. Can be read in one sitting.

The Pumpkin People, by David and Maggie Cavagnard, 1979. Charles Scribner's Sons. Grades 1 - 4. Can be read in one sitting.

Secret Garden, by Frances H. Burnett, 1971. Dell Publishing Co., Inc. Grades 4 and up. This is a longer story. It could be read during the winter of your garden program.

Eddie's Green Thumb, by Carolyn Haywood, 1980. William Morrow and Co., Inc. Grades 3-7. Can be read in one sitting.

September

Lesson 2: Seasonal Changes in the Garden
Graphing Soil Temperature and Hours of Daylight

Time Frame
1.5 hours

Objectives
To determine the connections between seasons, the number of sunlight hours in a day, the temperature of the soil and their influences on growing food.
To develop graphing skills.

Materials Needed
Soil thermometer, farmer's almanac (or any source listing the number of daylight hours for each day of school), two sheets of 1" graph paper, two sheets of graph paper for each student (graph paper for copy is supplied in manual).

Vocabulary
Horizontal, vertical, graph, environmental factors, migration, deciduous, coniferous, autumn.

Note to teachers: The term environment encompasses all those factors, large and small, that influence organisms. In this lesson the students will learn about two very important factors that affect the garden environment: soil temperature and daylight hours. By graphing soil temperature and daylight hours for the entire school year, students will be able to make connections between seasons, the number of sunlight hours in a day, the temperature of the soil and their influences on growing food. Students can use these graphs to make seasonal predictions, and identify patterns in temperature and daylight hours.

Procedure
Lead a discussion on seasonal affects on the garden by asking: Should we go out and plant the garden on this fine autumn day? Why not? Lead students to realize that as the days are growing colder they are growing shorter too. Ask students how late could they play outside in the summer before it grew dark? What time does it start to get dark now? The sunlight is not the same every day. It grows shorter and longer with the seasons. How are the plants outside responding to the shortening of the daylight hours? (Leaves on the deciduous trees are changing colors and falling. Flowering plants are no longer flowering. Grass on front lawns does not need to be mowed as often as it did in the summer.) How are animals responding to the shortening of the days? (Pets are beginning to grow their winter coats. Squirrels are gathering nuts and building winter nests. Birds are migrating.) Just as nature is preparing for winter, we must prepare our garden site for winter. This is not the time to start seeds. Garden plants need a certain amount of daylight hours in order to grow. The lengthen of the days as spring approaches signals the time to begin planting. We are going to keep our eyes on how the daylight hours change with the seasons by making a graph. This graph will help us to determine when to plant our seeds for the garden. We will keep our eyes on the rest of nature too. What type of animal activity do you think we will see when it is time to plant in the garden?

The temperature of the soil is another very important factor that determines when we can start certain plants. We will keep track of the changes of the soil temperature through the seasons with a different graph.

Soil temperature and daylight hours are called environmental factors. They are factors that affect the garden environment. Can you think of other environmental factors that affect the garden. Examples could include: air temperature, shade, water, insects, fertilizers.

Give each student a piece of graph paper and instruct them to prepare it in the following way.

Label the top Margin: Soil Temperature Graph.
Label the bottom horizontal axis: Date (You will take a reading every two weeks or every week if you want a more gradual graph).
On the left vertical axis create a temperature scale starting from 0°F to 80°F in 10° increments. Convert to the Celsius scale if you prefer.

Demonstrate how to record data on the graph by taking the first soil temperature reading. Bring your class outside to the area you will take the soil temperature. You should take the reading in the same place and at the same time each day. Spend a few minutes explaining how to read the soil thermometer. When everyone feels comfortable reading the thermometer, have one student gently push it into the ground. CAUTION: *Soil thermometers are fragile. They break very easily. During the winter, when the ground is frozen a lead hole will have to be made before the soil thermometer can be inserted into the ground. A long nail and a hammer can be used to make the lead hole.*

Leave the thermometer in the soil for about two minutes. Have each student practice reading the thermometer then go inside to record the reading.

Draw a quick graph on the board and lead students through a demonstration on how to record the soil temperature for the day. Be sure they record the day's date.

Hand out the second sheet of graph paper to each student. Instruct the students to prepare the graph in the following way.

Label the top margin as: Daylight Hours Graph.
Label the bottom horizontal axis: Date.
On the left vertical axis number the hours of daylight from 0 to 13.

Determine the length of day once every two weeks. You could take a reading every week if you want a more gradual change to appear on the graph. To determine the length of day use any source that gives you the time of sunset and sunrise for your area. Newspapers sometimes include this information. *The Old Farmer's Almanac* is a great source for this. You will need last year's version as well as this year's. They can usually be found in stores that sell paperback books. In the Farmer's Almanac look in the table of contents for the section titled: Length of Days. This section is put together month by month. The length of day is given for each day of the month. The length of day is calculated for Boston, so if you live outside of the Boston area you will have to adjust the information accordingly. Complete instructions for doing this are given in the Almanac.

Students can take the information directly from the Almanac once you have shown them how to read the chart or you may choose to use this as a lesson in the passing of time. The length-of-day chart also gives the time of sunrise and sunset for each day of the month.

Make class graphs that will be displayed in a place where they will remain for the school year. It is suggested that 1" graph paper be used and a few sheets taped together.

Journal Suggestions

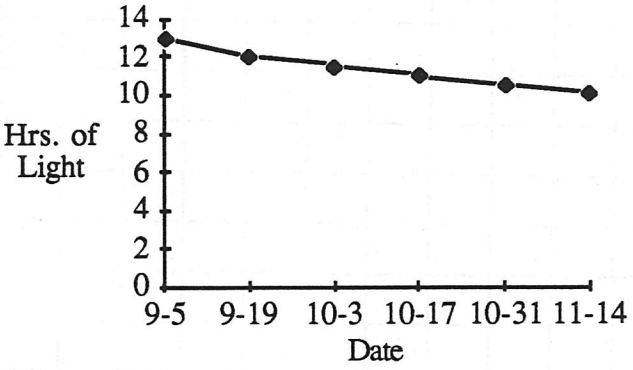
1. Have students keep their graphs in their journals. Ask them to make predictions of how the soil temperature and daylight hours will change during the next month.

2. Have the students brainstorm how the garden will change during the seasons. Give each student a piece of unlined paper divided into four sections. Instruct the students to draw a picture of how they think the garden will look during each of the four seasons. Share pictures and discuss seasonal changes. Turn your classroom walls into a "Garden Gallery" by hanging everyone's pictures. Put the garden pictures in the journals when they are taken down.

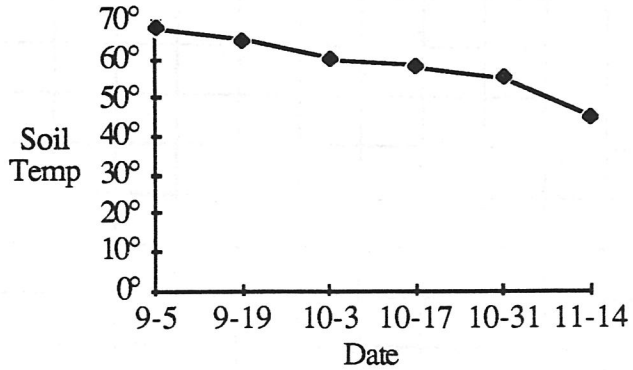
3. Write about your favorite fall activity.

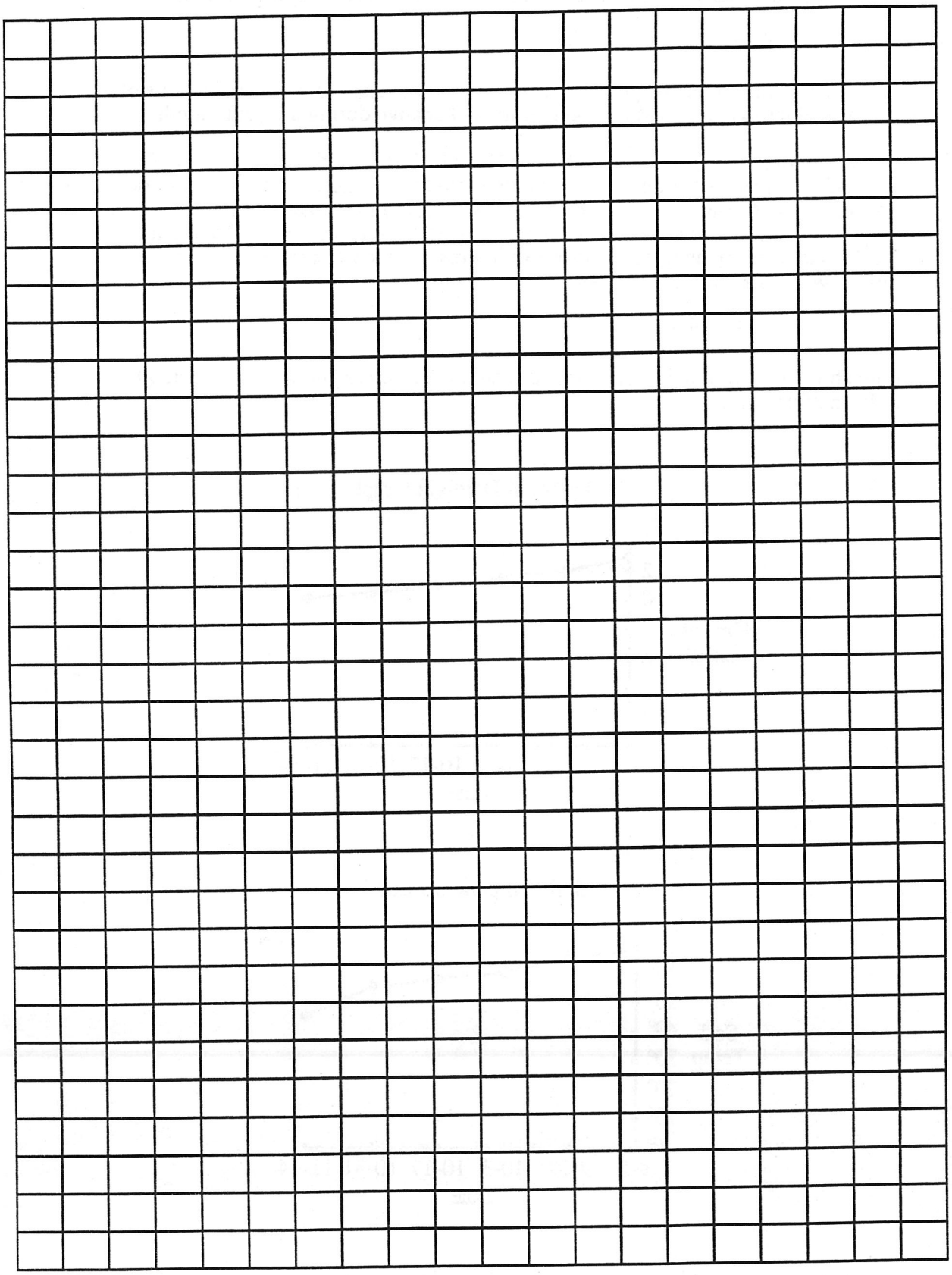
4. Write about what fall makes you think of and how it makes you feel This could be in the form of a poem.

Hours of Daylight Graph



Soil Temperature Graph





Fall Collection
Observation/Classification

1. Have students bring in things form the outdoors that are signs of fall. Allow this to be an ongoing collection — one or two weeks.

2. Every two or three days, discuss some of the things that have been brought in. Can students identify them? Make reference books available.

3. Have students group objects and explain their reasons. How many different ways can they find to classify them?

4. Make a big list of all the fall activities the students can think of, and then discuss the reasons that people do these things in the fall.

5. Draw a very detailed picture of one of the fall objects in the class collection. Can you label some of its parts?

Leaf Prints
Art and Science

Objective: To develop a sense of awareness of the different sizes and shapes of leaves and be able to differentiate among them on the basis of these characteristics.

Spatter Prints

Materials Needed: 9" x 12" metal wire screen (plastic or nylon net screen also will work), toothbrush, straight pins, tempera paint, 8-1/2 x 11" paper.

Ask your students to bring a variety of leaves to school or take the class on a walk to pick up leaves from the school grounds. Place a leaf on a sheet of paper and secure with pins. Place a screen over the leaf and paint across the screen using the toothbrush.

As the project progresses, talk with each student about the differences she/he sees in the shapes and sizes of the leaves being used. As a follow-up, ask the students to look at all the prints and group together those with leaves of similar shapes. Then ask them to group together all the leaves of similar sizes. The prints may be used to identify leaves observed outdoors during nature walks.

Wax Paper Pressing

Materials needed: leaves (preferably fallen autumn leaves rich in color), warm iron, towel, wax paper.

Place a leaf between two layers of wax paper. Cover with a towel. Press the towel with a warm iron in order to cover the area of the wax paper sealing the leaf between the layers.

The leaves may be cut out with a narrow margin left around each leaf. The leaves can then be made into mobiles, displayed on windows, bulletin boards and walls; or used as covers for greeting cards.

Talk with your students about the leaf shapes and ask them to group together the pressed leaves with similar shapes. Then ask them to group together the pressed leaves with similar sizes. The students can look to see whether or not all leaves of similar size have similar shapes. The students might create a chart to classify their findings.

The leaves could be kept in a box available to individuals and to groups of students to use in different, nonpermanent arrangements, as puzzle pieces, and for counting games.

Leaf Crayon Rub
Materials needed: leaves, newsprint, crayons

Have the students pick a leaf from a collection of varied leaves—possibly those gathered during one of the activities above. Then ask each student to lay their leaf down, put a sheet of newsprint on top of it, and use the side of a crayon to rub across the leaf. Some students will need to be encouraged to color over the entire leaf, rather than only part of it. Rubbing firmly all over the leaf will show the veins as well as the outline. A dark crayon will produce a clearer print.

Introduce vocabulary words such as vein, margin, palmate, and serrate to describe the rubbings.

From: *Project Learning Tree,* an environmental education project sponsored by the Western Regional Environmental Education Council and the American Forest Institute.

Adopt-A-Tree

Objective: To determine the seasonal changes of a tree.

This activity may be conducted as a class project, with a class divided into groups of three or four students each, or with students working individually. Begin by having the students adopt a tree (or trees) of their choice near your school site.

On the first visit:

Describe the tree as it is right now, today.
Look at its physical characteristics: size, leaf shape, bark color, and other features.
Look to see whether it is alive. How can you tell?
Look to see whether it appears to be asleep (dormant) or awake. How can you tell?
Listen to find out whether it makes any sounds.
Smell to find out whether it has an odor. Do different parts of the tree smell different—like bark, old leaves, new leaves?
Think about whether the tree and its parts might smell different other times of the year.
Think about how the tree got where it is and how new trees might come to join it.
Think abut what other living things might need this tree for survival.
Think abut what things the tree might need for its own survival.
Think about how long the tree might live.

Repeat the visits throughout the year and compare observations made each time.

Look to see how the tree has changed.
Look to see in what ways the tree has remained the same.
Think and talk about what the tree might look like the next time you visit it.
Write a description of your adopted tree. Draw it as realistically as possible. (Teacher could take a photograph of tree)

From: *Project Learning Tree*

Lesson 3: Ingredients of Soil
Soil Exploration

Time Frame
35 minutes

Objectives
To determine what soil is made of.
To sharpen students observation skills.

Materials Needed
*Soil observation sheets, hand lenses, trowels (or any device with which you can dig a shallow soil sample). *Included in manual.

Vocabulary
Organic matter, minerals.

Procedure
Soil is the basis of life in a garden. This lesson will give the students an opportunity to closely observe a soil sample to identify its various components. The lessons on the formation of soil and composting that follows are sequentially built on this lesson.

Divide the students into small groups of three or four. Tell them that they are all going to be soil scientists for a while. Put on your most professor-like voice and continue with: "Soil, as you all know, is the basis for all life in the garden. Without it, nothing would grow. Because it is so important, each scientific team will closely examine a soil sample to find all of it's basic ingredients. You will use the most valuable scientific tools known to humans to examine your soil sample—your senses."

Distribute the soil samples to each group or have them go outside to collect their own. A few handfuls of soil will do for each sample. You can use trowels to collect the samples. Be sure to dig up the soil from at least six inches below the ground level. You will want samples that contain plant and animal parts and visible minerals or small pieces of rock. It is not necessary for all groups to get their samples from the same site. Comparisons can be made if the sample sites are different. Possible collection sites are: the garden, the playground, a wooded area, a grassy area.

Once the groups have their samples, instruct them to do a preliminary exploration of the sample. Using the soil observation sheet provided have the students list sensory words that describe the way their soil sample looks, feels, sounds (pinch a bit close to your ears) and smells. Then using a hand lens, have the students carefully examine the soil and list all of the ingredients they find. Ask the students to group the ingredients together in a way that makes sense to them. Their groupings might be, plant parts, animals/insects, minerals/rocks. A grouping called "dirt" is not acceptable but leads nicely into a discussion on decomposition. The finer material that is unidentifiable is really the plants, animals and rocks after time has decomposed and weathered them.

Give each group an opportunity to share their discoveries with the rest of the class. Ask students, "Is soil alive? (Very much so. This will become more evident to the students after the lesson on the formation of soil). How? (Soil is composed of thousands of living organisms. Some we can see with our eyes, others can only be seen with a microscope.

These organisms are very important as you will see when we continue our exploration of soil in the future.) Do all materials in soil decompose at the same rate? (No. That is why you can clearly identify some ingredients but cannot recognize others). Which do you think decomposes faster, a leaf or a thick twig? What would earthworms do for the soil? If we did not have soil would there be hamburgers? (No. Cows eat grass and grass needs soil)."

Journal Suggestion

1. Have the students copy the group list of soil ingredients in their journals.

2. Have the students use the sensory words they used to describe their soil sample to write a Soil Poem.

The Ode to Soil

Dark
Soft
Gentle rainfall

Soil Observation Sheet

Names:

Use your senses to describe the characteristics of your soil sample. Our soil sample:

LOOKS LIKE

FEELS LIKE

SOUNDS LIKE

SMELLS LIKE

List all of the ingredients you find in your soil sample.

Group all of the ingredients into three major categories.

Earthworms
Living Plows of the Soil

Objective: To illustrate the role of earthworms in the garden.

Materials Needed: two terrariums or glass containers (large glass jars can sometimes be found at restaurants), earthworms (can be collected almost anywhere there is rich soil—try your garden), clay, sand, soil, organic matter, black paper to cover one container.

Read the following to students as an introduction:

> Can you imagine eating your own weight in food every day? That's what the earthworm does! The earthworm improves the soil by recycling it through it's digestive system. As soil passes through the earthworm, it is changed into a material (recycled soil) that plants like. Earthworms deposit this recycled soil on the earth's surface in the form of soft pellets called castings. These castings are good fertilizers for the soil. While earthworms eat soil, they make tunnels in it. They shove their heads into the soil and push to make an opening, taking mouthfuls of soil as they go. These tunnels are also very important to plants because they allow air and water to reach the roots more easily. Let's watch these living plows at work.

Set up two containers in the identical way by layering the clay, sand, soil, and organic matter. The clay and sand layer on the bottom should each be about one inch thick. The soil layer should be about five to six inches thick, and the organic matter on top about two inches thick.

Place three or four worms in only one of the containers. Keep the soil of this container slightly moist. Too much water will drown the worms.

Have the students describe and draw pictures of the soils of both containers in their journals. Ask students to write what they predict will happen to the soils.

Cover the worm container with black cloth or paper. Allow air holes for breathing. Remove the black cloth daily over the course of two weeks to observe the effect of earthworms on the soil. Can you see their tunnels? Did the earthworms go into all of the layers? What type of environment do you think earthworms prefer?

Return your earthworms to the garden after observation. If you decide to keep them through the winter, be sure you feed your worms lots of organic matter. Leaves, lettuce, humus is all good food for worms.

Adapted from: *The Growing Classroom,* curriculum by the Life Lab Science Program, 1156 High Street, Santa Cruz, CA 95064.

Knots
A Cooperation Game

Purpose
To develop the skills of cooperation and group problem-solving.

This exercise has students form a web with their connected hands. They are then challenged to untangle the knot without speaking or dropping hands.

To form the human knot give these instructions to the group:

Stand in a circle shoulder to shoulder.
Place your hands in the center.
Close your eyes.
Grab two other hands, as if shaking hands.
Make sure that no one holds both hands with the same person, or holds the hand of a person right next to them.
Now without speaking, or disconnecting hands, open your eyes.
Untangle the knot without speaking or breaking hands.
Occasionally a knot is too difficult to untangle. If that is the case, try again. A variation on this would be to allow students to speak while untangling the knot.

Questions
How did it feel when you were stuck: Did everyone have to contribute to the solution of this task? What does cooperation mean? What is a problem? Can you name some ways people work together to solve problems?

Adapted from *The New Games Book,* by Andrew Fluegelman. A Dolphin Book / Doubleday and Company, Inc., Garden City, New York.

September

Lesson 4: Putting the Garden to Bed for the Winter

Time Frame
35 minutes

Objective
To prepare the garden for winter by cover cropping and/or mulching.

Materials Needed
Winter rye seed (2.5 pounds per 1,000 square feet) and/or leaf mulch, rake.

Vocabulary
Cover crop, sowing, mulching, mulch.

Notes to the teacher on preparing the garden for winter.
Cover cropping is the practice of growing and turning under special crops which fertilize the soil and improve its texture. It also helps to prevent soil erosion. Winter rye is a cover crop that can be sown late in the growing season. Many others, such as annual rye, buckwheat, and sweet clover need a longer growing time before the first frost. The problem with winter rye is that it tends to return after it has been turned under in the spring at which time it becomes a weed. One way to minimize this is to turn it under early in the spring when it is about six inches tall. The rye will tend to break down a little faster if you add a little bit of composted manure as you turn it under.

The idea of preparing a garden for winter is to put a protective cover over the soil, preferably one that will enhance the fertility and texture of the soil by spring. A leaf mulch also works well as a winter cover. The leaves must be partially decomposed. Fresh leaves will just blow away. You could experiment with both. Sow winter rye over part of the garden, leaf mulch over the rest. See if one results in greater production of your garden vegetables. For more information on cover cropping call or write the New Alchemy Institute. If you are located close to New Alchemy you could get your supply of seeds and mulching material from there.

Procedure
Lead the following discussion with the students on preparing the garden for winter:

> "This is the time of year that nature is preparing for winter. We must prepare our garden for winter by making sure it has a protective cover over the soil. One way to protect the soil from the harsh weather ahead is to plant a cover crop. A cover crop is a special plant that will add nutrients into the soil just by growing. Just like we need nutrients to grow, garden plants need them too. We can make sure our soil is rich in nutrients in the spring by growing a cover crop in the fall. The cover crop we will plant today is called winter rye. Its a crop that can live through the winter in spite of the shortening of the daylight hours and the freezing soil temperatures. In the spring the winter rye will be the first plant we see in our garden. When it gets to be about six inches tall, we will break it up with our tools and turn it over into the soil. As it decomposes, it will release important nutrients that garden plants like. Let's go out to the garden to sow the winter rye."

Go outside to the garden area and gather students around you in a circle. Explain that sowing seed means to evenly spread the seeds over the growing area. Pass around some winter rye seed to show the students how small they are. Explain that winter rye is a type of grass and will look a bit like lawn grass that has not been mowed by the spring. Because the seeds are so small, we have to be very careful when we are spreading them over the garden. The method of sowing we will use is called the pinch method. Follow me to the garden where I will demonstrate.

The pinch method of sowing seed.

1. Place a small amount in the hand that you don't use to write with.
2. With your other hand take a small amount of the winter rye between your thumb and first two fingers and pinch it over the area you want to sow. The idea is to spread the seed evenly over the garden.
3. Give each student an equal amount of garden space to sow. You may want to delineate sowing areas by drawing boundary lines in the soil with a stick or the handle of a garden tool.
4. Distribute the winter rye seed and let the students **sow to it!** Monitor carefully to avoid plops of seed.
5. After the seed has been sown have the students gently rake their area to scratch the soil surface and assure even distribution of the seeds.
6. Then to assure good contact between the seed and the soil have students lightly walk over their area. You don't need to water.

Spread leaf mulch in a similar manner making sure the soil is evenly covered. You won't use the pinch method but make sure the cover of leaves is at least three inches thick. The leaves you use should be at least eight months old. In the spring if the leaves are black and falling apart they can be mixed into the top four to six inches of soil to add nutrients and organic matter. If the leaves have not decomposed enough by spring, they can be raked into the walkways to help keep the weeds down.

Journal Suggestions

1. Have students talk through the process of putting the garden to rest for the winter. Have them discuss the reasons for each step. Have them write directions for how to "put a garden to bed."

2. Brainstorm a list of other possible mulching material or different cover crop seed that could be used to protect a garden through the winter. Have them write their list in their journal.

3. Have the students make a list of all the things they noticed while they were in the garden. Did you hear birds singing? What colors did you notice around you? What was the weather like? What did you like about doing the garden work today?

4. Write a short story about an animal preparing for the coming winter.

5. Think about ways you and your family are preparing for winter and write these things down.

Magic Bug Eyes

Objective: To develop observation and recording skills.

Materials Needed:
String (about 20 inch lengths for each child) or rulers, journals, hand lenses

Procedure: Take your class to the garden or a place on the school grounds covered with different kinds of vegetation. Tell them you are going to give them "magic bug eyes" to use to explore 20 inches (or 12 inches if using rulers) of their very own miniature world. Have the students lay out they're string anyway they want to in the place of their choice. The string could be straight or curved or climb up a plant or drop down a ditch. Give each student a hand lens and instruct them to get on their hands and knees, bend close to the ground and peer through the lens. Now tell them to imagine they are a small bug crawling along the grass, moss, leaves or whatever they have focused on. If they come across an actual insect in their travels, encourage them to follow it and see where it goes and what it does along the way. Look closely at the plants on the trail. Notice their leaf shapes, edges, textures, colors.

Have students use their journals to write down the interesting things they see. Encourage them to draw a map of their bug trail indicating the points of interest. Have students share their findings by giving guided tours of their trails.

From: *Chickadee Chatter Environmental Curriculum* developed by Gus Link for the Manomet Bird Observatory, Manomet, MA 02345.

Sinking Ship

Objective: To develop communication and problem solving skills.

This exercise is designed to have students solve a problem in a cooperative manner through the use of a simulated disaster. Divide the class into small groups and read the following:

As a field trip, your group has taken a boat ride to see some islands which lie off the Cape Cod coastline. The boat comes in close to large island. We know that this island is deserted; there are no people on it. We do not know if there are animals on the island or if there is water on the island. From your boat, you can see that there are some trees and greenery on the island. Suddenly the boat scrapes along a large rock which tears a hole in the boat's bottom. The boat will sink in 30 minutes. Fortunately, there is a small lifeboat that you can use to get to the island, but it is not big enough to sail on the open ocean back to Cape Cod. There is room for all the people in your group and for five things that you can take with you from the larger boat. Your group must decide which five things you will take with you on the lifeboat to the island. Make a list of the five items and number them in order of their importance. All decisions made must be a group decision.

On the blackboard write the following list of things found on the boat.

1. Five jugs of water
2. Rifle and ten boxes of bullets
3. Canvas sail from the boat
4. Fishing rod and tackle
5. One box of kitchen matches
6. Ten flare kits
7. Axe
8. Knife
9. First aid kit
10. Pair of rabbits

Give your students about ten minutes to make their decisions. Have each group share their choices and their reasons for them with the class. There are no right or wrong choices. The group decision making process is the focus of this activity.

Adapted From: *The Growing Classroom*

OCTOBER

NOW IS THE TIME TO CONSIDER...

1. Arranging a field trip to Beebe Woods. See Optional Activities for Lesson 1.

2. Calling in Beth Schwarzman of the USGS office to present a lesson on the glacial formation of Cape Cod. See Optional Activites for Lesson 1.

3. Having the compost bin finished or designating the area for a free-standing pile.

4. Beginning to gather compost material. Ask the cafeteria to save vegetable scraps for one day. One day's collection should fill a garbage bucket. Begin collecting the day before you build the pile. Any longer, and the decomposition process will begin in the garbage bucket (not a pretty sight). Ask the cafeteria people to save only vegetable scraps. Avoid bread soaked with meat juice, meat , bones and fat. These things will attract animals.

   Other compost materials you will need include leaves, weeds, lawn clippings, crop residue, animal manures, straw—in short, any plant material or manure that you can find. Use what is readily available, but be sure you have a supply of bacterial activators. See the background information on composting for a detailed account of the process and material needed.

5. Acquire a few shovels, pitch forks and a water hose for building the compost pile.

Lesson 1: From Rocks and Life to Soil: Soil Formation

Time Frame
35 minutes

Objectives
To discover how rocks and organic matter become a part of soil.
To recognize decomposers as a part of the soil formation process.

Materials Needed
Samples of soil ingredients before decomposition and weathering has taken place (rocks, sticks, grass, insect remains, etc.), a piece of cloth, two small soft rocks like sandstone, a small piece of sandpaper, transparency or diagram of Life in the Soil (found in manual), overhead projector if using diagram as a transparency, pictures of glaciers, rivers and/or streams.

Vocabulary
Glacier, bacteria, decomposers, organic matter, weathering.

Procedure
Drawing from the previous soil exploration lesson, generate a list of the ingredients found in a soil sample on the blackboard with your students: leaves, sticks, roots, bugs, grass, rocks, etc. Take the soil ingredients that you have collected and pour them onto a cloth. Tell the students that all the ingredients that make up soil are right here in the cloth. Wrap the ingredients in the cloth and shake them up. Unwrap the cloth and show the results to the students. Ask, "Is this soil? What's missing?" Lead the students to discover that time is missing. "It takes 500 years to make one inch of topsoil! Time is needed to weather the rocks down. Time is needed to decompose the plants and animals. Let's take a look at how rock becomes a part of soil through weathering and how plants and animals decompose."

Begin by telling the story of how rocks have been weathered throughout time. This story will be greatly enhanced with pictures of glaciers on mountain tops, rivers and streams.

"For many millions of years weather has been breaking and carving the rocks of the earth. During the great Ice Ages, mile-deep glaciers of ice and snow covered much of the United States. These giant bulldozers pushed across mountains picking up large rocks and anything in their path. The weight of the glacier crushed the rocks into smaller and smaller pieces. When the earth began to warm up, the glaciers began to melt, and the resultant water washed the glacier sediment across the Midwest and eastern United States. Slowly, over millions of years, the rocky surface of the earth was broken down into the small pieces that are part of our soil.

Can you name and describe other ways in which rocks weather into small pieces to become a part of our soil?" Possible answers might be:

Rivers and streams: As water rushes down rivers and streams, it loosens small rocks and carries them along, pounding them against bigger ones, chipping off pieces, grinding them against one another, rubbing and scraping and wearing the rocks down into smaller and

smaller pieces." Rub the two soft sedimentary rocks together to demonstrate how a fine powder is made.

"Ice forming in the crack of a rock will expand and break smaller pieces off. Why do roads get potholes in the winter? Have you ever put a glass bottle filled with a liquid in a freezer? What happened?"

Wind picks up sand and blasts it against other rocks smoothing the rock surfaces, much like sandpaper smooths wood surfaces." Have students sandpaper a stone and watch the dust form.

"Now let's see how plants and animals decompose to become a part of the soil."

Show transparency of "Life in the Soil" or handout the diagram of the same.
Ask students to identify the animals living in the soil and to speculate on how their living habits help dead plants and animals decompose. "Worms actually eat soil digesting all that is in it. Earthworms recycle and concentrate decomposing organic matter as the eat their way through the soil. Burrows made by moles and other soil organisms bring in water and air that speed the process of decomposition. Snails eat leaves that drop on the soil surface."

Have the students focus on the small decomposers and say:
"The largest group of decomposers (organisms that eat dead plants and animals) are bacteria. These microscopic organisms are everywhere in the soil, air and water. Look at the bacteria in the diagram. They are so tiny that one spoonful of soil can contain more of these creatures than there are people on earth. These decomposers use dead plants and animals as food. When something dies, bacteria begin to eat it. They eat and grow and multiply so rapidly that in a very short time millions of them are working on the dead plant or animal. It is their eating which causes what we call decay or decomposition. Think about all the leaves and trees that fall to the ground each year. Think about all the animals, big and small, that die in nature. Think about all the food scraps we throw away each day. Now imagine a world without decomposers. What would it be like?"

For reinforcement of the process of soil formation ask: "Who can explain one way in which soil is made from rocks or organic matter? Is soil alive?"

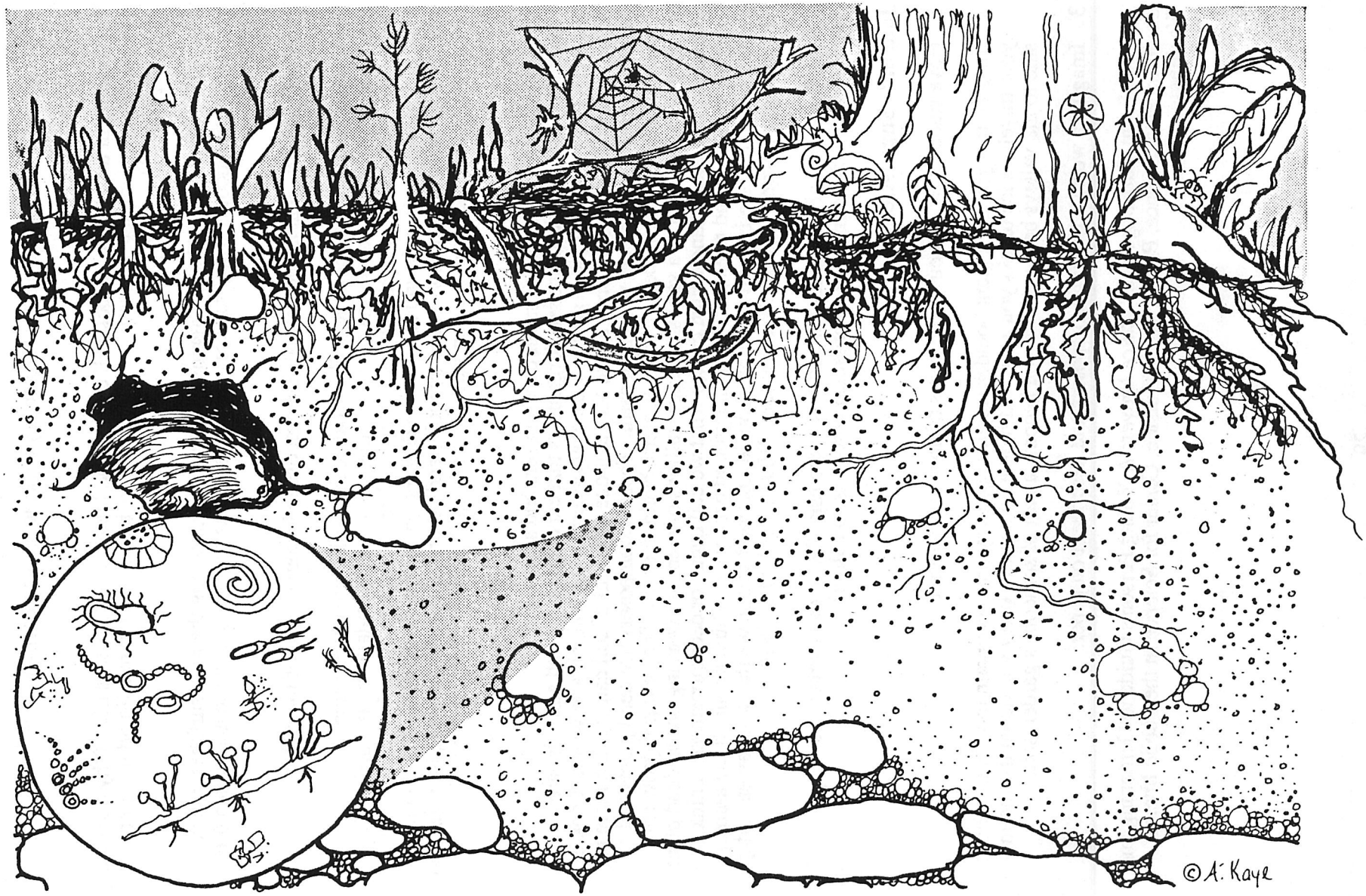
Journal Suggestions

1. Have students write their impressions of how soil is formed.

2. Imagine that you are a giant boulder weathering away on a mountain top. Write about your travels as ice breaks you apart and mountain streams carry you down the mountain side to the valleys below where you become a part of someone's garden soil.

3. Imagine a world without decomposers and describe it on paper.

Adapted From *Ladybugs and Lettuce Leaves:* A Young Person's Guide to Gardening and Environmental Science, Project Inside/Outside, Center for Science in the Public Interest, Washington, D.C.



Life In The Soil

How Did Glaciers Form Cape Cod?

Invite Beth Schwarzman from the USGS to come to your class and give a lesson on how glaciers formed Cape Cod. She does a terrific job with this topic and really helps the kids understand what a glacier is. Her number is: (508) 540-5432 or 0595.

Look for Glacier Evidence

Take a trip to Beebe Woods to look for glacial evidence. You will find a huge erratic (glacier boulder) and a kettle hole.

Make a Glacier and Watch it Slide.

Materials Needed: milk carton, stones, dirt, cookie sheet, a catch container, water, a freezer.

Take a milk carton and cut it in half the long way. Layer the bottom third of the carton with sand, sticks and small and large stones. Fill the rest of the carton with water and put it in the freezer for the night. The next day in class layer a cookie sheet to its brim with soil and adjust it so that it can stand in a slanting position on a desk top or counter. You will need a container below the cookie sheet to catch the water running off from the melting glacier. Cut the milk carton away from the dirty ice block and explain how it represents a glacier that has picked up boulders and other debris in its path. Set the glacier on the top of the slanting mountain side (the cookie sheet filled with soil) and let it melt during the day. Observe the glacier during the day to see how it digs a valley through the mountain side. Some rocks will get left behind as the glacier melts and some will be pushed to the bottom of the mountain. The ones that are left are the erratic and the ones at the bottom form the terminal moraine.

October

Lesson 2: Soil: Plants Can't Grow Without It
Soil Types and Influence on Plant Growth

Time Frame
35 minutes

Objectives
To determine that soil supports plant life.
To experiment and determine the relationship between soil type and plant growth.

Materials Needed
Soil samples of sand, clay, and compost or pure organic matter; three planting containers of the same size (paper cups with drainage holes in the bottom will work), fast- growing seeds like beans or radishes.

Vocabulary
Aeration, nutrients, organic matter.

Procedure
Ask: "What kind of soil do you think plants like to grow in?"
Make sure the students give reasons for their answers.

Tell them, "In order for soil to support plant life it must be able to give the plant what it needs to grow. Plants need water to grow. A good soil will hold enough water for the plant's needs but will still allow some water to pass through. Plants need nutrients from the soil too—nutrients that come from organic matter. Plant roots need air. Plants also need soil into which they can really sink their roots. We can find out which kind of soil plants prefer by doing an experiment with different soil types."

Have the students examine each soil type with their eyes and fingers. Ask them to think about what plants need from soil then predict which soil type will be the best in which to grow a plant. Have the students write down their predictions and the reasons for them in their journal.

Plant four seeds in each soil type. Label the containers. Keep all other growing conditions the same. Have the students record observations of the plant growth in their journals. Which plants came up first? Which were the greenest. Which soil type would you not want your plant to be in during a drought? (Sand provides good aeration, but fast drainage. It would not hold enough water for a plant in a drought.) Which sample could possibly suffocate your plant roots? (Clay holds water very well but does not supply enough air to the roots.) Pure organic soil provides the plant with nutrients but does not provide the plant will adequate support.

After the students have evaluated and recorded the results of their experiment in their journals, have them mix up the three kinds of soils to make the perfect planting media. Plant seeds in this new mixture and record the difference in the plant's health.

Journal Suggestion

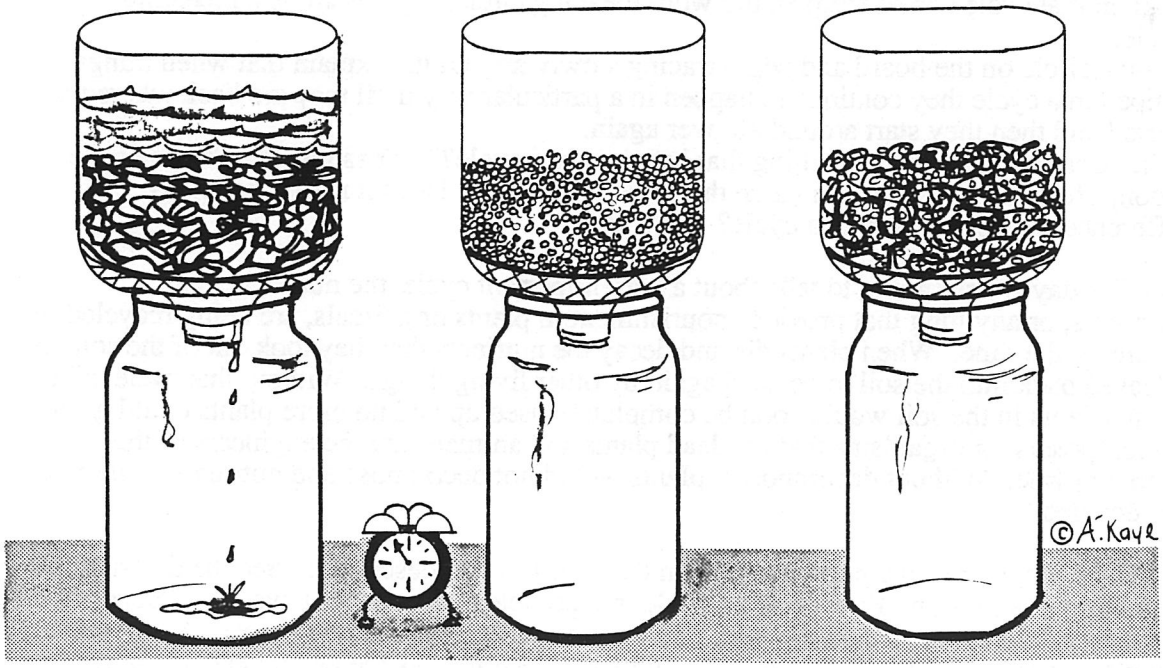
Record predictions and observations from the soil experiments. Have students draw a picture chart of the plants growth progress for each soil type. Be sure they include the dates of their observation.

Test The Drainage Capacity of Different Soils

Compare the drainage capacity of three types of soil by setting up a simple experiment.

Materials Needed: three pieces of fine-mesh screen (plastic onion bags) or nylon stocking, three plastic jugs, three clear glass jars, a measuring cup, samples of clay, sand and soil from the garden or compost.

Make three funnels out of plastic 1/2 gallon jugs as illustrated. Cover the tip of each funnel with wire mesh or plastic mesh screen (onion bags might work) or a piece of nylon stocking. Then put each funnel on a jar. Add one cup of clay soil to one funnel, one cup of sand to the second funnel, and one cup of soil from the garden or compost to the third funnel. Add one cup of water to each soil sample. Record the time it takes for the water to drain into each jar, then measure and record the amount of water in the jar. Discuss the drainage properties of these three soil samples and how they might affect plant growth. Clay soil absorbs water, while water passes quickly through sand. The garden soil or compost will probably be somewhere in between.



Lesson 3: What Goes Around Comes Around
Composting and the Nutrient Cycle

Time Frame
60 minutes (this lesson can be taught in two 30- minute parts)

Objectives
To demonstrate decomposition and the nutrient cycle.
To recognize the role of decomposers in the composting process.
To begin a compost pile for the garden.

Materials Needed
*Nutrient cycle diagram; compost materials like grass clippings, leaves, all food scraps (but no meat, bones, or fat); manures (not human), crop residues, and essentially anything that was once alive; a compost bin, a water hose, a few shovels and/or pitch forks. *Included in manual.

Vocabulary
Compost, nutrient cycle, organic matter, decomposition, decomposers, bacteria.

Procedure
Before you begin this lesson, read "Composting, A Thrilling Experience for Youngsters," following this section. It provides important background information for this lesson.

Part One: The Nutrient Cycle
Begin in the classroom by writing the word Circle on the blackboard. Ask, "What's a circle?"
Write Cycle beneath it. Ask,"What is this word?"
Rub out the IR of circle and write in Y.
Explain that cycle comes from an old word meaning circle. Cycles are just repeating circles.
Draw a circle on the board and begin tracing slowly around it. Explain that when things happen in a cycle they continue to happen in a particular way until they are back where they started and then they start around all over again.
Ask, "Can you think of something that happens in a cycle?" (Seasons, the phases of the moon, life cycles.) "Who can name the seasons in order? Does it really make any difference where you start in a cycle? Why not?"

Say, "Today we are going to talk about a very important cycle, the nutrient cycle. Nutrients, or anything that provides nourishment to plants or animals, are being recycled in nature all the time. When plants die and decay the nutrients that they took out of the soil are released back into the soil to be used again by other living things. Without this cycle, all of the nutrients in the soil would soon be completely used up and no more plants could grow. Decomposers, or organisms that eat dead plants and animals, are the engineers of the nutrient cycle. Without decomposers plants would not decompose and nutrients could not be recycled."

Draw the diagram of the nutrient cycle on the board as you describe it. See the diagram following this section. First draw an apple tree complete with its root system. "Here is an apple tree." Draw apples on the tree. "These are apples growing on the tree. Along comes a hungry person looking for an apple." Draw the person. "As the person eats the apple the

nutrients that were locked up in the apple are released in the person's body. What kind of nutrients do we get from apples? Vitamin A and C. Since apple cores decompose quickly out in an apple orchard the person can throw the core on the ground." Draw the core on the ground. "Immediately the decomposers that just happen to be there begin to eat the apple core breaking it down into smaller and smaller pieces just like the person broke the apple down with teeth. As the decomposers decompose the apple core nutrients are released into the soil." Draw big Ns to represent the nutrients. "The apple tree's roots begin to absorb the nutrients and transport them up into the trunk of the tree, the branches, twigs and leaves." Draw big Ns going up the trunk of the tree into the leaves. "The next season, the nutrients help the tree grow and produce more apples." Draw a few more apples. "Then along comes another hungry person and the process starts again." Trace the cycle with a piece of chalk around and around.

"Nutrients are being recycled wherever things are decomposing. Gardeners borrow natures great recycling plan to enrich their garden soil, but they can also speed the process up a bit by layering plant material in a pile. This garden task is called composting. Can you think of plant material around your house that is generally considered to be a waste product that we could use to make a compost pile?" (Lawn clippings, leaves, vegetable scrapes, etc.)

"We're going to start a compost pile this fall so that we can have plenty of nutrients to put into our garden soil by the spring." Go to the garden to demonstrate how to build a compost pile.

Part Two: Building A Compost Pile

The material you are going to use to build your compost pile should be ready near the composting area. The layering method described works well but is not the only way to compost. Use whatever material you have that is readily available. Remember the closer the compost is to the garden the easier it is to use. Make sure you have a hose available for watering the pile and a few shovels and pitch forks.

Get all of the students involved in the building of the compost pile by rotating the layering and watering tasks.

Have the students start the pile by loosening the soil where the pile will sit with their spading forks. If you are starting your pile on raised screening or wooden pallets, there is no need for this step. If you are building a free-standing pile, the students must loosen the ground in a 3' X 3' area.

Begin layering the material. Be sure each layer is watered down before the next is added. Without water on each layer the material will not decompose by springtime.

1. Start with a layer of dry bulky material for good drainage (corn stalks, kale stems, small branches.)
2. A nitrogen layer—green stuff (lawn clippings, leaves, stems, roots, manures, kitchen waste.)
3. A carbon layer—yellow stuff (dried grass, weeds, hay, sawdust, straw.)
4. Bacterial activators (soil, old compost, manures.)

Continue layering until the pile is at least three feet high. If you chop larger material up, the decomposition process will go faster.

Adapted from: *The Growing Classroom* .

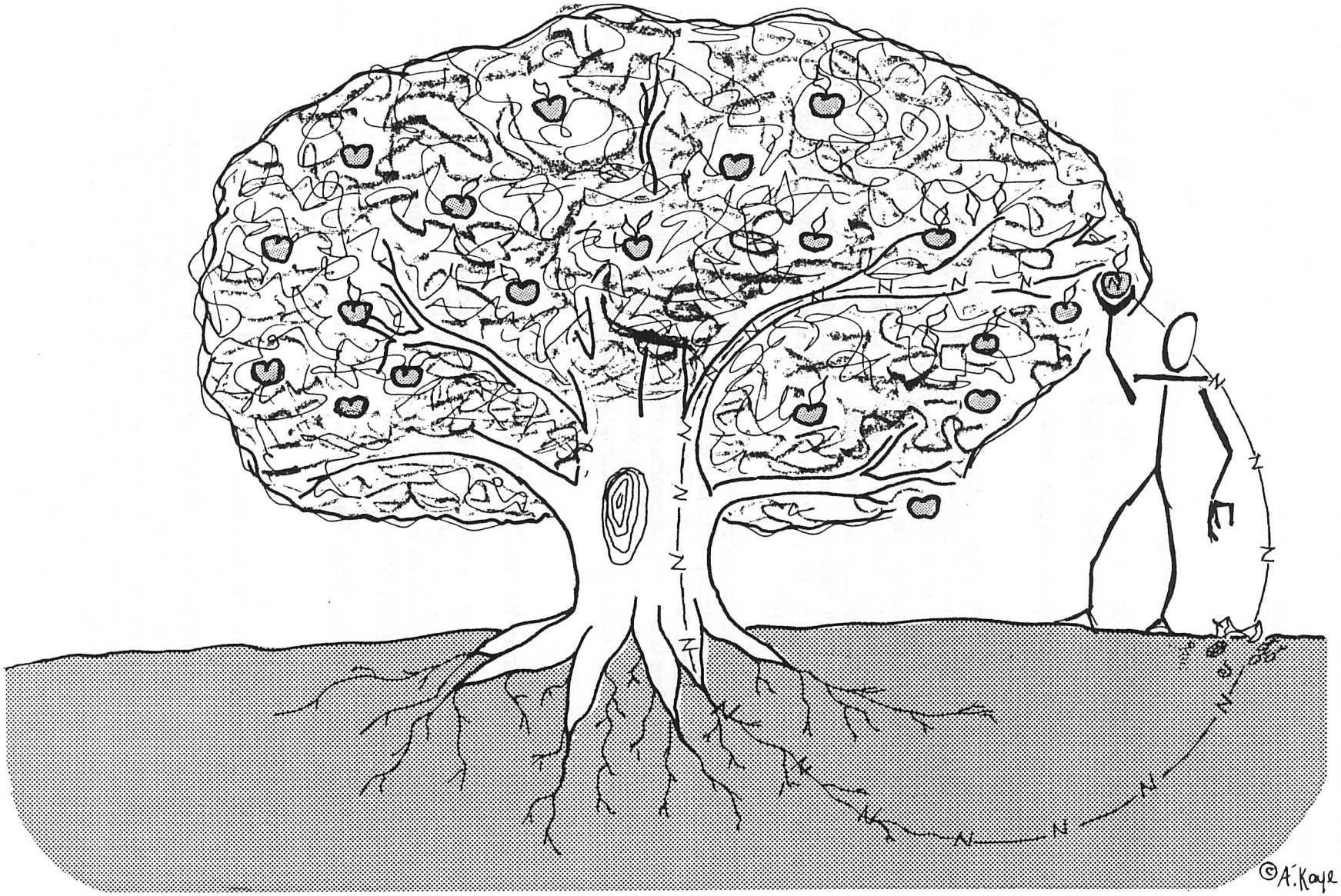
Journal Suggestions

1. Review the steps involved in making a compost pile then have the students record them in their journals.

2. Write your own explanation for how waste is really nutrients in disguise.

3. Do you belive that grass and other waste material can become food for our garden vegetables by springtime? Give your reasons for your belief.

4. Draw a picture of the compost pile now and what you think it will look like six months from now.



The Nutrient Cycle

Compost In the Classroom

While things are rotting out in your compost pile, your class can observe the decomposition process inside the classroom by making a compost bag.

Materials Needed: Plastic zip-lock baggie, small pieces of fruit, vegetables and bread; soil or manure, water.

Fill the baggie 1/3 full of soil. Place the food scraps on top of the soil. Moisten them and the soil with water. Do not over-water the ingredients. The decomposers need water and air. Too much water will create an anaerobic condition, and the bag will really start to smell! Close the baggie and shake the things up. Reopen the bag for a few seconds every two days to let some air in. Observe the baggie once a week. For a variation, add non-biodegradable objects like nails, aluminum, plastic. As observations continue, discuss the the implications of non-biodegradable waste in our environment. Continue observations for two to three weeks. When this project is completed, open the baggie outside and add the contents to the compost pile.

On the day you begin, have the students record in their journals the date and a list of the materials being used. Have them make journals entries every day that they notice a change in the materials. Describe the changes. What color is the mold or fungi that formed? How long does it take before you cannot recognize each piece of food (how long does it take to decompose)? Where did the mold and fungi come from? They are everywhere in the air and soil just like the thousands of other decomposers present in the bag that you can not see.

Reinforce Vocabulary Words by Making Anagrams

Construct an anagram, or word scramble, of vocabulary words from previous lessons and give one to each student with a list of the words to find and circle. When they have found all the words discuss and define them. When the students get the hang of this game, see if they can construct an anagram themselves, either individually or as a group.

From: *The Youth Gardening Book,* The National Gardening Association, 180 Flynn Ave., Burlington, Vermont.

Monitor the Temperature Changes of the Compost Pile

A compost pile that is built correctly will heat up to about 120 degrees. The dramatic change in heat is really exciting for students to feel. Place a compost thermometer (a soil thermometer with a long prong) into the middle of the pile. Record the temperature changes for a week. The pile will begin to cool down again after a while. If you can not get a compost thermometer, put a plastic bag over your hand and insert your hand down

into the pile until you can feel the temperature change. During cold weather, you should be able to observe steam rising from the compost pile.

Another way of monitoring temperature changes inside the pile is to lay a hose piece or pipe midway and horizontally on the compost layers when the pile is half built. Make sure the hose or pipe extends beyond the edges of the compost layers. Continue to build the pile on top of the hose or pipe to the desired height. Keep the pipe opening covered with a cork or stuff it with cloth until you want to take a temperature reading. The temperature of the interior pile can be measured by removing the opening cover and inserting a thermometer into the pipe. Students will be able to feel a temperature difference by placing their hand in front of the pipe or hose. Plug the opening again when you have finished.

Grow Microorganisms In the Classroom

Use the book, *The Smallest Life Around Us*, by Lucia Anderson to explore the world of microorganisms. The text is extremely suitable for fourth graders, the illustrations are instructive and the experiments are easy to follow and maintain. Your students will have a clear understanding of the function of decomposers after their experience with this book Crown Publishers, ISBN: 0-517-53227-1.

"Composting, A Thrilling Experience For Youngsters!"

Reprinted with permission from *The Youth Gardening Book.* A publication of The National Gardening Association, 180 Flynn Ave., Burlington, VT 05401.

We recommend that you designate a place for a composting project in your site plan. Composting is more than a way to turn organic wastes into a dark, rich, soil-building ingredient. It's a way to impress youngsters and get them excited about what one leader called "the essence of gardening."

We believe every youth garden should have some sort of compost activity—even it it's a small "baggie compost" project.

The point is, there's magic in composting. It's a process which turns "stinky things" into sweet-smelling soil, turns big chunks of organic matter into tiny pieces, and turns colorful vegetable scraps and leftovers into "black gold." And, unlike synthesized fertilizer, you simply can't use too much compost in your garden.

Some gardening leaders succumb completely to compost magic. At first they think compost piles won't actually work, or that they'd stink and wouldn't be proper near a school garden. But after building a good compost pile, and seeing the magic themselves, they become believers.

Compost piles are simple collections of plant and animal materials piled up enough to decompose through a natural heating process and the work of soil micro-organisms. Compost can be made in bins made of wood pallets, concrete blocks, snow fencing, chicken wire or even in old garbage cans with holes punched out. All bins need openings for air circulation.

A compost area at least 3 feet by 3 feet with a height of 3 feet or so is best. These dimensions allow you to organize enough material to insulate the pile, whose interior temperatures can reach 150° F. The actual size of the pile will depend on how ambitious you and the kids are and the amount of organic waste available.

Materials to use:
Grass clippings, leaves, all food scraps (but no meat, bones, or fat), manures, crop residues and essentially anything that was once alive.

Kids can also bring in organic matter from home. Also check with your street or public works department for leaves as many cities have leaf collection projects.

Building a compost cake
Start by loosening the soil where the pile will sit to provide good drainage.

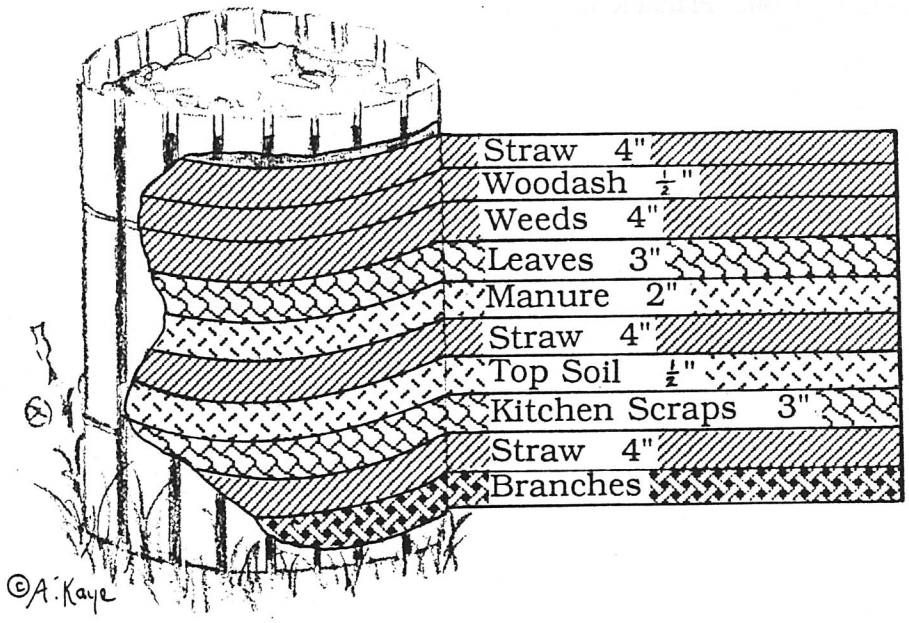
A compost cake consists of three layers. Start with a layer of dry materials on the bottom about 4-8 inches deep. Chop large materials before adding them and they will decompose faster.

Next add a 4-8 inch layer of green vegetation and kitchen wastes. On top of kitchen wastes, add a third layer of soil, but only about 1 inch or so deep.

The decomposition process uses up nutrients, especially nitrogen. To speed up the process add nitrogen-rich materials such as blood meal, fish meal, cottonseed meal or fresh manure. Two pounds of meal are enough for a big compost pile.

Keep layering until you have a pile about 3 feet tall or until you run out of materials. Be sure to cover any wet layers of kitchen scraps with soil to discourage odors and flies. To avoid visits by dogs, cats or rodents be sure to make the pile in a bin or wire organizer and cover the top.

Water the compost pile as you would the garden, keeping the material moist but not soaked. To aerate the pile, turn it with a spade or pitchfork, lifting bottom materials to the top to expose the inner materials to air. The pile should be turned after the first week and then once every few weeks over the 2-3 month period it will take to decompose.



NOVEMBER

NOW IS THE TIME TO CONSIDER...

1. Ordering the book *Corn is Maize—The Gift of the Indians.*, by Aliki. Harper and Row, 1976. This book is available at the Market Book Store in Falmouth. It can also be purchased at the Plymouth Plantation gift store.

2. Gathering wild edibles for your class. See Optional Activities for Lesson 1.

3. Inviting a cranberry grower to come talk to your students about the history of growing cranberries on the cape.

4. Invite a local Native American to come and talk to your students about their history and customs.

5. Arrange a field trip to Plymouth Plantation.

November

Lesson 1: From Wild Foods to Gardens: A History of Gardening and Native Foods

Time Frame
45 minutes

Objectives
To discover how gardening began and how it changed civilization.
To brainstorm a list of foods available to local Native Americans.
To determine how the Pilgrims learned to adapt to the conditions of the New World.

Materials Needed
Pictures of wild foods and early methods of gardening would enhance this lesson.

Vocabulary
Ancient, adapt, wild edibles, civilizations.

Procedure
Ask your students,"Do you think people have always known how to garden? No, they haven't. There was a time when people did not know how to grow their own food. They had to gather their food from wild plants and hunt animals. We are going to travel back to that time and you will see how gardening might have been discovered."

Lead your students through the following guided imagery activity. "Lay your heads on the desk with your eyes closed. Relax. Get comfortable. Let your imagination create a picture of what you hear me describe."

Pause between thoughts to give the students plenty of time to create pictures of the story in their minds.

> "We're going to travel back through time... a million years ago...when the first humans walked among the creatures of the earth. The world was very different then. This is a time before cars, machines and buildings. People lived in caves or simple shelters made of trees and animal skins...Imagine you are one of those people....Visualize the kind of home you live in...the kind of clothes you are wearing...the sort of games you play. You live with a small group of people. The men of the group hunt animals for food. The children and the women go off in search of wild plants for food. You are one of the food gatherers. You use sticks and bones to dig for roots. You gather berries and nuts in a bag made of animal skin. Much of the day is spent gathering food for the group.
>
> The group does not stay in one place for very long. You must move with the animals because the animals provide you with winter food and skins for clothes and their bones are used for tools. Just before the big move, you take one last walk through a nearby field where you often gather wild plants for food. You take a close look at one of the tall wild plants blowing in the gentle breeze, and you notice something falling from the part of the plant where the flowers once were. What you see is small, round, smooth, hard and colorful. These objects please you so you collect many of them and put them in your skin bag along with other things you cherish. You hear your mother calling you back to get ready for the move. Then the long move begins. You travel many

days to find a new shelter that is near a wintering herd of animals. The travel is slow and hard. One day the group finally comes to the new area you will call home for the next season. You settle in and wait for spring.

The days lengthen and grow warmer...the snow melts...the birds return...and you begin to see young green shoots of plants emerging from the soil. This reminds you of the pretty things you collected from the plants last fall. To thank the earth for warming and providing you with new green plants to eat, you bury your pretty things as a gift to the earth. A few days later while you are out gathering food you pass the spot where you buried your gifts and you notice tiny young plants coming up everywhere. Each day for weeks you visit the growing plants and watch them change. They soon remind you of the plants from which you gathered the pretty round things last fall. *It is the same plants*. You watch them grow tall. Then, when they are ready, you harvest all but a few of the plants. You let some remain standing in the hopes that they will form more pretty colorful things like the ones you collected. In time they do. You gather them, save them and offer them back to the earth in the spring. Again, new plants emerge which you can gather as food. You have just discovered gardening!

Now, come back to our time. Open your eyes and sit up."

Have the students share their images. Ask them, "What did your home look like? Your clothes? What kinds of games did you play? What did you like about your way of life? What did you not like?

How do you suppose your life would change after you discovered gardening? How do you suppose the people adapted to this new discovery ?"

Take this discussion as far as you think your students can carry it. Some points you might bring up during the discussion are:

1. Your food source would become more dependable. This would make it possible to support more people so the size of families would grow.

2. You would not have to move to find food. Because you would not have to move so often, you would probably build a stronger more permanent shelter.

3. Gardening required greater discipline. Seeds had to be gathered and planted at certain times during the year. Growing plants needed to be protected. The ripe food needed to be harvested and some of it stored for the winter.

4. People learned that growing food for survival meant that they were very dependent on the sun, soil and the rain. Many of the early people worshiped the earth and the elements for this reason.

5. Writing originated from the need to keep agricultural records. Civilizations rose! Villages developed around fertile land; then cities, and with them art, language, mathematics and governments.

Lead into the next discussion:

"It took many years to develop gardening to the art and science that it is today. Gardening knowledge has been passed down from one group of people to the next throughout the years. Who do you think the first gardeners were on the Cape? The Native Americans were the first gardeners here on the Cape. They are the ones who

taught the Pilgrims how to grow food here in America. Most of the Pilgrims lived in towns back in Europe and had never grown their own food. They would have not survived in the New World without the help of the Native Americans. They learned about many of the wilds foods that grew in Massachusetts like cranberries, Jerusalem artichokes, wild onions, Concord grapes, blueberries and sassafras roots. The Pilgrims also learned how to grow crops for their survival.

The Native Americans grew plants from seeds that came from people who lived further south. What kinds of garden crops do you think the Indians were growing? Corn, squash, beans, pumpkins, tobacco.

What kinds of tools do you think they used to make their gardens? They used sticks, shells and rocks.

What do you think they used as a fertilizer? They would bury a dead fish in a hill then plant corn, beans and squash on top of it. The three plants in the hill were called the "Little Sisters." The corn provided the pole for the beans to climb up. The beans added nitrogen to the soil needed by the corn. The broad flat leaves of the squash plants kept the weeds down and the vines discouraged raccoons from stealing the corn. Raccoons don't like to get their feet tangled in the vines.

The Pilgrims were so thankful that the Indians taught them how to survive in the New World they held a great celebration. What was it called? Thanksgiving.

What types of food do you think they had at the celebration?
What kinds of food do we have today for this celebration? Which ones would have been impossible for the Pilgrims to have eaten?

Today, you can grow your own food and learn as people did in ancient times how we depend on the sun, soil and plants. Pass on what you discover to your friends and neighbors and become part of the history of gardening."

Journal Suggestions

1. Draw a picture story showing ancient gardening practices.

2. Make a list of the foods that you associate with Thanksgiving. Circle the ones it would have been impossible for the Pilgrims to have eaten.

3. Write down three things that you learned from today's lesson. Start your sentences with, "I learned...."

Reinforce the Lesson with a Story

Read *Corn Is Maize: The Gift of the Indians* , written and illustrated by Aliki. A Harper Trophy Book, Harper and Row Publishers. This book is available through the Market Bookshop in Falmouth.

This story reinforces the guided imagery exercise with beautiful illustrations and a clear, descriptive narrative. It is the story of where corn came from—how it evolved from an ancient plant with a tall stalk and one ear at the top, to the multi-eared plant that we are familiar with today. The pictures illustrate the wild corn plant, ancient planting methods, the many uses the Indians found for the corn plant, some ancient corn gods and rituals, and how the Indians saved the Pilgrims by teaching them how to survive in the New World.

Have a Wild Feast

Gather some wild edibles native to Massachusetts to share with your class. Be sure to stress that they should never eat a wild plant unless it can be identified 100 percent correctly. Some wild plants are poisonous, but many are really quite good. Some examples of the wild edibles around Cape Cod are:

Rose Hips. They can be found near beaches as late as November. Jelly and tea are often made from this fruit.

Jerusalem Artichokes. They grow along many roadsides and fields. The part of the plant that you eat grows underground and tastes like a nutty potato. New Alchemy also grows them. Call the Children's Department at New Alchemy to see if there is a supply available for your classroom.

Cranberries. Make a cranberry cake and talk about how the Native Americans prepared them. They crushed cranberries with dried deer meat and melted fat to make pemmican—a convenient food that could be kept for a long time. They believed that the cranberry had medicinal properties and brewed cranberry poultices to draw poison from arrow wounds. Women made their rugs and blankets colorful with the red juice. Some Native Americans called cranberries "ibimi"—a bitter berry.

Take Advantage of Local Resources

Invite a cranberry grower to come to your class and talk about how cranberries were grown in the past and how they are grown today.

Invite a local Native American to come a speak about their culture.

Take a field trip to the Plymouth Plantation.

DECEMBER

NOW IS THE TIME TO CONSIDER...

Ordering seed catalogs for your class.

We recommend that you use the Johnny's Selected Seeds catalog from Albion, Maine. These seeds are organic and have a good germination rate. The catalog is fairly easy to read and most of the varieties are pictured. The company will send you a number of the catalogs for no charge. For seed variety we have included other seed companies with addresses below.

Johnny's Selected Seeds
Foss Hill Road
Albion, Maine 04910
(207) 437-4301

Stokes Seeds, Inc.
P.O. Box 548
Buffalo, New York 14240-0548

Vermont Bean Seed Company, Inc.
Garden Lane
Fair Haven, Vermont 05743

December

Lesson 1: From the Farm to the Table: Food Systems in the United States

Time Frame
45 minutes

Objectives
To determine where different foods are grown in the U.S.
To trace the steps involved in getting food from the farm to the table.
To discover that buying locally grown produce saves energy and supports the local community.

Materials Needed
*The following handouts for each student: United States map, "How Far Did Your Breakfast Travel?", "Imported Foods That Could Be Grown in Massachusetts: a ruler for each student, a large class map of the United States with the names of the states printed on it, *four Food System cards (These can be glued onto cardboard and laminated for greater durability.) Four paper dollars or something to represent the same. *Included in manual

Vocabulary
Climate, weather, local, transportation, distribution, community, energy.

Procedure
Start by asking your students, "What is your favorite real food to have for breakfast, lunch or diner?" Steer them away from junk food answers.

Make a list on the black board of the answers called out. Star any vegetables or fruit mentioned.

Say, "But this is December and not the growing season here on the Cape. How do we get vegetables and fruit in the winter? Where does the corn for our corn flakes come from?—the pigs for our bacon?—the cows for our beef?"

Lead students to discover that people of Massachusetts depend on other growing areas for over 90 percent of their food. This is true even in our growing season.

Facilitate the following discussion:
"At certain times of the year we must get most of the food we eat from other places in the United States. We are lucky that we live in a country that has many different climates.

What is the difference between the climate of an area and the weather? The climate of an area is the average weather condition of a place. It is determined by the average winter and summer temperature and the average amount of rainfall yearly. Weather is the condition of the sky at any moment and place. For example, the desert will always have a hot and dry climate but it could rain in the desert on a particular day. We would say the climate of the desert is hot and dry but the weather is rainy today.

Climates are very important because they determine the type of plants that can be grown in a particular area."

What type of food comes to mind when you think of Florida? Oranges. Florida has the right kind of climate to grow oranges. Oranges can withstand very high temperatures. They need winter temperatures above 40 degrees and moist soil.

Now find Massachusetts on the map. How would you describe the climate here? The average winter temperature is 25-35° F—cold. The average summer temperature is 70° F—warm. The average yearly rainfall is 44 inches.

What kind of food comes to mind when you think of Massachusetts? Apples. Apples need 45 days below 45° F and can withstand periods of dry weather. Massachusetts has a good climate for growing Apples.

Because we live in a country with so many climates we are able to to get vegetables and fruits when it is not our growing season."

Tell your students that you are going to write a breakfast menu on the board and they will determine how far it traveled to get to their table.

"Today's breakfast will be: corn flakes, toast, bacon, melon, home fries and orange juice, walnuts."

Once the menu items have been established ask the students to determine the major components of each breakfast item. Write these components on the black board next to the breakfast items.

corn flakes:	corn, sugar from sugar cane, milk
toast:	wheat
bacon:	pigs
melon:	melon
home fries:	potatoes
orange juice:	oranges
walnuts:	walnut trees

Give each student the handout, "How Far Did Your Breakfast Travel?" Explain the handout. Ask them where a few of the food items are grown. Help them to define "locally" as being any place in Massachusetts. Instruct the students to choose a growing area for the first food item of the breakfast menu. It is up to them to pick a growing area when more than one state is given. Once they choose the state they want the food item to come from, they should circle that state name on the handout to indicate their choice.

Give each student a map handout.
Instruct the students to find the state where the first breakfast item was grown. Pull down the class map of the United States or have them look at a map in their social studies book if they need help locating the states. Once they find the state have them draw a symbol representing the food item in the middle of the state and place a dot next to the symbol. When all have successfully completed the steps for the first food item, instruct them to do the same for all of the breakfast items on their menu.

Next have students locate and mark with a dot the approximate location of their hometown on the map. Have the students draw a line from the dots indicating the source of the food items to the dot locating their hometown using their rulers. Have the students determine and make note of which lines are shortest and which lines are longest. Turn this into a math lesson by having the students use the scale of 1 inch = 375 miles to determine the

distance each food item traveled. Have the students calculate the distance of each food item and the total distance of the entire breakfast.

Continue the discussion.
"Whenever we get food from another state, we say that it is imported. Massachusetts imports over 90 percent of its food. During part of the year, we must do this if we want to eat fresh vegetables and fruit, but during our growing season, we could grow a lot of the vegetables and fruit that we import."

Give each student the handout, "Imported Foods That Could be Grown in Massachusetts."
"Here is a list of all the food we import that we could grown during our growing season. Which do you think would be fresher? A head of lettuce from California or a head of lettuce grown in Massachusetts?

We save energy and support our community when we buy food that has been grown locally. I am going to call five of you up to the front of the class to help demonstrate what we mean by this."

Give the first student in line the potato plant card. Explain the following:
"This is a potato farmer growing potatoes out on a farm in Idaho. Who can find Idaho on the class map? Idaho is about 2652 miles away. This potato farmer harvests all of the potatoes and transports them to the nearest distribution center. Other Idaho potato farmers do the same."

Hand the second student the distribution center card.
"At the Idaho distribution center, potatoes from all of the farms are put on big semi-trucks and transported across the country."

Hand the third student the semi-truck transportation card.
"The potatoes are taken to the supermarket where you and your family drive to get them."

Hand the fourth student the supermarket card.

"So, now we need a hungry shopper coming to buy a bag of Idaho potatoes."

Select another student to come forward and hand her/him four paper dollar bills.
"Here is your money to buy the Idaho potatoes. When you buy these potatoes your paying for all the steps involved in the process of getting the potatoes from the farm to your table. So part of your money goes to the supermarket. Give one dollar to the student holding the supermarket card. You are paying not only for the potatoes, but for all the energy it takes to keep the supermarket operating. What kind of energy is being used here? Energy to run the electricity for the cash registers, the lights, the coolers, the freezers, the automatic doors, etc. You are also helping to pay the people's salaries who work in the store.

And you are paying for the transportation costs involved in getting the potatoes from Idaho to Massachusetts. Give one dollar to the student holding the semi-truck card. What type of energy is being used in this transportation stage? Gas and oil to fuel the truck.

You are paying for the operation at the distribution center where the potatoes are stored before they are transported out. Give one dollar to the student holding the distribution center card. Any energy costs here? Electricity, gas and oil to run the machinery that moves the potatoes around. The potatoes are also bagged by machines here.

Some of your money pays for the transportation costs from the farm to the distribution center. What are the energy costs here?

Finally, some of your money goes to the farmer. What kind of energy was used to grow the potatoes on this farm? Gas and oil for the farm machinery and fertilizers. Fertilizers are petroleum products.

Not much of your money stayed in your own community. Most of it went out to people in Idaho. What would happen if you bought potatoes from a local farmer on the cape? What steps could be eliminated? All of them except the last one if you bought them at a farm stand."

Collect all the money and give it to the local farmer holding the potato card.
"Now the local farmer has more money that s/he can spend in her/his own community. How many of your parents work for a local business?"

As students raise their hands to describe the type of local business their family is a part of, have the farmer buy something from them with the paper money. In this way the students can see how the money they spent on the potatoes is returned to the community through the business their families are associated with. Conclude by restating:

"Energy is saved and our community is supported when we buy locally grown produce. Local produce is often available to us during our growing season. Look for signs that say Native Produce or Locally Grown in the supermarkets during the summer. Buy from local farm stands on the side of the road."

Journal Suggestion

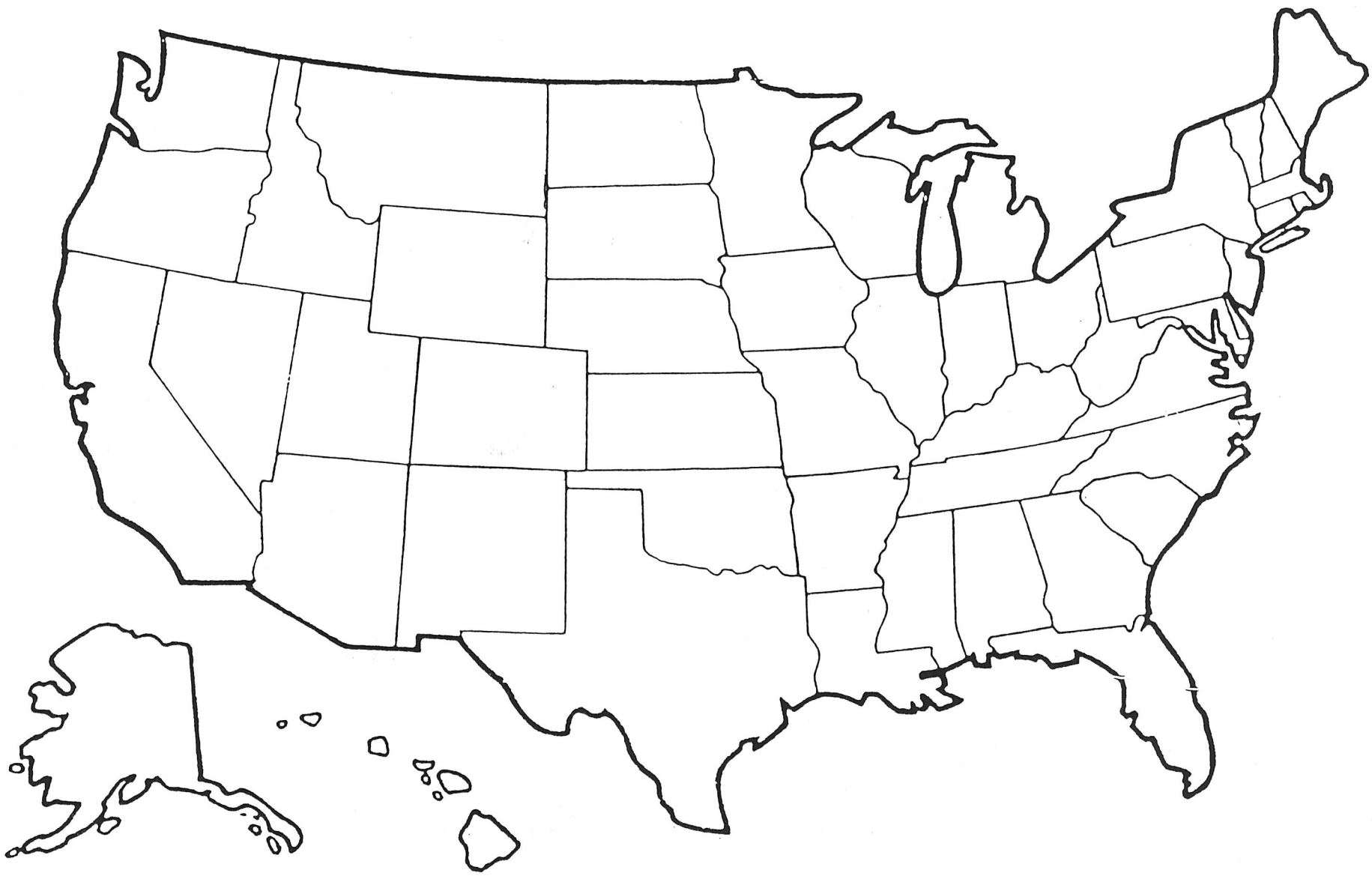
1. Write a paragraph explaining all the steps involved with getting potatoes from a farm in Idaho to the Cape. Start with planting the potatoes on the farm. Work with a partner. Check each other to make sure you don't leave out any steps.

HOW FAR DID YOUR BREAKFAST TRAVEL?

Location of Foods Grown In the U.S.A.

FOOD	LOCATION
ORANGES	CALIFORNIA, FLORIDA
WHEAT	KANSAS, NORTH AND SOUTH DAKOTA
SUGAR CANE	HAWAII, CALIFORNIA
PORK	INDIANA, IOWA, NEBRASKA
MELONS	CALIFORNIA, FLORIDA
DAIRY PRODUCTS	WISCONSIN, MINNESOTA, NEW YORK PENNSYLVANIA, LOCALLY
POTATOES	WASHINGTON, IDAHO, MAINE
CORN	IOWA, INDIANA, NEBRASKA, LOCALLY
WALNUTS	OREGON

MAP OF THE UNITED STATES



Note Alaska and Hawaii are not to scale.

IMPORTED FRESH VEGETABLES AND FRUITS THAT COULD BE GROWN IN MASSACHUSETTS

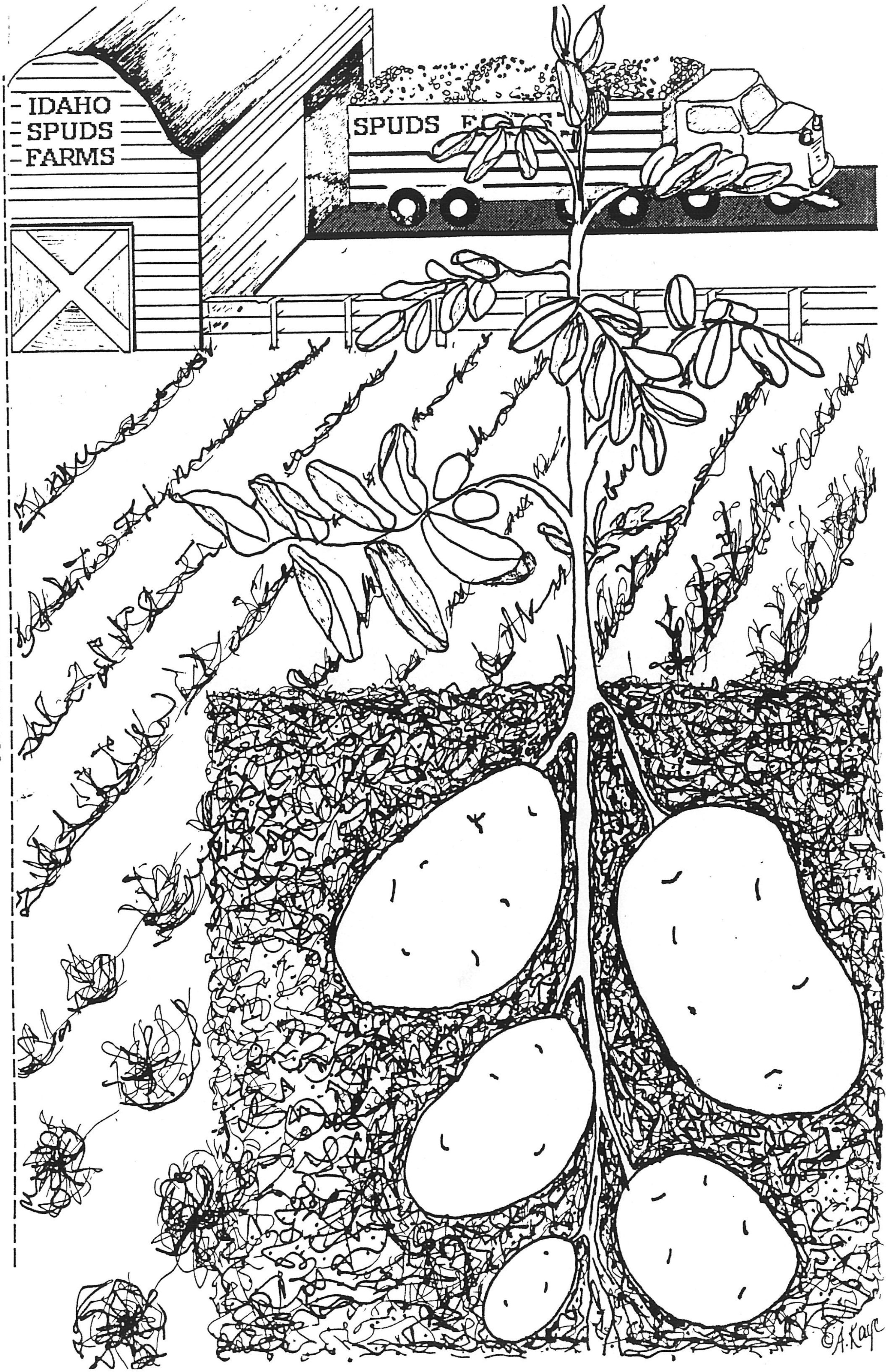
VEGETABLES	FRUITS
Asparagus	Apples
Broccoli	Blueberries
Cabbage	Cherries
Carrots	Grapes
Cauliflower	Melons
Celery	Peaches
Cucumbers	Pears
Eggplants	Plums
Lettuce	Strawberries
Onions	
Peppers	
Potatoes	
Snap Beans	
Spinach	
Tomatoes	

Visit a farm stand this summer to buy fresh local vegetables and fruits. Below you will find two local farm stands. You can find many more farm stands near by. Keep your eyes open for them. Look for locally grown food in you grocery store too.

Blueberry Acre Farm. 608 Route 6A, East Sandwich. Fresh, local fruits and vegetables 888-7114.

The New Alchemy Farm Stand. 237 Hatchville Road, East Falmouth. Variety of fresh vegetables and cut flowers.

CUT ALONG DOTTED LINE



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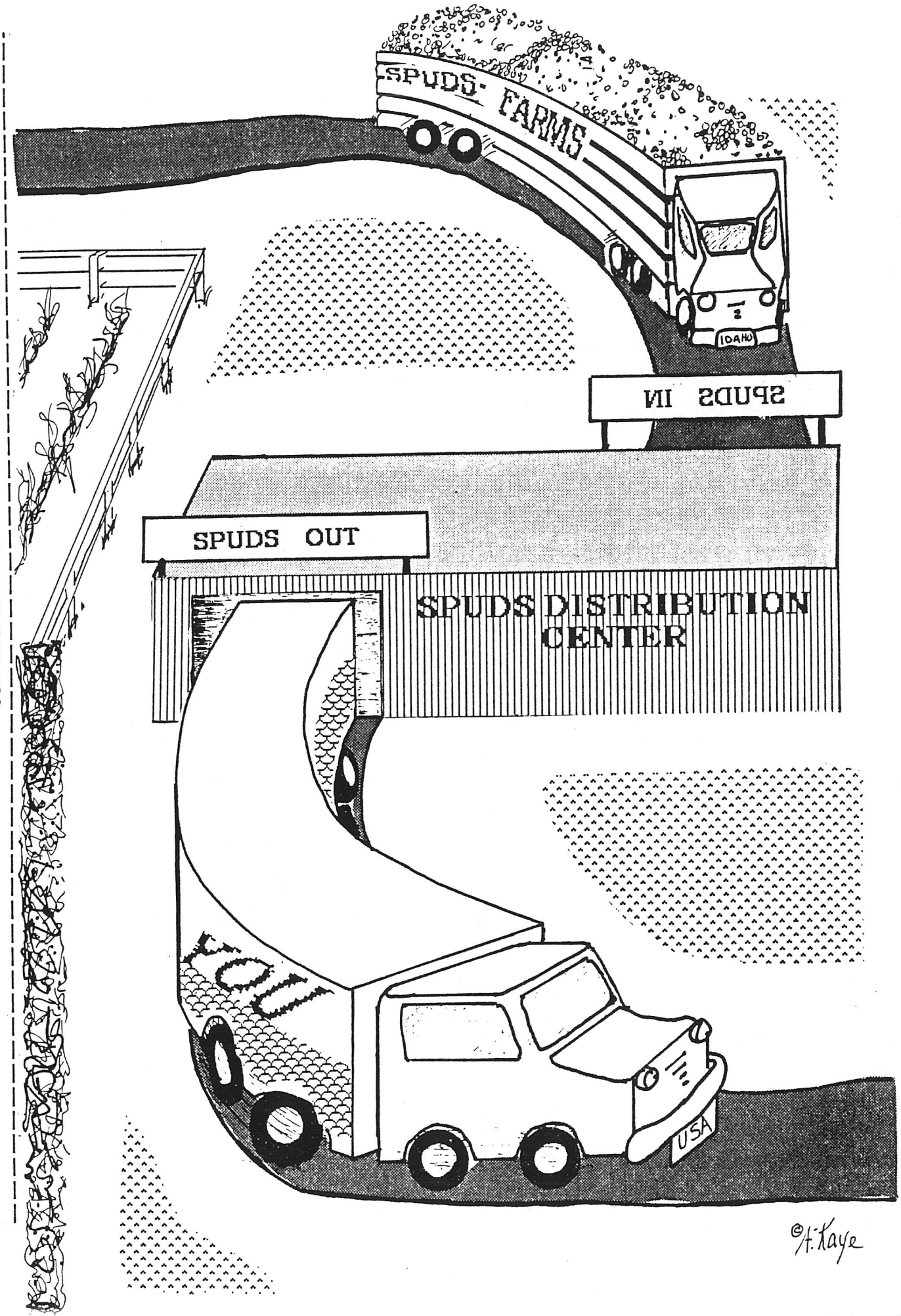

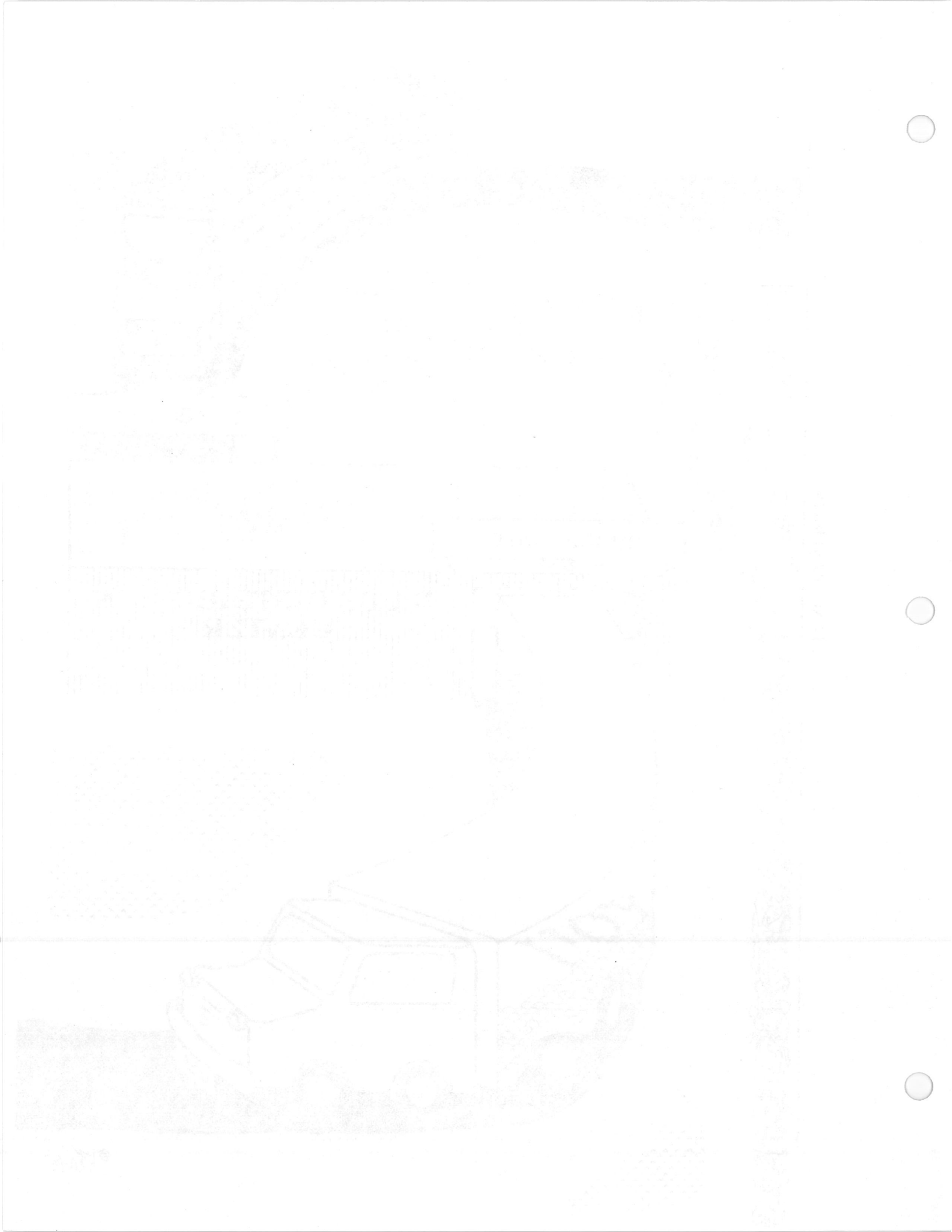

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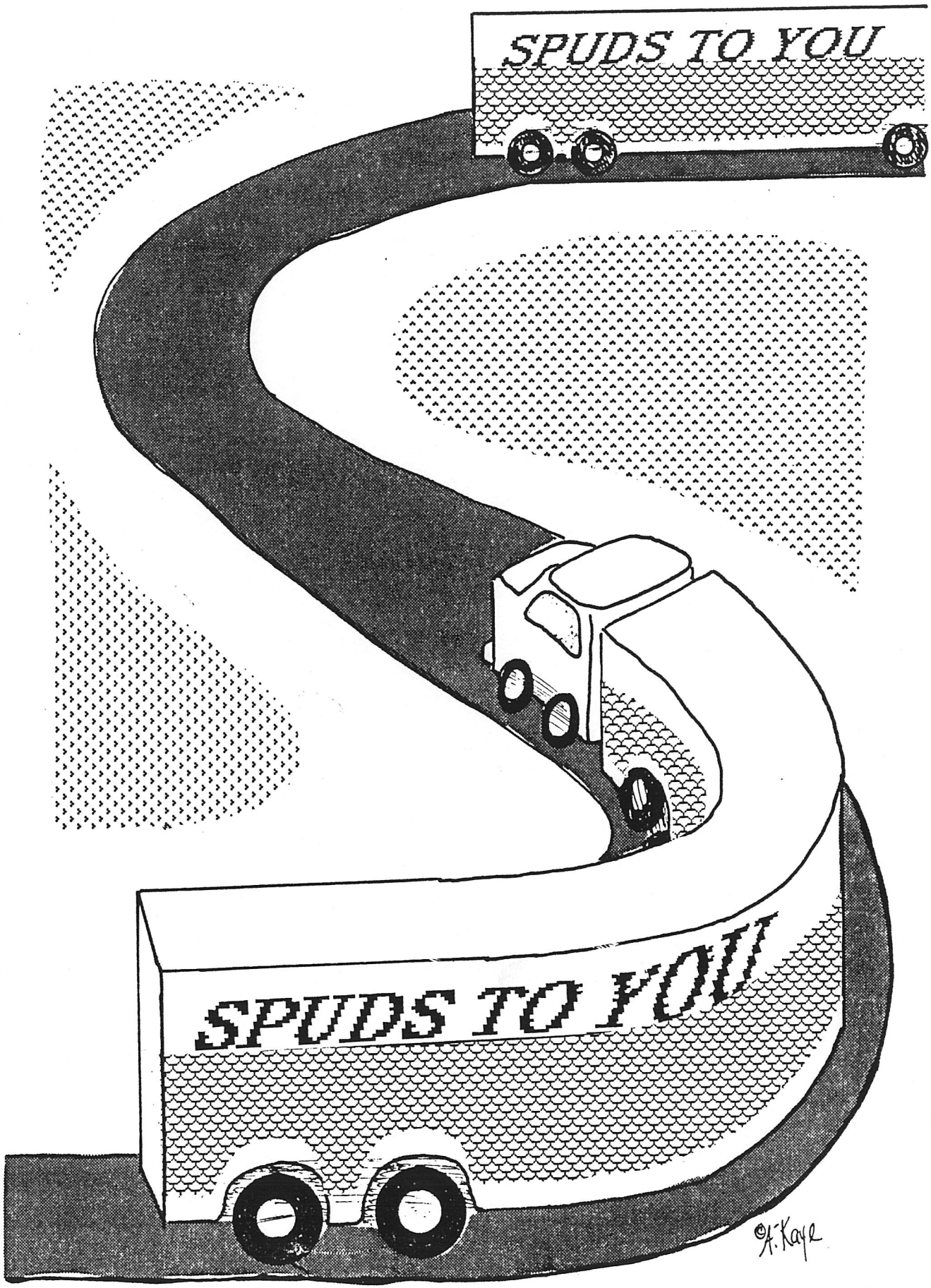

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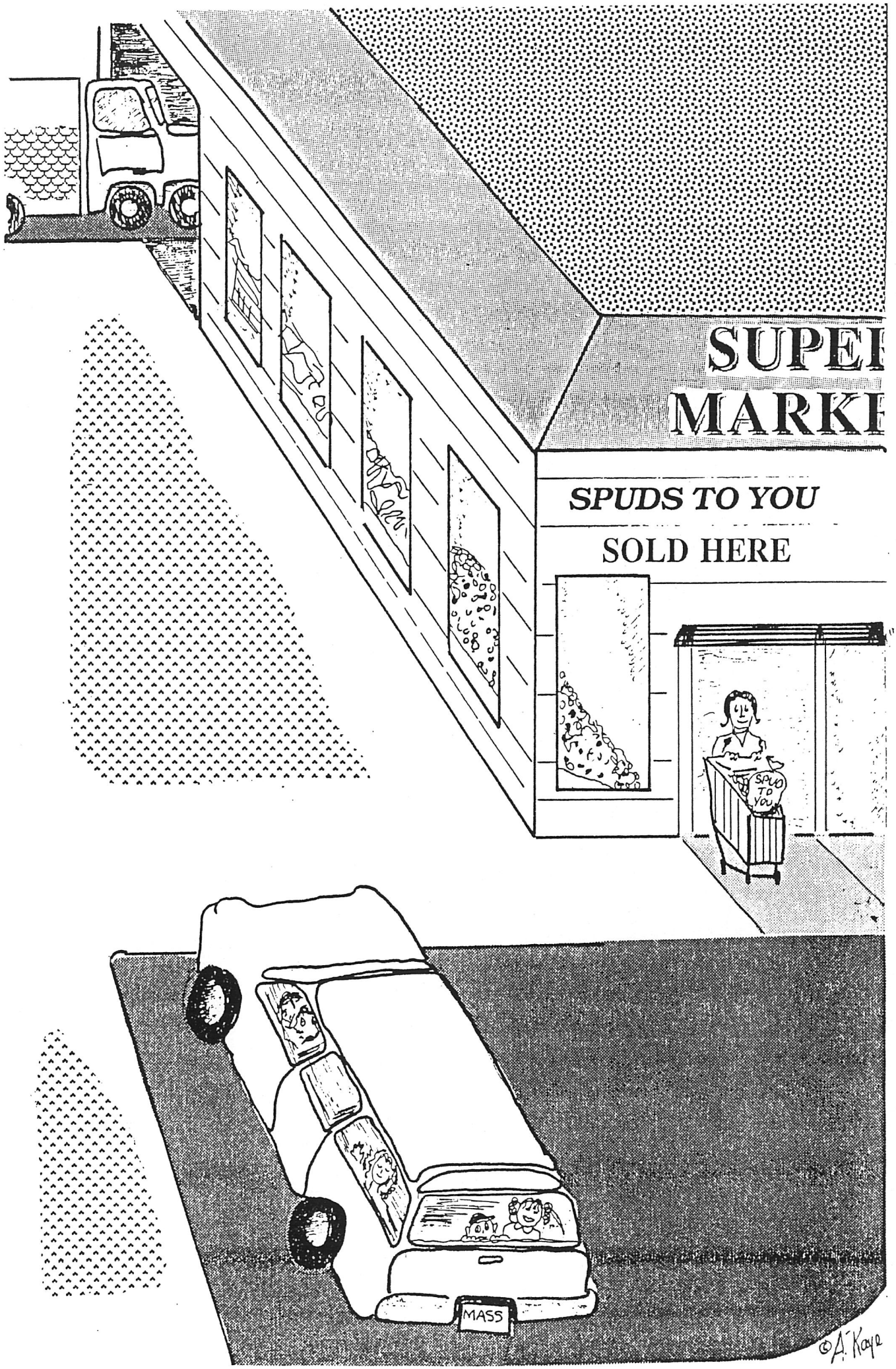


Lunch Bag Ecology

Materials
Students' bag lunches

Have each student select a lunch item and explore the following:

"What season was it probably harvested or butchered? If your food was not picked recently, how was it stored? (dried, canned, bottled, frozen, pickled, stored in root cellar or attic). If we are unable to preserve and store foods from seasons of great harvest what would happen to our population after lean harvests?

Transportation has helped people to overcome local seasonal limitations. Who has lunch food grown in another climate and transported here? Where is the food from? How far has it traveled? In what season was the food raised? Who has a lunch that traveled over 100 miles?" Example: Danish crackers, Florida oranges, New Zealand lamb, Guatemalan bananas.

"Who has a lunch that has traveled less that 500 miles? What would our lunch consist of today if we ate only fresh foods? Could we eat bread in the winter? Apples in the spring? What would the Massachusetts Indians have had for lunch today?" Make a menu. Example: Mint or sassafras tea, smoked fish, trail snack of dried seeds or berries.

From the *Growing Classroom*

JANUARY

NOW IS THE TIME TO CONSIDER...

1. Meeting with other teachers in the Green Classroom program to:
   a. coordinate seed orders for the garden.
   b. write a request to seed companies asking for a donation of last year's seeds.
   c. plan your indoor growing center, and purchase necessary equipment. (See "Setting Up An Indoor Growing Center" following the January section.)
2. Ordering copies of *The Reason for a Flower* by Ruth Heller (optional activity for Lesson 1: Ordering Seeds For the Garden), and *Seeds Pop-Stick -Glide* by Patricia Lauber (Lesson 2; Seeds: Packages of Life.)
3. Check your school library for the national Geographic filmstrip, "Seeds and How They Travel." Kit #5825. (Lesson 2; Seeds: Packages of Life.)

January

Lesson 1: Ordering Seeds For The Garden

Time Frame
1 hour

Objectives
To select seeds for the garden based on established criteria.
To compare different varieties of the same plant.
To learn how to use seed catalogues.
To practice making group decisions.

Materials Needed
Seed catalogues for each group of students, five apples, each of a different variety; *the "Different Variety of Carrots" diagram, *the "Plant Maturity Guide", *the "Vegetables for a Spring Garden" handout, a calendar.
*Included in the manual.

Vocabulary
Winter solstice, criteria, growing season, frost dates, frost tolerant, cool season vegetables, maturity time.

Procedure
While referring to the daylight hour graph, ask your students, "Have we passed through the shortest day of the year? How can you tell this by the daylight hour graph? What was the shortest day of the year? The shortest day of the year always falls around December 21. It is called the winter solstice. In history this was a time of rejoicing. People would gather together to celebrate the return of the sun. Longer days meant that the people could begin to plan for the planting of their fields in the hopes of a great harvest.

We are going to begin planning for our spring planting by ordering seeds for our garden. We are going to select the seeds by looking through books called seed catalogues. The seed catalogue shows pictures of hundreds of different types of vegetables that you can grow. Looking through a seed catalogue can help us decide what seeds to buy. It may even help you discover some vegetables that you never knew existed."

Divide the class into four or five small groups and hand out the seed catalogues. Instruct each group to go through the catalogues together and to pick out some vegetables that look good to them. Tell them to try some they have eaten before and some new ones. Have each group pick five kinds of vegetables and write their choices on a scrap piece of paper.

When the groups have finished, proceed with the following discussion.

"You have just finished the first step in making a garden. You have chosen what you would like to grow. There are other things, however, to think about before you decide with your classmates which seeds to buy and plant. These things that we must consider are called the criteria for selecting seeds.

One thing we have to consider is the growing condition of our area. Who can describe the climate of Massachusetts? We have cold winters and warm summers. We can not grow

plants in our gardens all through the year. We have a set growing season that is determined by our climate. Growing seasons are defined by the first expected day of frost in the fall and the last expected day of frost in the spring.

Farmers have been keeping track of frost dates in this area for years and have determined that we can usually expect our first fall frost around October 15 and our last spring frost around May 15. The growing season for plants that are sensitive to frost would begin on May 15 and end October 15.

Some vegetables are frost tolerant. That means that they can survive a frost without dying. We call these vegetables cool season vegetables. Cool season vegetables can be planted before the frost date in spring and will continue to grow a little past the frost date in the fall. Because we want to harvest vegetables before school gets out in June we will have to plant a lot of cool season vegetables in early spring, many of them before the spring frost date.

We must also consider the time it takes vegetables to grow up from a seed to a ripe plant. We call this the maturity time. Some vegetables have a long maturity time. Corn takes about 110 days to mature. Radishes only take about 23 days to mature. If you want to harvest some vegetables before school gets out it will be very important for you to consider the maturity time of the vegetables.

Let's take a look at some of the most popular choices of plants to grow and determine if they would mature before school ends for summer. We will look at watermelon, pumpkins, tomatos, cucumbers and peppers."

Hand out the "Plant Maturity Guide" for theses five plants and have the students determine the maturity dates using the information on the guide and a calendar. Establish the fact that these plants will not be ready to harvest by summer vacation. You may want to order some or all of these seeds anyway and have the students start them during school in peat pots and transplant them in their gardens at home. It is nice to give the students plants to grow at home as a continuation of the garden project.

"The last thing we will consider is the vegetable variety. Who thinks they know what we mean by vegetable variety?"

To demonstrate the meaning of variety ask five students to come to the front of the class. Hand each student standing a different variety of apple. Ask the class to explain the difference between each apple according to taste, size, color, shape. Tell the students that all of these pieces of fruit are apples but they are different varieties of apples. Vegetables come in different varieties too. Show the students the diagram of the carrot varieties and discuss the differences.

"Now we will make decisions on what to order based on the criteria that we have been talking about. What are the things we are going to consider when making our final decisions?" (Growing season, maturity times and variety.)

Give each planning group a "Vegetables for a Spring Garden" handout. Tell them that these are the vegetables that we can grow and harvest before the end of school. Divide the vegetables on the list evenly among the groups of students. Instruct them to use the seed catalogs to choose one variety for each vegetable for which they are responsible. All decisions must be group decisions. Choose a variety for one vegetable as a class to show students how to use the seed catalog. Go over the index, symbols used and the kind of information given in the variety descriptions used in the catalog.

Note: If your garden is going to continue throughout the summer you can order any vegetables you want to.

Instruct the students to fill out the order form in the catalog. Order the smallest package size available for each seed. You may want each group to present the varieties of their choice to the class.

Combine all of the class order blanks onto one. Hold a meeting with the other teachers in the program to formulate the final order form for the school.

Some seed companies will donate last year's seeds. Write or call the seed company to see if this is a possibility. Caution: The germination percentage of some seeds decreases with age. Be sure to ask for the expected germination percentage for the seeds you are interested in. You will have to compensate for this by planting more than you normally would.

Journal Suggestions

1. Describe the criteria we used to select seeds for our garden.

2. Describe the criteria for:
   a. food you would like
   b. an ideal room for yourself
   c. a pet
   d. a perfect birthday

3. Describe the growing conditions in our area.

4. List the vegetables that can grow well in our spring garden.

5. Describe what is happening on the soil temperature and daylight hours graphs

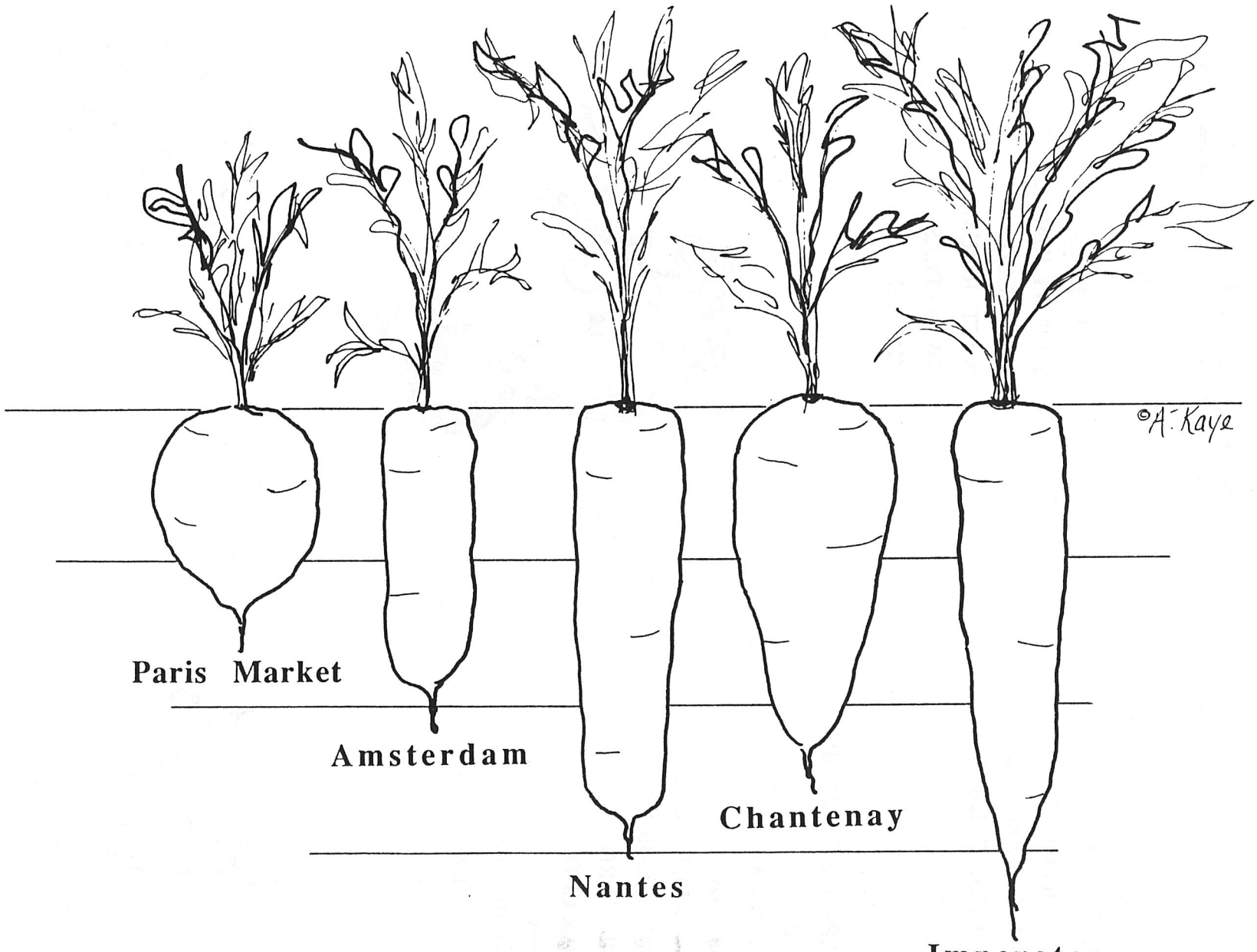
6. Granny Smith and Red Delicious are two different varieties of apple. Describe how they are different. Can you find out if they need different growing conditions?

Plant Maturity Guide

Use a calendar to calculate the harvest date for each of the vegetables listed below.

Vegetable	Planting Date	Days to Maturity	Harvest Date
Cucumber	May 15	55	
Peppers	May 15	60	
Pumpkins	May 15	120	
Tomatoes	May 15	65	
Watermelon	May 15	120	

Which of the vegetables above will mature before your summer vacation?



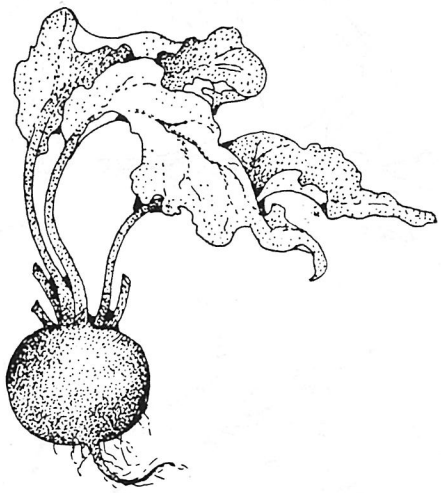
Different Varieties of Carrots

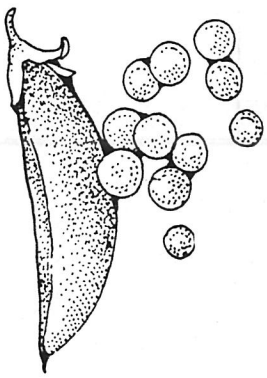
Vegetables for a Spring Garden

BEETS
BROCCOLI
CAULIFLOWER
CHINESE BROCCOLI
CHINESE CABBAGE
CRESS
DILL
ENDIVE
JAPANESE TURNIPS
KALE
KOHLRABI
KYONA
LEAF LETTUCE
MINI CARROTS
MUSTARD
PAK CHOI
PEAS
RADISHES
SCALLIONS
TATSOI

FLOWERS

CALENDULA
JOHNNY JUMP-UP
MARIGOLDS
NASTURTIUMS
SWEET PEAS
ZINNIAS





Climate or Weather?

Objectives:
To review the definitions of climate and weather.
To recognize that climates differ among geographical areas.

Review the definitions of climate and weather with the class. Facilitate a discussion of climate and weather with the following questions.

1. How does weather affect people?
2. How does climate affect people?
3. What are some ways in which people protect themselves from the weather? From the climate?
4. How can plants protect themselves from the weather and climate?

To illustrate climate differences among geographical areas, have the students chart and compare the weather and temperature in Miami, Anchorage and Boston one day a week for several months. Major newspapers provide information on this.

Adapted from: *Ladybugs and Lettuce Leaves*

The Reason for a Flower

Read *The Reason for a Flower* by Ruth Heller to the class. This is a beautifully illustrated book that describes how the pollination of flowers results in the manufacture of seeds. The text is brief and to the point and the full-page pictures are wonderful. A real treasure for classroom reading. This book can be purchased at the Market Book Store in Falmouth or at the New Alchemy Institute.

Lesson 2 Seeds: A Package of Life

Time Frame
45 minutes for reading *Seeds Pop Stick Glide.*
35 minutes for examining a seed and drawing and labeling its parts.

Objectives
To discover the adaptations seeds have for dispersal.
To identify the parts of a seed and their function.
To determine how seeds are formed in flowers.

Materials Needed
One large Lima bean for each student, magnifying glasses, *Seeds Pop, Stick and Glide.*

Vocabulary
Adaptation, dispersal, seed coat, first leaves, true leaves, stem, root tip, cotyledon.

Procedure
Read the book, *Seeds Pop Stick Glide* with your class. Discuss the many different kinds of seeds and their adaptations for traveling.

Examine A Seed
Soak the Lima beans in water overnight. The next day lead the following discussion.

"There are many different kinds of seeds. They come in all shapes, sizes and colors but they all have one purpose. What is it? All seeds grow into a new plant. Did you ever stop to consider that a small apple seed in the core of the last apple you ate could become a large apple tree. To find out how a seed becomes a plant we are going to take a very close look at a Lima bean seed."

Give each student a Lima bean seed, a magnifying glass, paper and a pencil. Lead them in the following discoveries. See "The Parts of a Seed" diagram following.

Ask, "What is a seed? It is a package of life. Inside every seed is a tiny living plant. Most seeds also hold a supply of food. The tiny plant uses this food until it can make its own. The plant and its food are packed inside a seed coat."

Instruct the students to carefully peel off the thin outer covering of the seed. Try to keep the seed intact. "This is called the seed coat. What do you think its function is? Seed coats protect the tiny plant and its food."

Instruct the students to:
"Look for a special place on the seed where you might be able to split it apart. Do so very gently. Look for the tiny young plant inside the seed with your hand lens. You should be able to see tiny leaves. These are called the first leaves. Below the first leaves is the part of the plant that will become the stem. The pointed end is called the root tip.

The young plant has all the food it needs right inside the seed. The food is stored in the two equal halves of the seed. Each equal half is called a cotyledon. The young plant will continue to get its food from the cotyledons until it sprouts and grows toward the light.

Once the true leaves appear the plant will begin to make its own food and the cotyledons will drop off. Every plant from a bean to a 300-foot tree starts from such a small beginning.

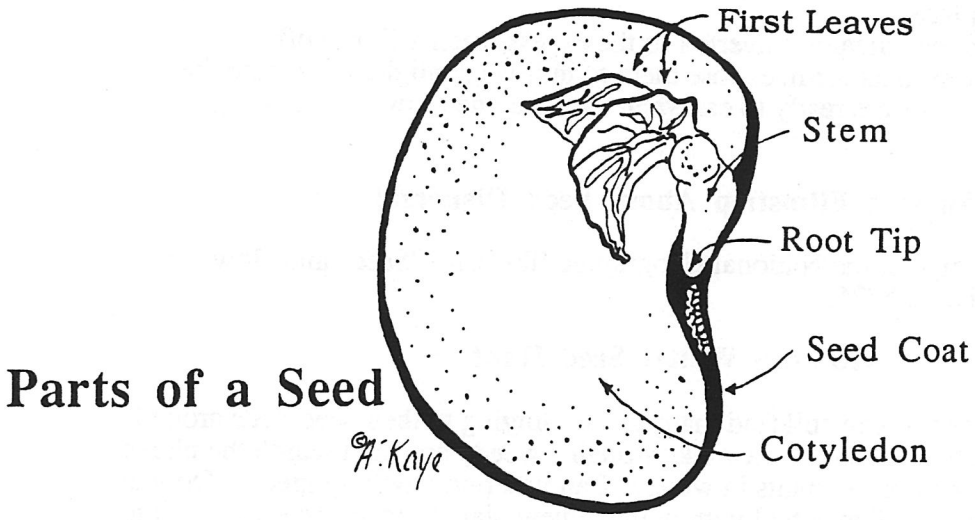
Journal Suggestions

1. Draw and label the parts of the Lima bean seed. Write a sentence telling what each part is for.

2. Write a story called, "Me, the Seed." Tell about how you travel away from your mother plant. What happens to you?

3. Describe three different ways that seeds travel. Which way do you think is the best? Give reasons for your decision.

4. Describe the class seed hunt. (See optional activities.) Where did people find seeds? What kinds were found? What kind of a day was it? Did anything funny happen?



Parts of a Seed

Sprouting Seeds To Eat

Materials Needed:
Seeds to sprout, quart jars, cheesecloth or a fine plastic mesh for each jar, a rubber band for each jar.

Sprouting seeds is an easy low maintenance activity for the classroom. Alfalfa seeds, mung beans, chick peas, lentils, and wheat grains are among the most commonly sprouted seeds. These seeds can be bought at a local health food store. Sprouts are crisp and delicious in sandwiches, soups, salads or as a snack. Sprout different kinds for your class to taste. Because seeds increase greatly in size after sprouting, use about 1/4 cup of seeds for every quart jar you would like to fill.

1. Rinse seeds in a jar and soak them in warm water overnight.
2. Drain off the water and place seeds in a large jar. Secure several layers of cheesecloth or fine plastic mesh over the mouth of the jar with a rubber band.
3. Keep the jar in a warm, (68° to 74° F) dark place.
4. Rinse the seeds two to three times each day with warm water, leaving the cheesecloth or plastic mesh in place.
5. After rinsing, leave the container inverted so the excess water will run off.
6. As the leaves of the sprouts form, expose them to indirect sunlight to increase their food value. The sprouts are ready to eat when they are one to two inches long.

Show a Filmstrip About Seed Dispersal

Check your school library for the National Geographic filmstrip, "Seeds and How they Travel." The kit number is 5825.

Go on a Winter Seed Hunt

Even though it is winter you can still find many seeds clinging to their seed pods around the school yard. Take the students for a walk through a weedy area and search the plants for seeds. Spend time exploring plants in winter. Can you find anything green? Do you think the seeds you found will eventually grow into a new plant? Bring the seeds back to the classroom to make a collection.

Many seeds can also be found in our kitchens. Have the students collect seeds we eat from their kitchens.

Once the class seed collection has grown in number divide the students into small groups to observe and arrange the seeds according to various characteristics. Discuss each group's findings and arrangements. See if the seeds can be identified by tree, weed, flower or another source.

As a class, brainstorm and discuss foods that are eaten as seeds. Try to determine which ones they eat whole, which ground, and where they come from.

Make a seed collage from the seeds in the collection.

Lesson 3: Seed Germination Experiments
Sprouting New Ideas

Time Frame
40 minutes for the lesson
2 weeks for the experiments

Objectives
To determine what environmental factors affect germination.
To write a hypothesis and design an experiment.
To conduct an experiment.
To record observations and form conclusions of the experiment.

Materials Needed
Containers for germinating seeds. (Shallow ones like jar lids or petri dishes work well. Cut down paper cups work also.) Paper towels or blotter paper; bean, pea or radish seeds, a refrigerator, a dark place, a warm place, any other materials the students may need for their experiments.

Vocabulary
Germinate, hypothesis, environmental factors.

Procedure
On your blackboard, write the definition of the word germinate—to begin to grow or develop.

"When a seed begins to grow into a plant we say it has germinated. But what triggers seeds to germinate? Why aren't the popcorn seeds in your kitchen germinating into corn plants?"

Have students brainstorm about what environmental factors influence germination. Write their answers on the board. The list may include: light, water, soil and heat. Tell the students that the list represents their best guesses as to what seeds need to germinate. Have each student choose one guess that they want to test.

Direct the students to write a statement about the environmental factor(s) they believe influences germination. For example: Seeds need light to germinate. Explain that they have just written a hypothesis: an unproven guess. "All great experiments begin with a hypothesis."

Ask the students to think about ways they could set up an experiment to test their hypothesis. Work with the students to help them design their experiments. Stress that in order to test one thing all other conditions must be the same. Give them the materials they need to conduct their experiments. Have them record their observations and conclusions in their journals.

Have the students conduct their experiment over a two-week period. Suggest they make a chart to record their observations. Be sure each observation is dated.

At the end of the testing period share results and form a final conclusion of what environment factors affect germination.

Notes for successful experiments:

1. Water can be added to the experiments by putting a paper towel or blotting paper in the bottom of the container and keeping it moist. Make sure that the moisture level is maintained. Do not let the paper dry out over the weekend or overnight. The seeds should never be completely covered in water.
2. Have students use at least two seeds per container in case some are not vital.
3. Place the seeds in a refrigerator to test for their need for warm temperatures.

Journal Suggestions

1. Record all observations of the germination experiment. Use headings such as:
   What I want to find out:
   What I did find out:
   What happened:
   Conclusions:

2. Write a summary of your experiment. What happened? Did it prove your hypothesis? Explain. What results surprised you?

Enough Peppers to Cover The Earth
A Math Lesson

Divide the class into small groups. Give each group a green pepper. Have the students split the pepper open and count the number of seeds in one half of the pepper. Put the pepper aside for later use.

Ask:
1. "How many seeds does it take to make one pepper plant?"
2. "How many plants could you grow from one half of the pepper?"
3. "From the whole pepper?"
4. "If one pepper plant produces 30 peppers, how many plants could you grow from all the seeds in those 30 peppers?"
5. "How many peppers could you get from the plants produced in question three?"
6. "Why don't pepper plants cover the earth?"

Wash the peppers and cut them into strips for the class to munch on.

Adapted from *Ladybugs and Lettuce Leaves.*

Upside Down Seeds

Place several layers of moistened blotting paper or paper towels against the sides of a clear container. Push some Lima beans between the glass and the papers. (Make sure the paper is kept moist.)

Position the seeds so that they face various directions—up, down, and toward both sides. Have the students determine how the position of the seed affects the germination and growth of the plants.

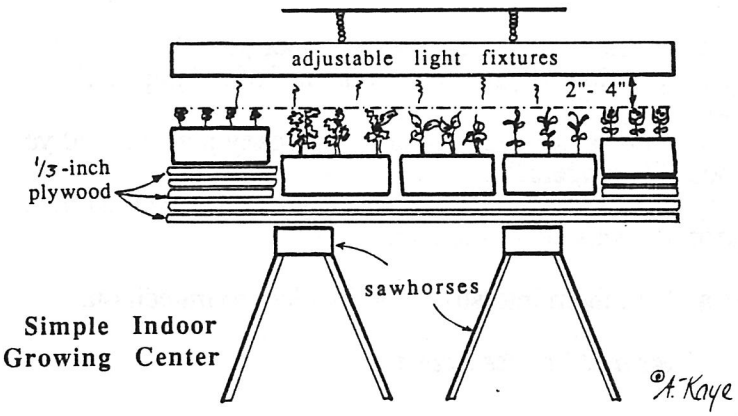
Who Was Johnny Appleseed?

Read a story about Johnny Appleseed. Discuss his role in dispersing apple seeds along the frontier.

Setting Up An Indoor Growing Center

Conducting a school garden program in the Northeast means that you will have to start many of the vegetables for the spring garden indoors. If you have a greenhouse or sun room attached to the school, great. If not, you will have to create an environment that will provide the necessary warmth and light needed to start seedlings in the spring.

Indoor growing centers can be fairly simple structures. The National Gardening Association suggests the following small system in the Youth Gardening Book.



Simple Indoor Growing Center

Lights, Fixtures, and Support Structures

Seeding flats can be grown under cool-white (40 watt) fluorescent bulbs and standard fixtures. Put the seeding flats on 1/4-inch thick plywood supported by sawhorses. The seedlings must be two to four inches from the bulbs at all times. If you cannot adjust the lights, use pieces of wood to raise the flats closer to the lights and lower them later as the plants grow. The flats must be rotated because the light is strongest near the center of the table. Do not set up your growing center near a heater. The seedlings will dry out too quickly.

Use one pair of bulbs for every one-foot width of growing area. At the East Falmouth Elementary School, we grew three flats of seedlings under two 48" double cool-white florescent bulbs. Use shatterproof, clear plastic fluorescent tube sleeves over the light tubes to avoid any injury if breakage occurs. The lights can be purchased at department stores. They vary in length and price

Timer

The lights should be on for 16 hours a day. To regulate the light you will need to purchase a timer for turning lights on and off during the day and night.

Watering

Seedlings under lights must be maintained for moisture. Water the plants when they need it. Check your plants every day. The soil must be keep moist but not sopping wet.

A base material of perlite can act as a water reservoir to maintain moisture over the weekends and holidays. Perlite is a volcanic ash that has been processed by exposure to very high temperatures. It is readily available at garden centers. Pour one to 1.5 inches of

perlite in a plastic seedling flat or deep-sided tray. Add two to three gallons of water to the perlite before leaving for a weekend or vacation. Place the seedling containers onto the trays filled with perlite.

You may notice a green algae growing all over the perlite. It will not hurt the plants but can be quite messy. You may have to replace the perlite after the first growing season. **An additional note of caution when using perlite:** The perlite dust created when you pour perlite into the trays can irritate your lungs. Wet the perlite first before pouring it.

Safety

All wiring must be attended to by a person experienced with electrical wiring. Use only receptacles, plugs and electrical devices that are grounded.

Grow Labs

The National Gardening Association has developed a 2 X 4 X 3-foot indoor garden center called a Grow Lab. Grow Labs are specially designed to provide ideal conditions for growing most vegetables, herbs and flowers from seed to maturity. Grow Labs can be purchased ready-to-assemble or you can write for the plans to build one yourself. A complete instructional guide for using a Grow Lab is also available. For more information about Grow Labs write or call: The National Gardening Association, 180 Flynn Avenue, Burlington, VT 05401, (802) 863-1308.

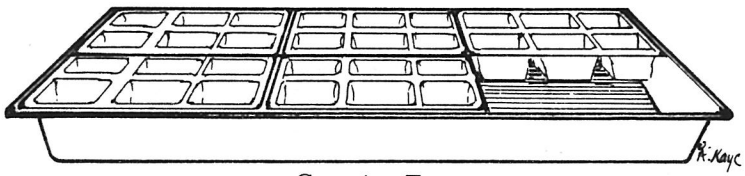
Additional Supplies to Complete Your Indoor Growing Center

Containers

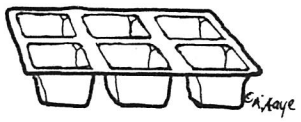
Any kind of container that will hold at least three inches of soil will work. Yogurt containers (8 oz), milk cartons cut lengthwise, or homemade wooden flats will all do. You must put drainage holes in the bottom of each container.

At New Alchemy we use commercial containers. They are sturdy and can be reused from year to year. Containers called 'six packs' work well for small group planting activities. Each container has six individual cells for planting seeds. Containers with 1 to 72 individual cells are available for purchase at garden and greenhouse supply centers. Eventually you will want to round out your collection with a variety of sizes. To start with, 25 six packs, one 24-cell container (for flower seeds) and five 6-inch fiber pots per class will be plenty. Fiber pots are needed if you are planning to plant vegetables that do not transplant well such as eggplant, squash, and cucumbers.

Carrying trays for the six packs will make it easier to move the seedlings from the growing center to the garden. One 11" by 21" plastic tray will hold 6 six packs. Five carrying trays per class will be plenty to begin with. We planted 11 flats of seedlings (including 2 flats of flowers) for the 10" by 63" East Falmouth garden.



Carrying Tray



Six Pack

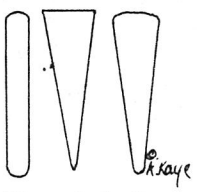
Potting Soil

A commercial soilless potting mixture is best for starting seedlings indoors. Garden soil may contain disease organisms that will cause damping off and seed rot in young seedlings started indoors. Experienced gardeners will often make their own potting mixture by combining perlite, sphagnum peat moss, and vermiculite. Good gardening books will have recipes for soilless potting mixtures but we recommend that beginners buy sterile professionally pre-mixed brands.

Most soilless mixes will be a combination of perlite, vermiculite,sphagnum peat moss and starter nutrients. Potting mixes can be purchased at any gardening center. Five pounds of potting soil per class should be plenty. If you buy by the bale you'll save money.

Plant Labels

Wooden or plastic plant labels are needed to identify the planting date and variety type of seedlings. Plant labels come in different sizes. Children have an easier time writing on the larger labels. Buy them by the box. A box of 100 will be enough for the entire school.



Plant Labels

Permanent Markers
Waterproof, smear proof markers for writing on the plant labels are necessary. Sharpie pens work well.

Liquid Fertilizer
Once the seedlings have their true leaves they should be fertilized once a week. A liquid fertilizer made with seaweed will work well. One pint of a concentrated sea-mix will be plenty for the entire school.

Seedling Watering Can
A watering can with a gently spray is needed for each indoor growing center. The gentle spray will not beat down the young seedlings.

Supply List for A Simple Indoor Growing Center

As illustrated on previous page.

Item	1988 Price
1/4- inch thick plywood	14.00
2 or 3 48" double cool-white florescent bulbs with fixtures per growing center	30.00
3 cu. ft. potting soil (enough for six or more classes)	11.00
5 carrying trays per class	4.00
5 permanent markers per class	3.90
40 oz bag of perlite per growing center	3.50
1 automatic timer for lights per growing center	10.00
5 trays of six packs per class (each tray has 6 six packs)	3.00
fluorescent tube sleeves for each light	15.00
1 bottle of concentrated liquid fertilizer	3.25
1 box of plant labels	2.92
1 seedling watering can per growing center	8.00
sawhorses	free material

*Prices will vary with supply center. This supply list is for one classroom. Order in bulk for more than one class to reduce cost.

A Grow Lab Indoor Garden and Mobile Stand from the National Gardening Association can be purchased for $469.00. You can send for the plans and build one yourself for about $150.00.

Supply Centers

Griffin Greenhouse and Nursery Supplies—Orders must be $100 or more, 1619 Main Street (Rt. 38), P.O. Box 36, Tewksbury, MA 01876, (508) 851-4346

Let's Get Growing: A catalogue of supplies for school garden projects. General Feed and Seed Co., 1900-B Commercial Way, Santa Cruz, CA 95065.

Local gardening centers, lumber yards and hardware stores.

FEBRUARY / EARLY MARCH

NOW IS THE TIME TO CONSIDER...

1. Completing the indoor growing center. You will need all of the supplies and equipment for the indoor growing center by the end of February. (See Setting Up An Indoor Growing Center following the January section.)

2. Determining the garden layout. To do this, all of the teachers involved in the program must work out a planting scheme. It will help at this point to sketch the garden to scale on graph paper. Use the "Planning-Your-Garden Chart " following the end of the February/Early March section to determine where you will plant what.

   You must decide on your garden approach (see page 3). Will the garden be communal or will each class be responsible for individual beds? Which class will plant what seeds? How many flats of each variety will you plant? Be sure to take into consideration loss due to poor germination. Start twice as many seedlings than you want to end up with. Will there be special areas for flowers, herbs and other ornamentals? See the example garden layout diagram following the optional activity for Lesson 2: "Planning The Garden With The Students."

3. Acquiring the necessary gardening tools. If you need to order tools through the mail, you must allow for shipping time. (See the supply list and supply center addresses at the back of the manual.)

Early February

Lesson 1: Plants: Green Wonders of the World

Time Frame
60 minutes
This lesson can be taught in two 30-minute parts.

Objectives
To identify parts of a plant and their function.
To discover how plants make their own food.
To examine the interrelationship between plants and animals.

Materials Needed
*The "Root Systems of Plants" diagram, one 1/2-inch piece of celery cut crosswise for each student, a whole celery stick, red food coloring, a real leaf (it can be attached to a plant), *the Inside the Leaf Food Factory" diagram, *the "Photosynthesis" diagram.
*Included in the manual at the end of this lesson.

Vocabulary
Carbon dioxide, chlorophyll, fibrous roots, nutrients, oxygen, palisade cell, photosynthesis, root hairs, stems, stomate, tap roots.

Procedure

Part One: Roots and Stems

Lead a discussion on the parts of a plant and their functions.

Roots, the Waterworks of the Plant

Begin to draw a plant starting with the roots on the blackboard. Draw a fibrous root system complete with root hairs (see diagram of root systems). Do not draw the rest of the plant yet. Ask your students to think of three important jobs that roots perform for a plant. List them on the board.

1. Roots anchor the plant in the soil.
   "Did you ever try to pull up a dandelion in your lawn?"

2. Roots absorb water and minerals from the soil and transport them to all parts of the plant.
   "A mature apple tree absorbs 50 gallons of water a day."

3. Roots store food for the plant's future needs.
   "We use the food that some vegetables have stored in their roots when we eat root crops. Can you name some root crops that we eat? (Carrots, beets, turnips, radishes.)"

"There are two kinds of root systems that plants can have. Some plants have tap roots and some have fibrous root systems."

Write, Tap Roots and Fibrous Roots on the board.

Give each student the diagram showing the two different root systems and ask the students to determine which is which. The carrot is an example of a tap root and the lettuce is an example of a fibrous root system.

Ask the students for descriptive words that characterize both types of root systems. Write the descriptive words below the type of root system on the board.

Tap Roots	Fibrous Roots
thick, long, one main root	thin, stringy, many

Using the diagram, have the students notice the very thin, hair-like threads on both root systems.

"These roots are called root hairs. Root hairs are the real wonder workers of a root system. They are the first roots to absorb water and minerals from the soil. The water that is absorbed by the root hairs does not come from puddles and streams. It comes from water trapped between individual grains of soil. Roots hairs are small enough to collect the water that surrounds and coats the grains of soil. Soil nutrients are absorbed in each tiny droplet of water.

The water and soil nutrients are transported from the root hairs to the pipelines inside the larger roots, then into the stem and finally into the leaves."

Continue drawing the plant on the board showing a stem growing from the main root of the system.

Stems: Transporters and Supporters

"The pipelines in the roots are connected to the stem of a plant. Stems come in many sizes and shapes. Have you ever heard about the giant redwoods in California? Their stems reach more than 300 feet straight up into the sky. Dandelions have stems which are hollow inside. We eat some plant stems. Can you think of some stems we eat? (Rhubarb and celery.)

Stems have two important jobs? Can you think of what they are?" List the answers on the board.

1. Stems are transporters. "Small tubes inside a stem transport water and soil nutrients up from the roots to the other parts of a plant. We can see the tubes in a stem."

   Hand out one piece of celery stem and a hand lens to each student. Instruct them to look at the end of the celery piece for the tiny tubes that run through the stem. They will look like tiny circles.

   Put a whole celery stick in a glass of water with red food coloring. Set it aside for now. Over the next few hours watch the stem transport the colored water up into the leaves.

2. Stems are Supporters. "Besides being transporters, stems do something else for plants. What ? They hold the leaves up into the air and sunlight."

Draw some leaves on the plant diagram on the board.

Stop here if you are teaching the lesson in two parts.

Part Two Leaves—Food Factories

Have the students focus on a real leaf while you are carrying out the following discussion.

"For many years, people asked the question, 'How does a plant get the food it needs for growth?' We know that we need to eat to survive but what about plants? After a lot of thinking and experimenting the mystery was finally solved. It was discovered that the leaves of every vegetable, tree and blade of grass contain a kind of 'food factory.' Although a leaf may appear as thin as paper, it really has an inside. The leaf is like a sandwich, with all the equipment for making food packed between its upper and lower surfaces.

We are going to take a look at the inside of a leaf to see how food is made within this factory."

Hand out the "Food Factory" diagram. Explain that this is a drawing of the inside of a leaf magnified many times.

"We are going to take a tour of this 'food factory' and identify all of its workers. The workers in this 'food factory' combine four different ingredients to make food for the green plant.

The first ingredient enters the factory through the topside of the leaf. Find the topside of the leaf on your diagram. This ingredient is all around us every bright day. Can you guess what it is? SUNLIGHT."

Write SUNLIGHT on the board.

"The 'food factory' goes into operation as soon as sunlight strikes and penetrates the surface of a leaf. Once inside the leaf sandwich, the sunlight is trapped by the palisade cells. These are the long sausage-like cells underneath the topside of the leaf. Find the palisade cells on your diagram.

The second ingredient enters the leaf through tiny openings called stomata on the underside of the leaf. Stomata look a bit like the lips of a circus clown. Find the stomata on your diagram. Stomata are so tiny that one inch of leaf surface may contain 250,000 of them. The ingredient that enters the leaf through the stomata is all around us all of the time. Can you guess what it is? A part of the air called carbon dioxide. How does carbon dioxide get into the air? All animals exhale it with every breath."

On the board write + CARBON DIOXIDE after the SUNLIGHT.

SUNLIGHT + CARBON DIOXIDE

The next two ingredients enter the leaf through the veins. Find the vein on your diagram. The pipelines in the veins are connected to the pipelines in the stem which are connected to the pipelines in the roots. These new ingredients come up from the roots. What are they? Water and soil nutrients."

On the board, add water and soil nutrients to the equation.

SUNLIGHT + CARBON DIOXIDE + WATER + SOIL NUTRIENTS

"Remember that everything we have talked about is happening inside a leaf. Now that we have the four ingredients, we need a cook. The cook of the food factory is inside the palisade cells and is called chlorophyll. Find the chlorophyll on your diagram. They are the little black dots on your diagram. Chlorophyll grains are really green and microscopic. There are so many of them in a leaf, that they are what gives the leaf its green color. Without chlorophyll, leaves would not be green.

The chlorophyll is responsible for combining the sunlight, carbon dioxide, water and soil nutrients together. It shakes up all four ingredients to make food for the plant.

Leaves make food by combining these four ingredients."
Have the students say the equation out loud.

SUNLIGHT + CARBON DIOXIDE + WATER + SOIL NUTRIENTS = FOOD

"That's not all that comes out of the leaf factory. Something else is produced from combining these four ingredients. Something that we could not live without. What ? Oxygen! Lucky for us, plants produce oxygen that we need to breathe at the same time they are making their own food."

Add oxygen to the equation.

SUNLIGHT + CARBON DIOXIDE + WATER + SOIL NUTRIENTS = FOOD + OXYGEN

"This process has been going on since the beginning of life on the planet earth. It has a special name: **PHOTOSYNTHESIS.** 'Photo' means light and 'synthesis' means to combine. Photosynthesis is the process of combining light with the other ingredients to make plant food and oxygen."

Have the students write the equation for photosynthesis on their diagram.

Adapted from : *Ladybugs and Lettuce Leaves*

Journal Suggestions

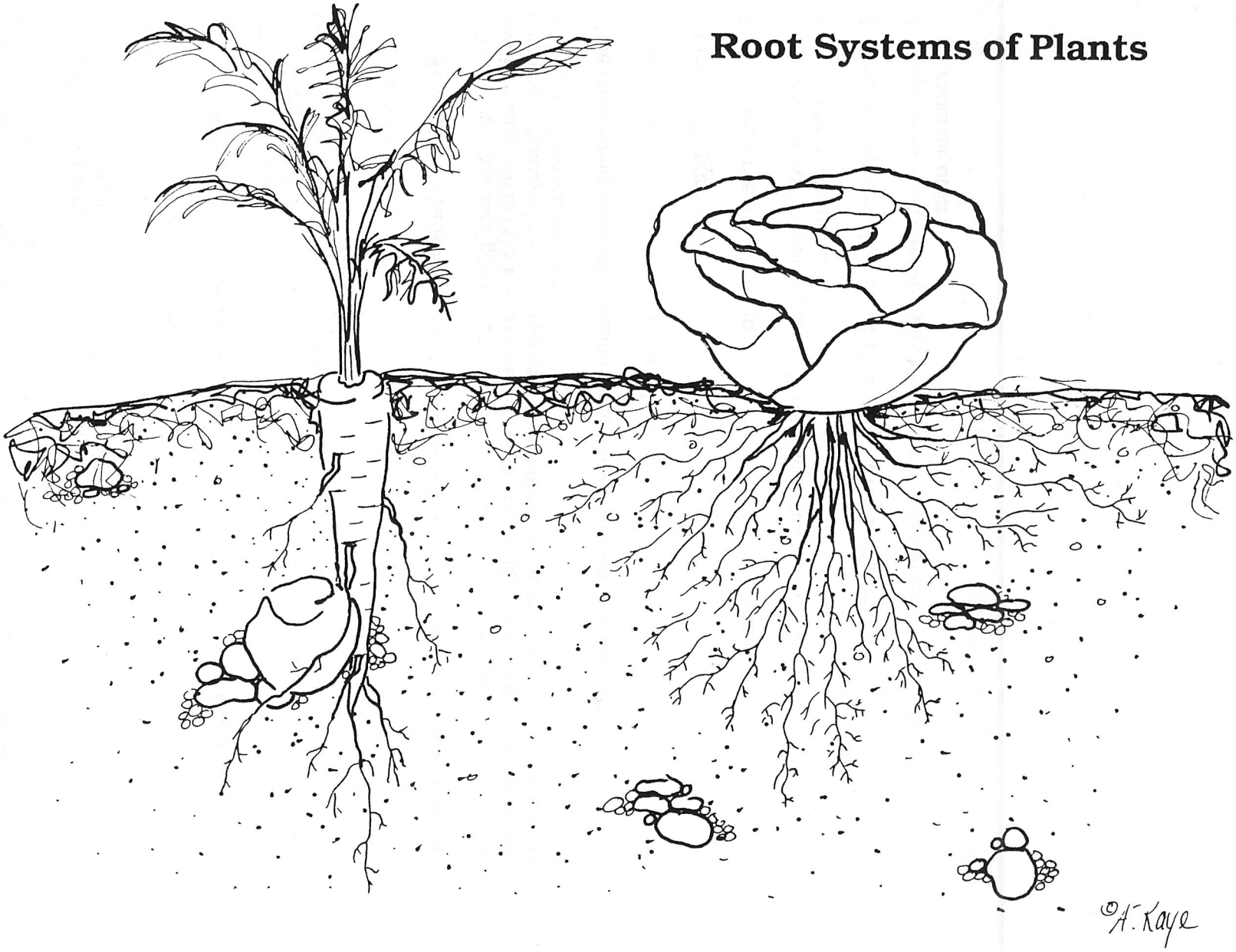
1. Have the students write sentences using the vocabulary words.

2. Imagine a world without plants. Write a short story about that world. Would there be any other forms of life?

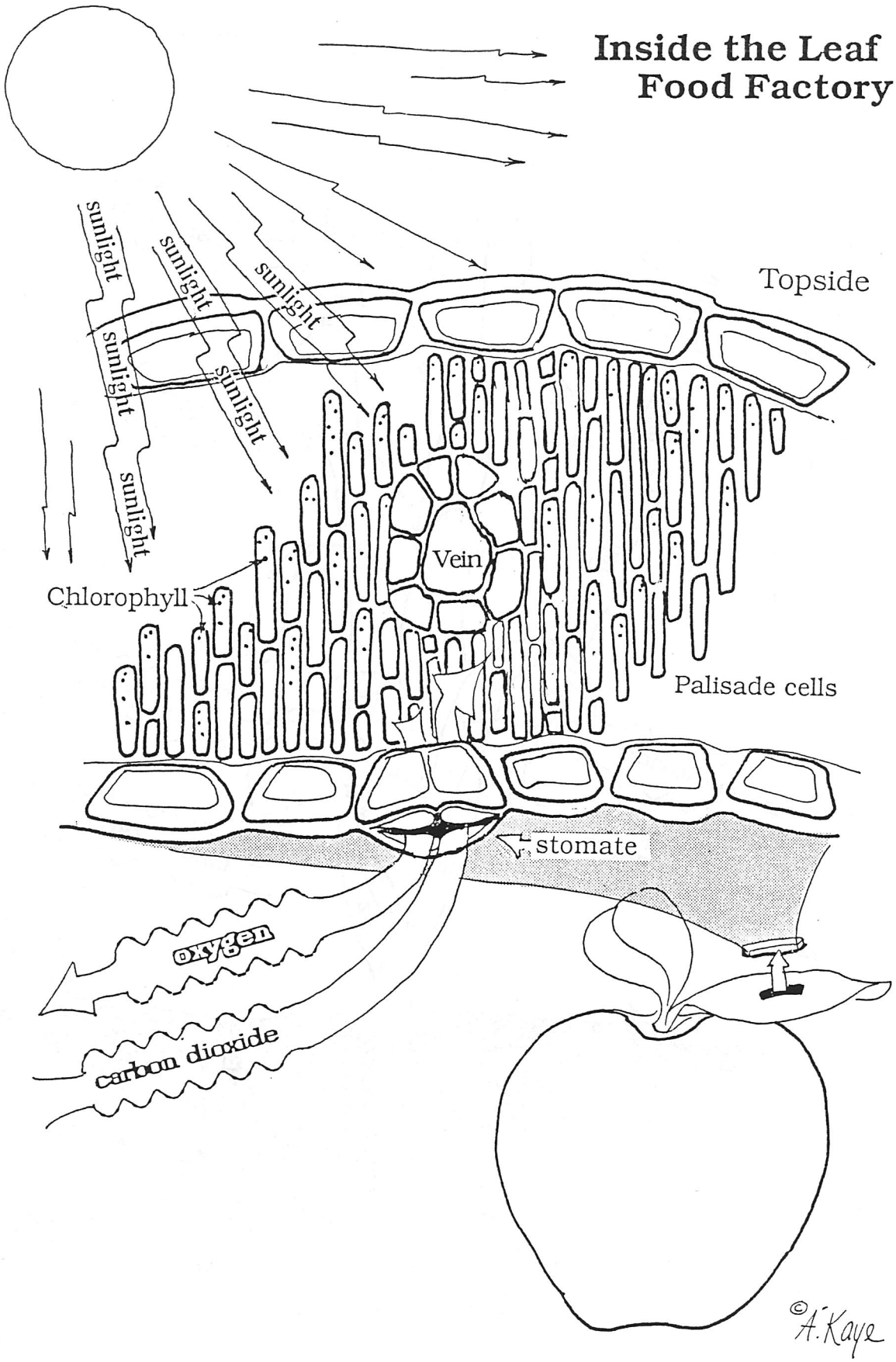
3. List five reasons why you are glad plants cover the planet earth.

4. Explain the unique relationship between plants and animals. Could there be one without the other?

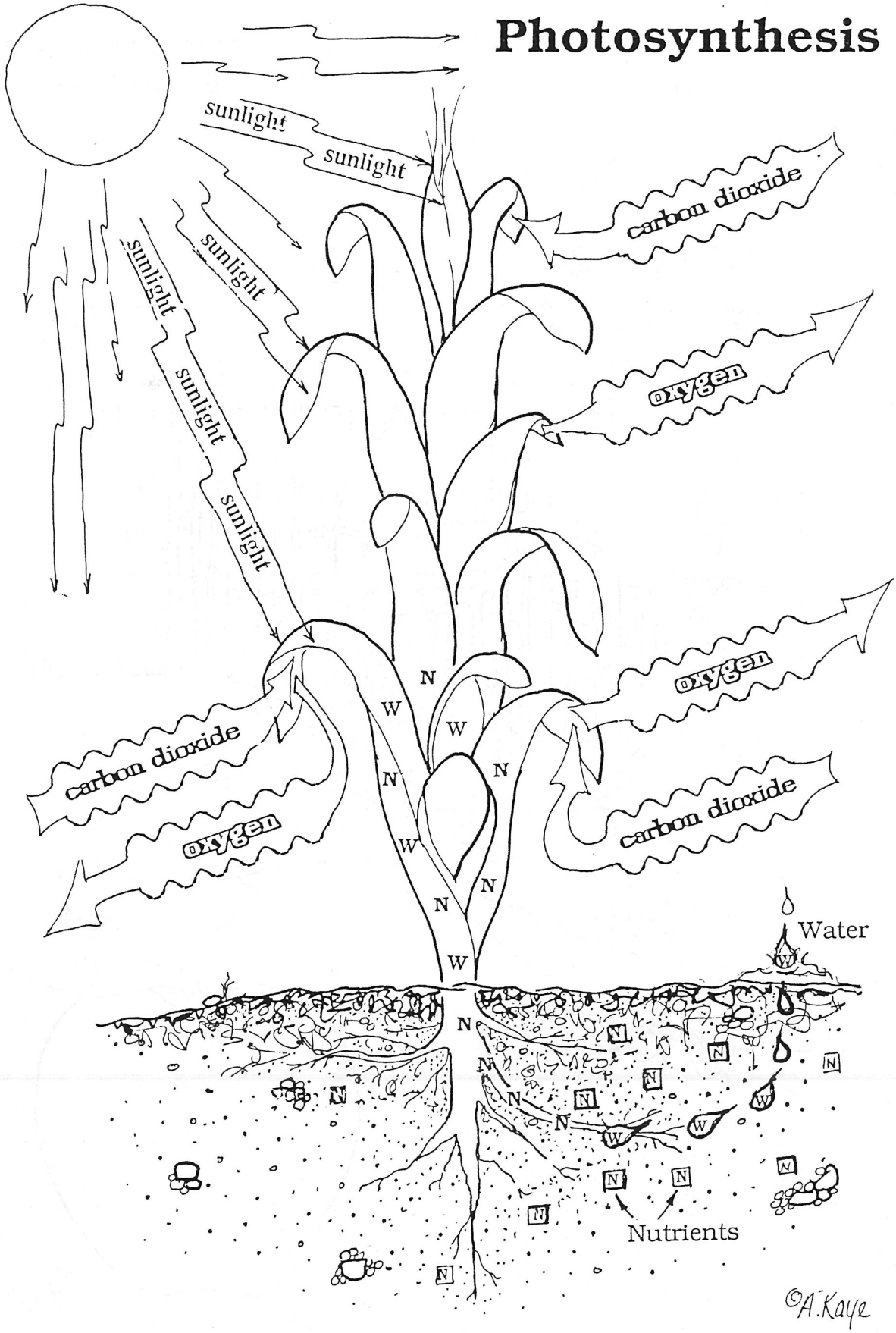
Root Systems of Plants



Inside the Leaf Food Factory



Photosynthesis



Air Ballet

Objective: To reinforce the interrelationship between green plants and animals: plants release oxygen and consume carbon dioxide, and animals release carbon dioxide and consume oxygen.

This class demonstration will help students understand that green plants release oxygen and consume carbon dioxide while animals release carbon dioxide and consume oxygen. Select half of your class to be animals and the other half to be plants. Each group should line up in a straight line. The animal line should face the plant line. Make sure there is plenty of space between the two lines.

The students will dramatize the following dialogue delivered by the teacher. Tell the students to gracefully ham things up a bit. Begin with the plants.

"Plants take in carbon dioxide..."
Movement: Students reach their arms out toward the animals to catch carbon dioxide then bring their arms back toward their bodies, and end up hugging themselves.

"...soak in the sun's rays..."
Movement : Students raise and stretch arms above their heads, looking very much like plants, and gently sway back and forth to soak in all of that sunshine.

"...absorb water and soil nutrients with their roots..."
Movement: The students bend and stretch their arms down toward their feet and slowly pull the water and soil nutrients up toward their leaves.

"... and release oxygen."
Movement : Students blow oxygen gently out of their mouths toward the animals with their hands and arms directing the flow of the oxygen.

Now it is the animals turn to respond.

"Animals breath in oxygen..."
Movement: The animals reach out for the oxygen and bring it toward their bodies.

"...shake it all over their bodies..."
Movement: Animals shake and wiggle their bodies.

"...and blow out oxygen."
Movement: Animals gently blow out oxygen toward the plants using their arms to direct the flow.

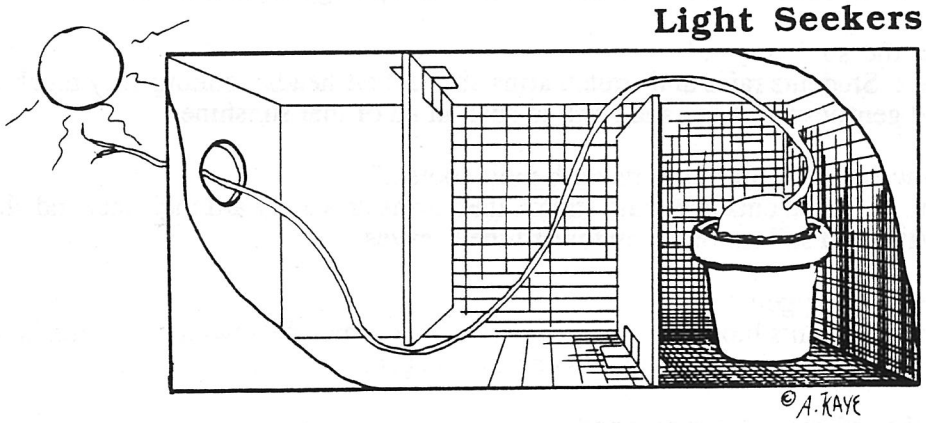
Repeat the ballet again in slow motion. Speed things up to fast motion for the last act.

Light Seekers

Objective: To demonstrate that plants will grow in the direction of a light source (phototropism).

Materials: a potted young bean plant or a sprouted potato, a sunny window, a shoe box with dividers.

Place the plant in a shoe box that has been arranged with dividers similar to those shown in the diagram. The dividers can be made from oak tag and taped or glued into the shoe box. Keep the box covered for about a week (except for brief observations and for watering). The plant will grow around obstructions to the light source. Have the students observe and record their observations of the plant for a week or more. Ask them to predict the fate of the plant? Will it die or live? Will it grow around the dividers? What will happen to the plants color?



Do Plants Need Air?

Objective: To demonstrate that plants need air to survive.

Materials: Petroleum jelly, actively growing plant with leaves.

Cover both surfaces of several leaves thickly with petroleum jelly. Also cover the upper surfaces of some and the lower surfaces of others. Check daily to see what happens. Have the students predict what will happen to the leaves. Blocking the stomata should cause the leaves to fade and die.

Late February / Early March

Lesson 2: Getting An Early Start
Planting Seeds Indoors

Time Frame
45 minutes

Objectives
To start the cool season vegetables for the garden.
To begin an experiment that will demonstrate the developmental stages of plant growth.

Materials Needed
Planting containers, soilless potting mixture, plant labels, permanent markers, watering can for seedlings, an appropriate indoor growing center, cool season vegetable seeds, egg carton, bean seeds for experiment, *"When to Plant Vegetables for a Spring Garden" chart, paper bag. Optional: small quantities of perlite, vermiculite and sphagnum peat moss.
*Included in manual.

Vocabulary
Cool season vegetables, six pack (if that is the type of container you are using), carrying tray, flat, planting depth, soilless potting mixture, seedlings.

Procedure
The garden layout must be determined by now. If you wish to involve the students in this process, conduct the optional activity, "Planning Your Garden," following this lesson.

Before the lesson begins, the soilless potting mixture must be moistened. Use a plastic garbage pail to mix the soilless mixture with water. Enough water has been added when you can just form the mixture into a ball. It should not be sopping wet.

Starting Seeds for the Garden
Explain to the student that all of the plants they will start today are called cool season vegetables. Ask, "What do you think we mean when we say a plant is a cool season vegetable? It is a plant that can tolerate low soil and air temperatures. Some vegetable seeds will germinate when the soil temperature is cool and some will not. All of the vegetables we start today are examples of cool season plants." Refer to the "When to Start Vegetables for A Spring Garden" chart at the end of this section to determine starting dates.

Divide the class into small planting groups—three or four to a group. Identify the planting equipment and explain the planting procedure.

Containers
Identify the name of the containers the students will use for planting the seeds, i.e. six pack, carrying tray, flat.

Soilless potting mixture
Pass out a sample of the soilless mixture for the students to examine. "This is the soilless mixture that in which we start our seeds. It is not garden soil. Garden soil is full of disease organisms that may cause seeds and young seedlings to rot, and weed seeds that would compete with the seedlings. To be sure that the seedlings we plant today get a strong start, we will use this soilless mixture. Most soilless mixtures are made with three major ingredients: perlite, vermiculite and sphagnum peat moss."

Optional: Hand out samples of each ingredient found in the soilless mixture and explain what they are and the job they do.

Perlite
"Perlite is made from volcanic rock that has been expanded by exposure to very high temperatures. Perlite creates good air and water spaces so the root hairs have plenty of spaces to grow and feed." CAUTION: Wet the perlite before passing it around to avoid creating a dust that can be irritating to lungs.

Vermiculite
"Vermiculite is a mica-like mineral that has been heated to very high temperatures. The mica has popped and expanded creating an accordion-like structure. Vermiculite holds water like a sponge."

Sphagnum Peat Moss
"Sphagnum peat moss is a plant that is found in very wet areas like bogs. Peat moss holds water and improves the structure of the planting material."

Planting Instructions
Remind the students that each member of the planting group must cooperate with one another. Everyone must have a chance to do something. Let the students decide who will do what.

1. Choose your seed packages.
   Put the packages of seeds that will be planted today in a paper bag. Have one student from each group reach into the paper bag without looking to draw the seed package that they will plant.

2. Fill the planting container with the soilless mixture.
   A second student from each group should fill the planting container with the soilless mixture. The container should be filled to the edge. Gently press the soilless mixture down a little. Do not compact the mixture too much.

3. Determine planting depth.
   Have students determine how deep the seeds should be planted by reading the information on the back of the seed package. You could extract this information beforehand and tell the students what the planting depth for each seed is. Planting depth is important. If the seeds are planted too deep they may not germinate. Some flower seeds must not be covered at all.

   Have the students use their fingers to measure the planting depth. Half an inch is the distance from the tip of a finger to the first knuckle. One fourth inch is the length of a short fingernail.

4. Make planting holes and insert seeds.
   Once the planting depth has been determined, have the students poke holes in the soilless mixture using their fingers for measurement. If you are using six packs two seeds can be planted in one cell. Two seeds are planted per cell in case one seed does not germinate.

   If you are using flats, follow these planting instructions:
   Fill the flat about three-quarters full.

Scatter the seeds across the surface of the potting soil. Make sure you get a fairly even coverage. Cover the seed with an eighth-inch to a half-inch of potting soil. The smaller the seed, the more shallow the planting. You could have the students make holes for the seeds like they did when using a six pack. You will have to thin the plants out after they reach two inches in height.

5. Water the seeds.
   Each finished container should be well watered. The soilless mixture should be moist but not sopping wet. If the potting soil has been premoistened, it may not be necessary to water at this stage. Just make sure the seeds are making contact with a moist planting mixture.

6. Label the containers.
   Using the plant labels and permanent markers have the students label the container with today's date and the vegetable name.

7. Final check.
   Check each container for the proper amount of water and correct label. Have students put the containers in a carrying tray. When filled, place the carrying tray under the lights.

   Have the students check the moisture content in the containers each morning. The soilless mixture must be kept moist. Do not let the seedlings dry out. On the other hand, too much water can cause the seeds to rot. Water whenever the potting soil does not feel moist to the touch. Make it a daily ritual to check for watering.

   Refer back to the information on Indoor Growing Centers for proper plant maintenance.

Thinning out.
When the seedlings are about two inches tall, thin them out to one plant per cell or thin as the instructions on the seed packages indicate if you are planting in flats. Thin seedlings out by pinching the unwanted plants off at the soil line. Pinching off instead of pulling up will prevent disrupting the remaining plants root systems.

Start The Plant Growth Experiments

Begin an experiment to demonstrate the stages of plant growth.

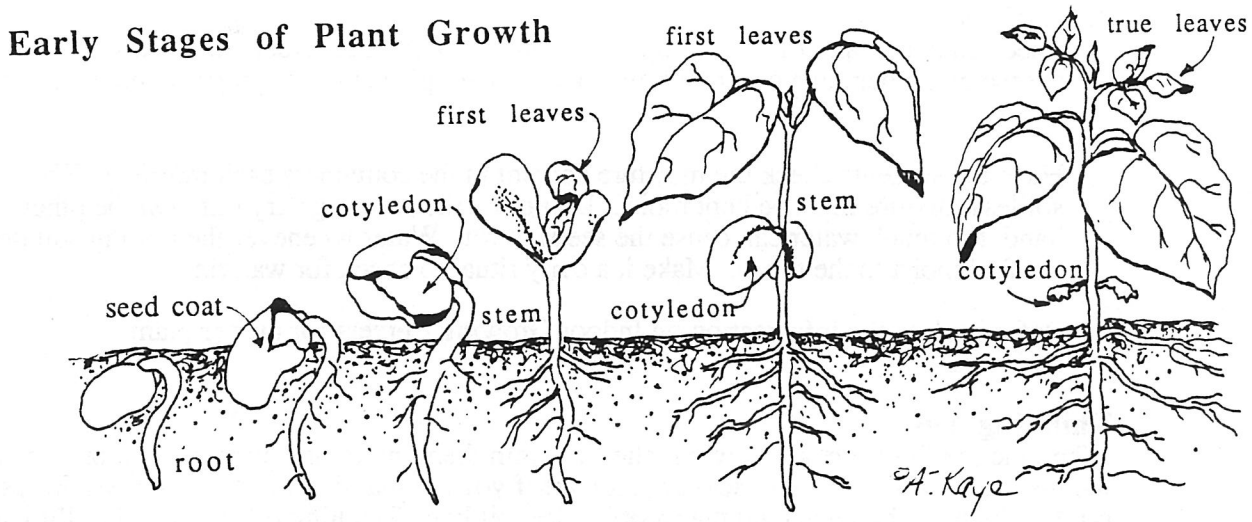
1. Fill an egg carton with potting soil. Plant a bean seed in each egg cell. Water the seeds until the potting soil is moist. Have the students take turns removing a planted seed from the egg carton every other day. Remove all potting soil with the seeds to keep track of where the remaining seeds are.

2. As a class, discuss the new development in growth after each seed removal. Be sure to identify and note the different parts of the seed and how it is changing.

3. Have students draw every removed seed in their journal, creating a picture growth chart that shows the developmental changes. This experiment should last between three and four weeks. Be sure to water the plants when needed. Keep the experiment under the lights.

Journal Suggestions

1. Make a list of the vegetables you started today.
2. Write directions for planting seeds indoors. Could someone else do this job successfully by following your directions? Be sure to get all the steps in order. Have another student read your description for accuracy.
3. Draw a picture of every seed removed from the egg carton experiment to create a picture growth chart.
4. What did you like about today's activities?



When To Plant Vegetables for a Spring Garden

Vegetable	Start Seedlings Indoors	Transplant To Garden Weeks from sowing seed to transplanting in the garden.	Plant Seed Directly Into the Garden
Beets	Late Feb./ Early March	5 to 7	
Broccoli	Late Feb./Early March	5 to 7	
Cauliflower	Late Feb./Early March	5 to 7	
Chinese Cabbage	Late Feb./Early March	5 to 7	
Dill			Early April
Early Turnips			Early April
Endive	Late Feb./Early March	5 to 7	
Kale	Late Feb./Early March	5 to 7	
Kohlrabi	Late Feb./Early March	5 to 7	
Kyona	Mid-March	5 to 7	
Leaf Lettuce	Mid-March	5 to 7	
Mustard	Late Feb./Early March	8 to 10	
Mini Carrots			Early April
Pak Choi	Mid-March	5 to 7	
Peas			Early April
Radishes			Early April
Scallions	Late Feb./Early March	8 to 10	
Spinach			Early April
Tatsoi	Mid-March	5 to 7	
Flowers			
Calendula	Late Feb./Early March	After Frost Date	
Johnny Jump-Ups	Late Feb./Early March	8 to 10	
Nasturtiums	Late Feb./Early March	After Frost Date	
Marigolds	Late Feb./Early March	After Frost Date	
Sweet Pea Bush	Late Feb./Early March	After Frost Date	
Zinnias	Late Feb./Early March	After Frost Date	

Important Notes:

1. The planting dates for these spring vegetables are based on the Cape Cod climate and the necessity to harvest before school ends in mid-June. Adjust dates to your specific growing conditions. See references for recommended gardening books in the back of this manual.
2. If seedlings begin to look spindly (very long, extended, droopy) they are not getting enough light. Add a dose of sea mix fertilizer each week until it is time to transplant them in the garden.
3. If the spring weather does not cooperate, the transplanting dates may be delayed. In that case, you may have to transplant some plants into larger containers indoors to maintain healthy seedlings with unbound root systems. If the plants are outgrowing their containers, transplant to larger containers and apply a sea mix fertilizer once a week.
4. It is very important to keep young seedlings strong and healthy. Weak seedlings will slow down the growth of the plant and increase loss during transplantation.

Cool Season and Warm Season Vegetables

Objective: To demonstrate one difference between cool season and warm season vegetables.

Materials Needed: A clear glass jar, paper towel, bean and head lettuce seeds.

Conduct an experiment using two kinds of seeds: bean and head lettuce. Mix the seeds. Line a clear glass jar with a damp paper towel, and place the seeds between the paper towel and the container. Keep the towel moist. Put the jar in a refrigerator. Remove the jar when the lettuce seeds have germinated. Have the children discuss why the bean seeds do not germinate. Cool season vegetables, such as head lettuce, will also germinate in warm weather, but the plants will go to seed prematurely.

From: *Children's Gardens:: A field Guide for Teachers, Parents and Volunteers.*

How Deep Can You Plant Seeds?

Objective: To demonstrate the effect of planting depth on seeds.

Materials Needed: A clear jar, potting soil, pea seeds.

Fill the glass container 1/3 full of premoistened potting soil. Place about five pea seeds on top of the layer of soil against the sides of the jar. Add enough potting soil to fill the jar 2/3 full. Plant five more pea seeds at this level. Fill the jar 2/3 full of potting soil then plant a third layer of seeds. Cover this last layer with 1/2 inch of soil. Have the students observe and record the germination rate of each layer of seed. Discuss the reasons for the results.

Planning The Garden With the Students

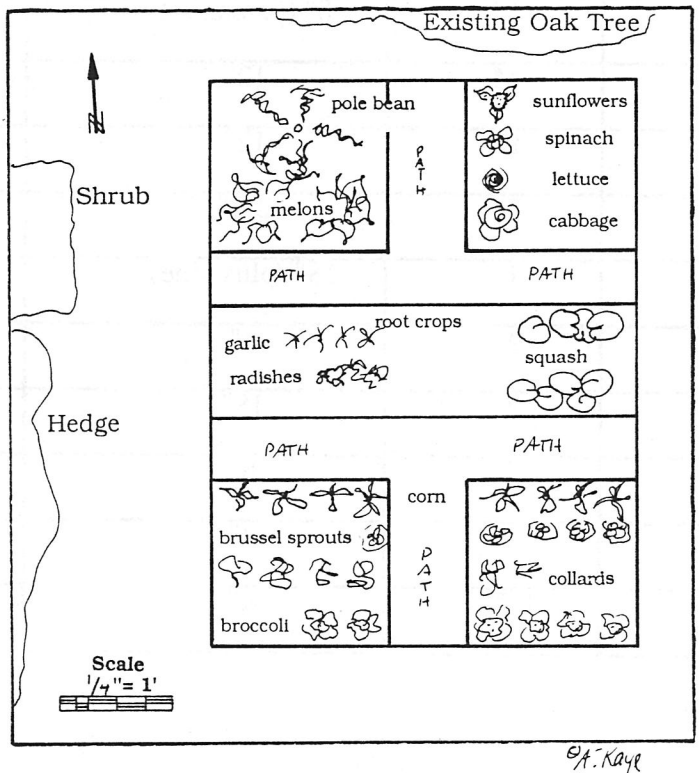
Planning the garden on paper can be an exciting lesson in problem solving. Think of it as a jigsaw puzzle.

The most important part of drawing a garden plan is to place each vegetable where it will get the space and light it needs. See the end of this section for a chart listing plant spacing requirements and a sample planting scheme. Some vegetables like corn, melons and squash require a lot of space. Some vegetables, such as broccoli, root crops and leafy vegetables can be planted in parts of the garden that do not get full sun. Place the plants that will reach the greatest height (pole peas, sunflowers, corn) along the north end of the garden in rows that run east and west. Put medium-sized plants (bush beans, brussels sprouts, collards) in the middle, and the smallest plants (radishes, garlic, lettuce) in the front. Be sure to leave enough room for walkways between beds. Walkways should be at least three feet wide.

On a large sheet of newsprint or a large poster board, sketch out the garden to scale. Include existing trees, other features of the garden area and compass directions. Tape the garden sketch onto the blackboard. Beside it, make three columns with the following headings:

What to Plant Height How Much Space

Copy the information from the "Planning-Your-Garden Chart " to the blackboard. As a class, determine what to plant where. Once the decisions have been finalized, finish the schematic drawing of the garden plan.



Planning-Your-Garden Chart

L = up to 24" M = 24"- 48" H = 48" and up.

Vegetable	Height of Mature Plant	Distance Btw. Plants	Distance Btw. Rows
Beans, snap (bush)	M	4"	18-30"
(pole)	H	6"	36-48"
Beets	L	3"	12-18"
Broccoli	M	18"	24-30"
Brussels sprouts	M	18"	24-30"
Cabbage (Chinese)	L	12"-18"	18-24"
(Red and Green)	L	24"	24-30"
Cantaloupe	L	18" (plus vine)	60-72"
Carrot	L	2"	16-24"
(Mini carrots)	L	1"	16-24"
Cauliflower	L-M	18"	30-36"
Celery	L-M	6"	24-30"
Chard	M	12"	18-24"
Chive	L	8" (perennial)	10-16"
Collards	M	12"	24-30"
Corn	H	12"	30-36"
Cress	L	2-3"	12-16"
Cucumber	L	18" (plus vine)	48-72"
Dill	M	6"	10-16"
Eggplant	M	18"	36"
Endive	L	8"	12-24"
Garlic	L	3"	12-18"
Kale	L-M	18"	18-24"

Kohlrabi	L	4"	18-24"
Kyona	L	10"	16-18"
Lettuce (head) (leaf)	L L	12" 8"	18-24" 12-18"
Mustard	L-M	6"	12-18"
New Zealand Spinach	L-M	8"	18-24"
Okra	M	18"	18-24"
Onion (bulb)	L	3"	12-24"
Pak choi	L	10"	16-18"
Parsnips	L	3"	16-24"
Peas (bush) (pole)	M H	3" 4"	18-24" 36-48"
Peppers	M	18"	18-24"
Potato	L	12"	24-36"
Pumpkin	L	36" (plus vines)	48-96"
Radish	L	1"	6-12"
Scallions	L	6"	16-18"
Spinach	L	3"	12-24"
Squash (summer) (winter)	L-M L-M	18-36" (plus vines) 36" (plus vines)	36-60" 48-120"
Tatsoi	L	8"	16-18"
Tomato	M-H	18" (staked)	36-60"
Turnip (Japanese turnips)	L L	3" 3"	16-18" 16-18"
Watermelon	L	36" (plus vines)	60-72"

Planting distance will change with variety. Always read the planting directions on the seed packages to confirm appropriate distance between plants.

MARCH

NOW IS THE TIME TO CONSIDER...

1. Continuing to plant seedlings. Pak Choi, Tatsoi, Kyona, and leaf lettuce should all be started by the third week in March.

2. Testing the garden soil.
The basic assumption of organic gardening is that if the soil is healthy the plants will be healthy. A fertile soil has good amounts of the three major plant nutrients—nitrogen, phosphorus and potassium; a sufficiency of micronutrients (trace elements), and an abundance of organic matter. To be fertile the soil must also have a nearly neutral soil pH as well as good structure and drainage. Your garden soil must be tested so you know its nutrient levels, organic matter content, and pH.

   Soil tests can be run at a local Extension Service or state agricultural experiment station, usually for a small fee. Results will normally include remedies for problems shown by the tests. To have your soil tested in Massachusetts write or call:

   Soil and Plant Tissue Testing Laboratory, Suburban Experiment Station, University of Massachusetts, 240 Beaver Street, Waltham, MA 02254. (617) 891-0650

   The Suburban Experimental Station will send you a sample bag and complete instructions for taking the soil sample. When filling out the questionnaire, specify that any recommendations for treatment should be for an organic garden.

   You can purchase a do-it-yourself soil test kit. Tests in some kits are complicated so it would be difficult to involve students in the procedure, but it may be worth a try. A good kit has instruction for analyzing the tests and recommendations for fertilizing. Results are not as accurate as they would be if you sent your soil away to be tested.

   Use a trowel, a sampling probe, or a spade to gather a sample of soil from a depth of six inches. Take several samples from random areas all across your garden site. Mix all samples together, then perform the tests.

   Soil test kits can be purchased in small quantities from the:

   Necessary Trading Company, P.O. Box 305, New Castle, Virginia 24127 or

   The New Alchemy Institute, 237 Hatchville Road, East Falmouth, MA 02536. (508) 564-6301

3. Purchasing any soil amendments needed to improve the fertility of the garden soil based on the soil test recommendations. See the "Teacher Information on Soil Fertility" following the April section.

4. Arranging to take a field trip to study different habitats: Lesson 2: Habits and Habitats. The sites you visit could be within walking distance from your school.

5. Building a cold frame.
A cold frame is a garden structure designed like a bottomless box with a clear lid. It traps the sun's heat while protecting plants against cold air, wind and other unfavorable growing conditions. You can use cold frames to "harden-off" seedlings prior to transplanting or to start cold weather plants.

A cold frame can be made from plywood or other scrap lumber, old windows, or a wooden frame over which plastic is stretched. To build a cold frame large enough to hold three flats of seedlings (each standard flat is 19 inches by 19 inches square) use five pieces of 3/4-inch lumber. The front piece should be five inches high by 61.5 inches long, and the back piece 12 inches high by 61.5 inches long. The sides should be five inches and 12 inches on the ends, 20 inches long on the base, and 21 inches on the top. Each side must be cut from one piece of wood.

Butt the sides against the front and back pieces and join with nails and angle brackets as shown in the diagram. Attach a support piece three inches by 61.5 inches across the back using wood screws. This forms the base of the cold frame.

If you have windows to use as the top, modify the dimensions of the base to fit. A scale drawing will help you calculate the dimensions. Attach the windows with hinges for easy opening.

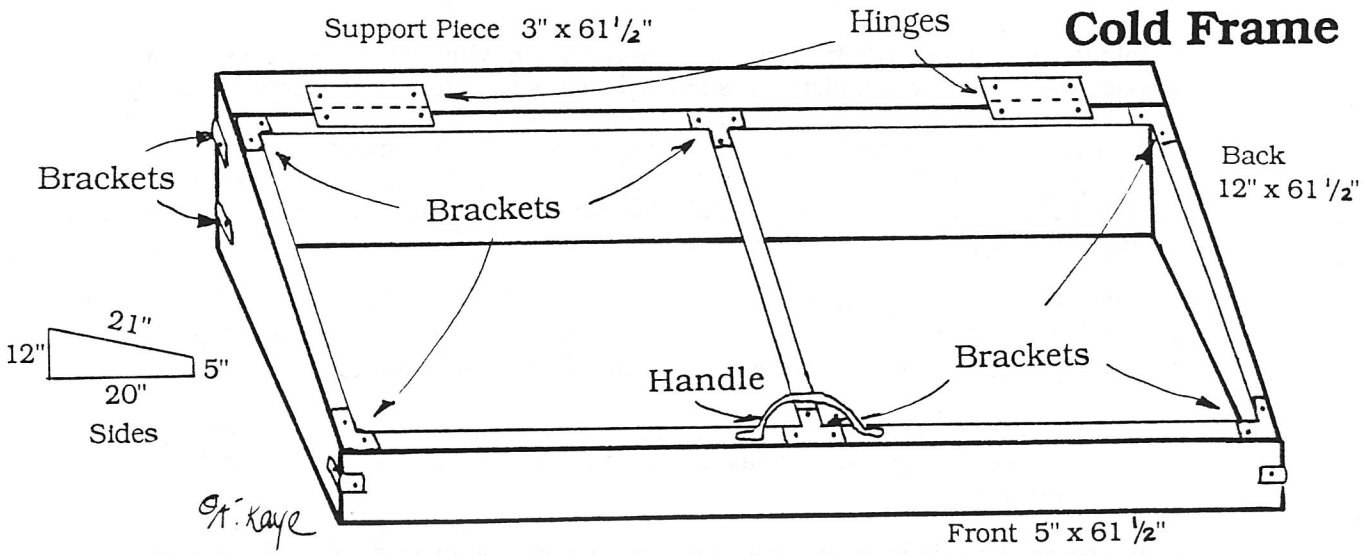
If you do not already have windows for a top you can build a lid. To build the lid, make a frame out of 1-inch by 2-inch (1 x 2) lumber. The outside dimensions should be 18.5 inches by 61.5 inches. The corners can be mitered and joined with glue and nails, or butted together with angle brackets (see diagram). For added strength, you can include a center support 15 inches long, also fastened with angle brackets.

Attach two hinges and a handle, if desired, with wood screws. Cover the top of the frame with a sheet of four to six-mil polyethylene plastic and fasten with a staple gun. Stretch the plastic so that it is fairly taut. Cover the back of the lid with another sheet of plastic. This creates an insulating air space.

Attach the lid to the cold frame using wood screws to fasten the hinges to the three-inch crosspiece. It will probably take two people to carry this cold frame to the garden. Use a 12-inch stake to prop open the lid on warm sunny days to allow for air circulation.

The wood on a cold frame should be painted to prevent water damage. Do not use treated wood since the preservatives will damage plants inside the bed. If you have more than three flats to "harden-off" you will need a larger cold frame or more of the same size described here.

This design for a coldframe is taken from: *Children's Gardens: A Field Guide For Teachers, Parents and Volunteers.*



March

Lesson 1: Everything Is Connected To Everything Else
Interdependencies in the Garden Environment

Time Frame
45 minutes

Objectives
To identify the environmental factors that affect the garden environment.
To explore the interdependencies between the environmental factors in the garden.

Materials Needed
A ball of string, paper for name tags, magic markers, tape.

Vocabulary
Environmental factors, abiotic, biotic, environment.

Procedure
With your students, generate a list on the board of all the things you can think of that make up a garden environment. Encourage the students to include both nonliving, and living ingredients with the following questions:

What do the plants need to live?
What organisms are needed to continue the nutrient cycle in the garden?
What organisms might be attracted to the garden environment to find food?
What might we find in the garden that would affect the way the vegetables grow?

The list could look something like the following.

A Garden Environment

soil (rocks, plants, animals)	ants	vegetables
birds	water	manure
decomposers	worms	sunlight
leaves	slugs	warm temperatures
bees	nutrients	rabbits
aphids	ladybugs	flowers
shade	herbs	

Tell the students that the items listed on the board are called environmental factors. An environmental factor is anything that is near the garden that affects the way the garden grows. Some of these factors are caused by plants and animals. The others are caused by nonliving things. Ask the students to identify the factors on the board that are caused by nonliving things. Circle all of the nonliving factors as they are identified. Note that soil is made up of both nonliving and living ingredients. Ask the students if all of the items that are not circled are from or caused by living things. When everyone is satisfied with the list, introduce the terms biotic and abiotic.

"The environmental factors caused by nonliving things are called abiotic factors. Those caused by living organisms are called biotic factors." Write abiotic and biotic on the board. Ask the students, "Are the circled items abiotic or biotic factors?"

Lead the following discussion:
"Everything that we have listed on the board makes up a garden environment, and everything listed is connected to everything else one way or the other. We are going to see how all the ingredients of the garden environment are connected by playing the roles of each nonliving and living thing found in the garden."

Assign a garden ingredient to each student in the classroom. Use different types of vegetables and have at least five students become decomposers. Be sure to have both nonliving and living ingredients represented. Have the students write the name of the ingredient that they represent on a piece of paper. Tell them to write big. Tape their name tags on the front of their shirts.

Form a circle together in the front of the room. Make sure everyone's tag is in place and legible. "This circle represents a garden environment. Everyone in this environment is connected to everyone else. We are going to show the connections with this ball of string. Lets start with the sun because everything gets its energy from the sun."

Hand the ball of string to the student representing the sun. Tell that student to look around the circle and find one garden ingredient that she/he is connected to in some way. "Who do you need or who needs you to survive? A plant needs the sun's energy to make it's own food." Have the sun wrap the end of the string around her/his finger and pass the ball of string to a plant. "The plant is connected to the sun because the sun gives the plant energy it needs to survive. OK plant , look around this circle and find someone that you are connected to in some way. What else do you need to survive or what needs you."

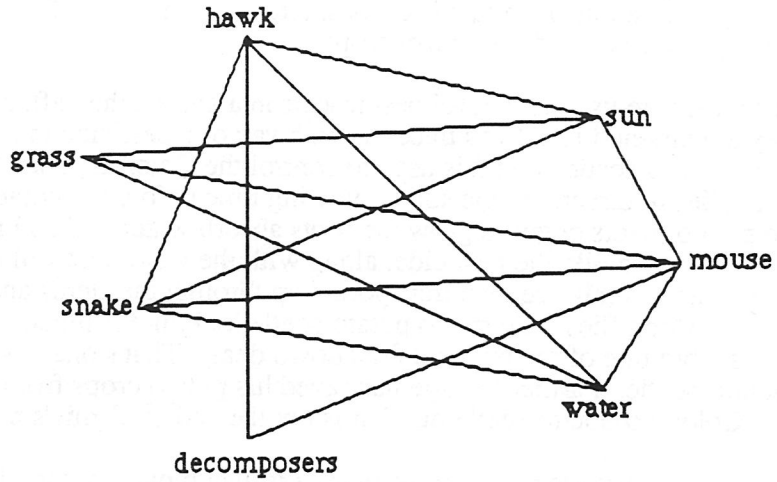
Continue in this manner until everyone has a piece of the string wrapped around a finger. Remind the students that decomposers eat dead things so they can connect to any living thing. All living things die. In an organic garden, decaying plant material becomes nutrients for plants.

In the end the circle will resemble a web. To demonstrate how each individual is important to the whole garden environment, by some plausible means, take away one member of the web. For example, a drought occurs one year and there is no available water for the garden. When the water is gone it tugs on the strings it holds; anyone who feels a tug in her/his string is in some way affected by the absence of water. Now everyone who felt a tug from the tree gives a tug. The process continues until every individual is shown to be affected by the lack of water.

Journal Suggestions

1. Make a new web for a different type of environment like a forest or a beach environment. Write down all of the members of your new environment. Draw a diagram showing how each member is connected to the others.

A Field community



2. Remove a member from the garden environment established in the classroom and describe the consequences of its loss. Do not use an example that was already discussed in class.

3. Tell what you thought of today's lesson. Did you like being a part of the garden environment. Using the words from the vocabulary list, explain what you learned from today's lesson.

4. Draw a picture of a garden environment including all of the environmental factors listed on the board. Add more as you think of them.

Where Do Pesticides Go?

Objective: To demonstrate how pesticides move through a garden environment into our water supply.

Read the following story about Temik, a toxic pesticide, to your class. Discuss the consequences using toxic pesticides on farm crops.

"When toxic pesticides are used to control pest insects in a garden they affect much more that the pest they are targeted for. Let's trace the pathway of a pesticide in a garden environment. Temik is a pesticide that is used to control the Colorado potato beetle. Farmer George applies it directly to the soil at plowing time before the potato plants are planted. As the potato plants begin to grow the roots absorb water and soil nutrients. The roots are also absorbing Temik, the pesticide, along with the water and soil nutrients. The water, soil nutrients and Temik are then transported up through the stems and to the leaves of the potato plant. Along flies a Colorado potato beetle looking for lunch. It lands on the potato plant, takes a big bite of the leaf and falls down dead. That's one costly lunch for the Colorado potato beetle. Farmer George has saved his potato crops from being destroyed by the Colorado potato beetle but that is not the end of Temik's travels.

Just as the Temik was transported up into the plant it is also moves further down into the soil. As rain falls on the soil the Temik is washed deeper and deeper until it finally reaches the underground water table.

The Swift family lives next door to Farmer George's potato farm. They get their water from a well that is filled from the underground water table. The well water does not smell or taste different than usual but the family begins to suspect that something is contaminating their water supply. The symptoms are scary. When Temik is ingested by humans it can cause blurred vision, vomiting, a very fast heart rate, headaches, loss of appetite, nervousness, birth defects and cancer.

All the families around the potato farm are experiencing the similar problems. The well water has been contaminated with Temik and the families can no longer use it. Can you imagine living in a house and not being able to use the water? Think of all the things you use water for—baths, cooking, brushing your teeth, washing your dog, washing dishes, and drinking.

The Temik story is a true one. Families who live near the potato fields on Long Island, New York can no longer use their well water because it has been contaminated by Temik. The same thing happened in the small western Massachusetts town of Whately. The use of Temik is banned in both places now but it is still being used in other places. When will farmers learn that, "Everything Is Connected To Everything Else?"

The good news is that the Mycogen Corporation in San Diego, California has developed a control for Colorado potato beetles that does not cause problems to the rest of the environment. M-One is a bacterium that occurs naturally in nature. This bacteria causes a disease in the larval stage of the Colorado potato beetle. Because it is a natural control that only affects Colorado potato beetles, it does not pose a threat to other animals.

Make a Homemade Safe Pesticide

Objective: To make a nontoxic pesticide from natural ingredients.
To experiment with different homemade insect sprays.

Read the following information to the class.

"Pest problems in a garden can be dealt with in a way that is safe for the environment. At New Alchemy, the scientists have conducted research for many years to learn how best to control pest insects in the greenhouses and gardens.

The Institute uses a combination of different methods to control pest insects. Some of the methods used are described below.

Mimicking Nature: Many pest insects can be controlled by a predator, parasite or a disease that is specific to the pest in question. For example, the aphid, a very common pest, can be controlled with its natural predator the ladybug. Colorado potato beetles can be controlled with M-One, a bacteria that causes a disease in the Colorado potato beetle. The tomato hornworm can be controlled by a tiny wasp. The braconid wasp will lay its eggs on the back of the hornworm caterpillar. When the larvae hatch from their eggs, they begin to feed on the hornworm caterpillar. When the wasp larvae have grown big enough, they crawl out of the caterpillar and spin cocoons on the worm's skin. In time, this kills the caterpillar and the larvae emerge as tiny wasps.

Traps: White Flies are a common pest insect found in greenhouses. They can be controlled with a yellow sticky card. The white fly is attracted to the color of the card. When it makes contact with the card, it sticks to it like houseflies stick to fly paper.

It is also important to put healthy plants into fertile, well-conditioned soil, to practice garden hygiene by removing diseased plants, to use varieties that are naturally resistant to diseases, to plant several varieties of vegetables in the garden, and to shift crop locations in different planting seasons so that disease organisms do not establish a firm presence in the soil.

Activity

You can make a homemade concoction to keep insect pests out of the garden. Test the following garlic-pepper recipe for protection against cabbage worms, caterpillars, tomato hornworms, aphids and other pesky insects.

Materials Needed:

Six cloves of garlic, crushed
One onion minced
1 tablespoon dried hot pepper
1 teaspoon pure soap (not detergent)
1 gallon hot water

Aphid

What to do:
1. Blend garlic, onion, pepper and soap in hot water and let the mixture sit for a day or two.
2. Strain before using as a spray.

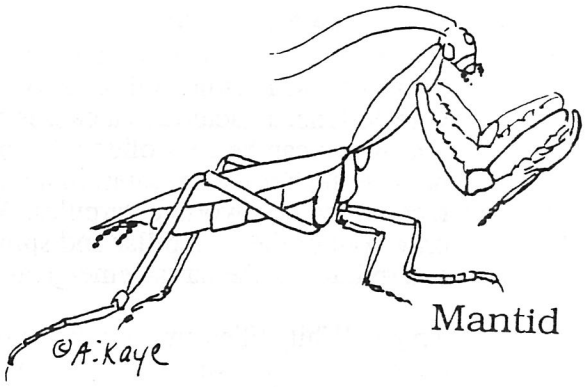
Tips:
Water is the carrier, soap makes the spray stick and the plant juices are the active ingredients. When using soap, Naphtha is recommended. It will dissolve easily if you add four teaspoons of alcohol to a gallon of water.

Doing More
Experiment with different mixtures that you come up with on your own. Make sure you do not use any toxic material.

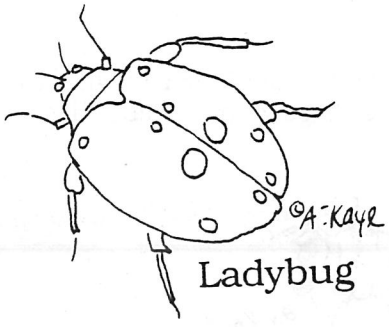
Why do you think garlic, onions, and hot peppers are used?

Design a trap to catch a pest insect in your garden.

Adapted from: *The Youth Gardening Book*



Mantid



Ladybug

Everywhere Is Somewhere

When people spray poisons into the air
to kill plant-eating insects,
the insects may die
but the poison does not go away.
It stays, unseen, in the air.
And it falls, perhaps years later,
on other plants, and on the land.
When the rains come, some poisons wash off of the plants
and run off the land
into ponds and lakes and rivers.
The poison is always somewhere.
It gets into water plants
and small water animals
and into the fish that eat them.
Birds of the air catch the poisoned fish,
or eat the poisoned insects,
and poison gets into the birds.
The poisoned birds lay eggs with soft eggshells.
No baby birds will come out of these eggs.
Some kinds of birds will never fly through the air again.
They are gone forever,
because of poisons in the air.
In the air, everywhere is somewhere.
Nowhere is away.

From: *Save the Earth:* An Ecology Handbook for Kids, By Betty Miles

Lesson 2: Habits and Habitats

Time Frame
3 hours

Objectives
To show the interdependence of all living things.
To develop an awareness and understanding of the needs of all living things.
To develop a sense of personal responsibility for the environment and its protection.

Vocabulary
Herbivore, carnivore, omnivore, habitat, habit, niche, food chain, food web, predator, prey, nocturnal, camouflage.

Materials Needed
Books, magazines, posters illustrating the different habitats you are going to visit and the animals that live there.

Procedure
A great introduction to this lesson is the optional activity, "Everybody Needs a Home," following this section. Consider doing the optional activity first.

Habits and habitats introduces students to some of the animals that are found in the local area. You and your students will look at their habitats and discuss their needs for survival. This activity tries to convey to students the interdependence of all living things and the tremendous capacity humans have to introduce change—both good and bad—in the environment.

The lesson begins with a discussion of what a habitat is and what things an animal needs to have in its habitat in order to live there: food, water, shelter, and protection from enemies. How do different animals meet these needs? What kinds of foods do animals eat? How do they protect themselves? What kinds of homes do animals live in? What are some habits of animals? It should be stressed that each animal has specific requirements in types of food, water, shelter and protection for its habitat, and if any of these requirements are missing an animal will not be able to survive in that habitat. The group then visits several habitats and talks about some of the animals that live there. Have pictures on hand to illustrate some of the animals which live in the areas you will visit.

In each habitat ask the students to determine what kinds of things live in the area you are visiting. What adaptations do these animals have that help them live in this habitat? The group can try to discover the sources of an animal's home, protection, food and water. Have the students think about one animal in the area. If they were that animal, where would they go to look for food or hide from a predator?

Some habitats to visit: a lawn, pond, forest, creek, meadow, beach, salt marsh, or a garden. Make comparisons between different animals and different habitats. How are they similar? Different?

To conclude, discuss what our habitat is. Where do we get our food from? Where does our water come from? What kind of shelter do we have? Do we have to protect ourselves from predators? What would happen to you if someone came to your neighborhood and bulldozed all of the houses? What would happen to the animals if we bulldozed their

habitat? Can animals move some place else? Discuss habitat destruction and habitat improvement. What can we do to help animals and protect their habitats? What about protecting the kind of habitat we like to have?

Journal Suggestions

1. Have the students keep a chart to compare the different habitats visited. They can record the names of the animals in the habitat, their sources of shelter, food, water and means of protection.

2. Make up an imaginary environment and invent an animal that would be adapted to live there. Draw a picture of your creation.

3. Which one of the habitats visited was your favorite? Tell why.

Everybody Needs A Home

Objective: To make students aware of the fact that people and other animals share a basic need to have a home.

Materials Needed: Drawing paper, crayons or chalk.

Background Information:
Humans and other animals, including pets, farm animals and wildlife, have some of the same basic needs. Every animal needs a home. But that home is not just a "house" like people live in. Home, for many animals, is a much bigger place, and it's outdoors. The scientific term for an animals' home is "habitat." An animal's habitat includes food, water, shelter or cover, and space. Because animals need the food, water, shelter and space to be available in a way that is suitable to the animal's needs, we say that these things must be available in a suitable arrangement.

The major purpose of this activity is for students to realize that animals need a home. Homes are not just houses. A house may be considered shelter. People build houses, apartments, trailers, houseboats, and other kinds of shelter in which to live. Animals don't need a home that looks like a house, but they do need some kind of shelter. The shelter might be underground, in a bush, in the bark of a tree, or in some rocks.

Everybody needs a home. A home is bigger than a house. A home is more like a neighborhood that has everything in it that is needed for survival.

1. Ask the students to close their eyes and imagine: a bird's home, an ant's home, a beaver's home, their home, the president's home. Talk about the things every animal needs in its home: food, water, shelter, and space in which to live, arranged in a way that the animal can survive.

2. Have the students draw a picture of the homes they imagined including all of the things every animal needs for survival.

3. Make a "gallery of homes" out of the drawings. Point out to the students that everyone has a home.

4. Summarize the discussion by emphasizing that although the homes are different, every animal—people, pets, farm animals, and wildlife—needs a home. Talk about the idea that a home is actually bigger than a house. In some ways, it is more like a neighborhood. For animals, we can call that neighborhood where all the survival needs are met a "habitat." People go outside their homes to get food at a store, for example. Birds, ants, beavers, and other animals have to go out of their "houses" (places of shelter) to get the things they need to live.

Adapted from: **Project Wild**, an interdisciplinary, supplementary environmental and conservation education program for educators.

Habitat Lap Sit

Objective: To 1) identify the components of a habitat 2) recognize how humans and other animals depend upon their habitat 3) interpret the significance of the loss of or change to a person or animal's habitat.

Procedure

1. Ask the students to number off from "one" to "four." All the "ones" go to one corner of the room, the "twos" to another, etc.

2. As the students move to their corners, clear a space in the center of the room or go outside to a grassy area.

3. Assign each group a concept as follows: "ones" = food, "twos" = water, "threes" = shelter, "fours" = space.

4. Have the students form a circle by linking chains of food, water, shelter, and space. Have a student from each of the four groups walk into the cleared area. The four students stand next to each other and face into the center of the circle. Four more students, one from each group, join the circle. Keep adding to the circle in sets of four until all the students are in the circle.

5. All students should now be standing shoulder to shoulder, facing the center of the circle.

6. Ask the students to turn to their right and take one sidestep left toward the center of the circle. They should be standing close together, with each student looking at the back of the head of the student in front of her/him.

7. Don't panic—this will work. Ask everyone to listen carefully. Everyone should place their hands on the waist of the person in front of them. At the count of three, have the students sit down on the knees of the person behind them, keeping their own knees together to support the person in front of them.

   You then say, "Food, water, shelter, and space—in the proper arrangement (represented by the students' intact "lap-sit" circle)—are what is needed to have a suitable habitat."

8. The students at this point may either fall or sit down.

9. Let the students try the circle activity again. This time ask them to hold their lap-sit posture. As the students lap-sit identify a student who represents "water." Then say, "It is a drought year. The water supply is reduced by the drought conditions." Have the student who was identified as representing "water" step out from the lap-sit circle, and watch the circle collapse.

Try the lap-sit again and vary the disasters: pollution of water supply, urban sprawl limiting availability of all components, soil erosion impacting food and water supplies, etc.

10. Ask the students to talk about what this activity means to them. Ask the students to summarize the main ideas they have learned.

From: *Project Wild*, an interdisciplinary, supplementary environmental and conservation education program for educators.

APRIL

NOW IS THE TIME TO CONSIDER

1. Reviewing the soil test to determine what fertilizers are needed to improve the garden soil. Read the teacher information on soil fertility following Lesson 1 to determine your needs. Once determined, purchase all needed soil amendments and have them on hand for Lesson 1: "Healthy Soil Means Healthy Plants."

2. Arranging to have your garden rototilled. Your garden soil needs to be worked as early as possible. Deciding when to cultivate is one of the more difficult problems facing a new gardener. Working a soil when it is not ready for cultivation can do more harm than good. Moisture is the most important determinant of when a soil can be worked.

   Soils are hard to work when wet. Especially clay soils. Working a clay soil when wet will produce clods that will become rock-hard when baked dry by the sun. Work the soil when it tells you it is ready.

   Perform this simple test to find out when your soil is ready to work. Grab a handful of soil and squeeze it into a ball in your hand. If you can crumble the ball into small pieces with gentle finger pressure, it is ready to work. If the ball is wet and sticky and you cannot break it apart, the soil is too moist to work. If you cannot press the dirt into a ball, it is probably too dry to work.

3. Taking a field trip to a nearby wooded area to examine a rotting log (See the optional activities for Lesson 1.)

4. Collecting all tools needed for preparing the beds for planting. You will start using tools from now on. Borrow what you need if you were unable to secure tools by now. (See the supply list at the back of the manual to determine what tools you will need.)

5. Contacting volunteers to help you and the students prepare the garden beds for planting. (See Lesson 2: "Spring Into Action.")

6. "Hardening off" the cool weather crops before you transplant them into the garden. One to two weeks before transplanting into the garden, all seedlings need to be moved into a cold frame. See Lesson 3: "Move Em' Out—Move Em' In."

7. Transplanting and direct seeding cool season plants into the garden (refer to the "When To Plant Vegetables for a Spring Garden" chart in the February /Early March section). Follow instructions given in Lesson 3: "Move 'Em Out—Move 'Em In."

April

Lesson 1: Healthy Soil Means Healthy Plants
A Lesson on Soil Fertility

Time Frame
35 minutes for indoor lesson
25 minutes to add soil amendments with your students.

Objective
To identify the three major minerals needed for a healthy soil.
To become familiar with common soil deficiencies and their treatment with organic fertilizers.

Materials Needed
Results from a soil test, any necessary soil amendments based on soil test results, tools needed for applying fertilizer (if you will be doing this with the students).

Vocabulary
Minerals, nitrogen, phosphorous, potassium, an organic fertilizer, pH, acid, alkaline, soil fertility.

Procedure
Before you begin this lesson you should be familiar with the results of the soil test and have the necessary soil amendments on hand. Read the teacher information on soil fertility following this lesson to determine what and when to add needed amendments.

Read and discuss the following information with your students. You may want to photocopy the material and give it to your students as a reading assignment.

Is Your Soil Healthy?

Nutrients are substances that are part of all living and nonliving things. Good healthy soil contains a variety of nutrients. When the garden soil is healthy, the plants we grow will be healthy.

Nutrients are available to plants when rocks erode and plants decompose. Plants absorb these nutrients through their roots. Once inside the plant the nutrients become part of the plant's structure or take part in energy reactions that keep the plant growing. These nutrients eventually become part of your body after you eat a plant.

Poor garden soil is often too low in nutrients. Some nutrients are called minerals. Nitrogen, phosphorous and potassium are the minerals most likely to be present in low amounts in poor soil. Plants growing in poor soil will have stunted growth or odd-colored leaves. Poor garden soil usually results from over-using land without putting back any nutrients.

Your garden soil was tested to find out how healthy it is. If the test shows that your soil is low in any one of the three major minerals, you can add them back into the soil by using an organic fertilizer.

Organic fertilizers come from decomposing plant and animal material or natural rocks. If your compost pile has decomposed enough, you can add it to your garden soil to improve

its fertility. The compost is ready when you cannot identify any of the plant parts and it is black.

Organic fertilizers such as cow manure or compost not only supply a balance of minerals and nutrients but also improve the soil's ability to hold water and circulate air. Even if your soil test reveals an adequate supply of minerals, adding a little compost or manure will be of benefit.

Your soil was also tested for its pH level. A pH measures how acidic or alkaline your soil is. PH is measured on a scale from 0 to 14. A pH reading below 7 indicates that your soil is acidic, above 7 your soil is alkaline. Plants grow best in soil with a pH of 7—right in the middle.

Go over the soil test results with your students. Discuss the deficiencies of your soil and the types of fertilizers you will use to treat these deficiencies. Have samples of the fertilizers on hand for the students to examine. (Use the information on organic fertilizers following this lesson to determine what fertilizers you will need to add to your soil.)

If timing is right, take your students outside to add the fertilizers to the soil. This task may be easier handled by adults, but if possible, include the students. If your compost is very well decomposed (you cannot recognize any of the plant material and it is black in color) have the students spread this over the garden to be rototilled in. Composted manure can also be added now. Some fertilizers are best added as a "side-dressing" after the seedlings have been established. If you are spreading fertilizer on the soil before planting, have it rototilled into the top three inches soon after application.

CAUTION: If you are using chemical fertilizers (not organic) do not have children working with them. We highly recommend the use of organic fertilizers.

Journal Suggestions

1. Use the information from today's lesson to determine if your compost is ready to add to your garden. Describe what your compost looks like now. How has it changed since the fall? Describe the steps involved in adding the compost to your garden.

2. Write a paragraph describing the characteristics of a healthy soil. What three minerals must be present? What should the pH be?

3. As a class exercise, write a note to next year's students describing the condition of your garden soil and what your class did to doctor it up. Put the note in a time capsule along with a soil sample so next year's students can see how the garden soil has improved by your good work.

Make a "Manure Tea"

Objective: To make a liquid organic fertilizer.

Materials Needed: Fresh or dried manure, old grain bag, large bucket with a lid, a stirring stick.

"Manure tea" for plants is made by dropping an old grain bag full of dried or fresh manure into a large bucket of water and "steeping" it for a few days. Kids will love this project! Follow the steps below.

1. Put a few shovelsfull of manure into the grain bag.
2. Drop the bag into a large bucket of water. Put a close-fitting cover over the top to keep out flies. Give the brew a stir or two every day until the water is very dark.
3. You may want to dilute the tea somewhat, especially if you are watering very young seedlings with it.
4. When you're finished brewing, empty the bag. Put residue on the compost pile or around plants to mulch them.

From: *The Youth Garden Book*

Visit A Rotting Log

Objective: To examine how nature recycles nutrients into the soil.

Go on a field trip to a wooded area where a rotting log can be found. Equip the students with magnifying lens. Gather students around the log and direct them to close their eyes and:

Listen: as they tap the log—Does it sound hollow or solid?
Smell: does it smell wet or dry? Like anything you know?
Feel: does it feel hard or soft, wet or dry, rough or smooth?

Have the students open their eyes and begin to examine the log with the magnifying glass. Look for signs of decomposition. Can you find any visible decomposers?—bark beetles, mushrooms, lichens, fungi. Be careful not to disturb the log or its inhabitants.

Gently roll the log over. What did you find underneath? Look for parts of the log that have crumbled in piles on the ground. Discuss the role of animals and plants in the decomposition process. Return the log to its original place.

Ask your students to imagine what the log will look like in 10 years, 50 years, 100. Dig up a small cube of soil and compare it to your garden soil. Have the students explore the forest soil with all of their senses.

Soil pH

Objective: To determine the pH of the garden soil.

Materials Needed: Soil sample, pH paper (4-9 range), container, distilled or purified water. Optional: lemons, baking soda, sugar.

Have the students take a sample of the top five inches of their garden soil. Stir the soil in a clean container to get a uniform mix, and add distilled or purified water. Have each student tear off a two-inch strip of pH paper and dip it in the soil/water mixture. The pH paper dispenser should contain a color guide indicating the pH levels. After one minute, have the children compare their pH paper to the color guide and determine the relative acidity or alkalinity of their garden soil. Soil samples from other parts of the garden can be tested for variations.

The children can also taste the garden soil and compare the results of the pH paper test with their taste test.
Sour (lemon) - acidic
Bitter (soda) - alkaline
Sweet (sugar) - neutral

From: *Children's Gardens*

Soil Fertility; How to Improve Soil Deficiencies with Organic Fertilizers

Fertilizer is a substance added to the soil to improve its fertility. A fertile soil has sufficient amounts of the major plant nutrients—nitrogen, phosphorus and potassium; a sufficiency of micronutrients —zinc, manganese, boron, iron, sulfur, cooper, magnesium, molybdenum, and chlorine; an abundance of organic matter, and humus. To be fertile, the soil must also have a nearly neutral soil pH (7) as well as good structure and drainage. In an organic garden, natural fertilizer maintains and contributes to the improvement of all these necessary elements. The basic premise of organic gardening is; if your soil is healthy, your vegetables will be healthy.

Nitrogen Deficiency

Nitrogen is one of the major minerals necessary for fertile soil. Nitrogen is responsible for producing leaf growth and greener leaves.

A deficiency causes yellow leaves and stunted growth. An excess produces an overabundant growth of foliage with delayed flowering. Plants with nitrogen deficiency are more subject to disease and their fruit will not be top quality.

Treatment:
Compost, manure, bone meal, dried blood

Note about nitrogen fertilizers: With the exception of compost, do not leave nitrogen-rich fertilizers on the soil's surface since nitrogen will escape into the air.

Phosphorus Deficiency

All growing plants need phosphorus for proper seed development. Phosphorus hastens plant maturity, increases seed yield, fruit development, the plant's resistance to winter kill and diseases, and the vitamin content of plants.

A deficiency causes a reddish-purple discoloration in leaves, leaf veins and stems.

Treatment
Manure, phosphate rock, bone meal

Potassium Deficiency

Potassium, the third major nutrient, is equally important to the strength of the plant. It helps in the formation of carbohydrates and is necessary for protein syntheses. In addition, it promotes early growth, improves stem strength and contributes to cold hardiness. It is also known to improve the keeping quality, color and flavor of fruit.

Plants deficient in potassium are usually stunted and have poorly developed root systems. Their leaves, particularly the older ones, are usually spotted, curled or mottled, and may even appear "burned" around the edges. Even before these symptoms appear, they produce low yields of crops.

Treatment
Manure, compost, greensand, granite dust

How and When to Apply Organic Fertilizers

Side-dressing: To "side-dress," sprinkle the amendment right along the row of vegetables one to two inches from the base of the plants. Work the soil along the row with a hoe before "side-dressing" to roughen up the soil a bit. The amendment will leach down into the soil when it rains delivering nutrients that are dissolved in water.

BONE MEAL

Bone meal, as the name implies, is made from bones and is rich in phosphorus and nitrogen. Because of its lime content, bone meal tends to reduce acidity. Steamed bone meal is the most common of the bone meal fertilizers sold. This type is made from green bones that have been boiled or steamed at high pressure to remove the fats. Raw or charred bone meal is also sold.

Application

Best results are obtained when bone meal is applied in conjunction with other organic materials. Till bone meal into the soil prior to planting or use as a "side-dressing." The high nitrogen content of bone meal makes it an excellent addition to a compost pile.

COMPOST

Compost can be added to the garden at any time but it is especially effective when added in the spring. Organic matter is vital to garden soil because it 1) improves tilth and structure 2) improves water-holding capacity 3) aids in nitrogen fixation and 4) makes nutrients available to plants. Well-decomposed compost in which you cannot distinguish plant parts, is an excellent source of organic matter.

Application

Add a generous amount any time during the growing season. You can't add too much. Work it into the top three inches of soil. Compost can be rototilled into the soil, gently forked into the first two to three inches of the soil when you are making your garden beds, added as a "side-dressing" after the seedlings have been established in the garden, or used as a mulch throughout the growing season.

DRIED BLOOD

Dried blood is a byproduct of slaughterhouses that is collected, dried and ground to powder or meal. Dried blood is an excellent source of quickly available nitrogen. It should be used carefully around plants which might overgrow or produce excess foliage at the expense of fruit or root growth, such as tomatoes. It is an excellent "side dressing" for quick-growing lettuce, greens, and corn.

Application

Use as a "side-dressing" around plants and then work into the top few inches of soil. Work into the soil immediately after application so it will not attract dogs and carnivorous wild creatures.

GRANITE DUST

Granite dust or granite stone meal is an excellent source of potash. It causes no changes in soil pH and releases its potash very slowly over a long period of time.

Application

Granite dust can be used as a "side-dressing," worked directly into the soil or used when establishing a cover crop. In the garden, suggested rates of application are ten pounds per 100 square feet.

GREENSAND

Greensand is mined from deposits left by ancient seas and contains traces of most of the elements which occur in seawater. It has been used successfully for soil building for more that 100 years and is a fine source of potash. Greensand has an ability to absorb and hold large amounts of water in the surface layer of the soil where the plant roots feed, and to slowly release, over a long period of time, the potassium necessary to stimulate photosynthesis.

Application

Greensand may be applied at any time in the spring or fall without danger of injuring plants. An application consists of about 1/4 pound of greensand per square foot of soil (or 10 pounds per 100 square feet). Greensand is used as a "side-dressing" around plants, tilled in or added to compost heaps.

LIME

The primary use for lime in the garden is as an alkalizer, to raise the pH factor, and thereby lower the acidity of the soil. Ground limestone is the best form in which to provide lime so that it will be available to plants over a long period of time. There are two kinds of limestone available, calcic and dolomite. The latter is particularly valuable because it contains magnesium, a trace element important to plant growth.

Application

To increase the pH of the soil by one unit, apply 30 pounds of ground limestone to every 1,000 square feet of soil if the soil is very sandy; if it is a sandy loam, spread 50 pounds; on loam, spread 70 pounds; and on a heavy clay, 80 pounds. Repeat the application every three to four years. Fall or spring applications well in advance of planting are best. Liming is done on freshly cultivated soil. Make sure that the lime is spread evenly and thoroughly to avoid skipping areas.

When using lime, do not expect a tremendous change in pH the first year. The second year will be better. Do not overdo it since a pH over 7 is not beneficial for most plants.

MANURE

Animal manure is an excellent source of nitrogen. The most common domestic animals that produce useable manure are horses, cattle, goats, sheep, pigs, rabbits, and poultry. Use what is available. Be aware that horse manure is typically 95 percent sawdust and 5 percent manure. The sawdust does not break down very easily. For a school garden it is best to use composted manure. Fresh manure should never be applied directly to the garden in spring or summer unless it is tilled in four weeks before planting. There is rarely enough time for this when you are racing against the school calendar. Have manure set aside in the fall for use in the spring.

Application

Use only manure that has been aged for about six months. Composted manure can be added to the garden anytime in the spring. Rototill it in with the other soil amendments, use it as a "side-dressing," or turn it into the soil when you are making your garden beds. It is best used as a bacteria activator in a compost pile. Always apply generous amounts.

PHOSPHATE ROCK

Phosphate rock is a natural rock product containing from 28 to 30 percent phosphorus. It is the organic gardener's best source of phosphate. The bacteria that thrive in soils rich in organic material secrete organic acids that promote the breakdown and availability of phosphorus. These organic acids release rock phosphate nutrients slowly so that they are available to plants for a long time.

Application

Phosphate rock is most effective when applied in combination with manure—about 25 pounds of manure for every 10 pounds of phosphate. In late fall or early spring, spread manure on your garden, then work the manure into the soil. Add phosphate rock a month or two later. Sprinkle the ground phosphate on the soil just as you would lime, then work it into the top inch of soil, or simply leave the mineral on the soil and rain will wash it into the root zone.

For more information on organic fertilizers refer to the several books on gardening listed in the reference section of the manual.

Lesson 2: Spring Into Action
Preparing the Garden Beds for Spring Planting

Time Frame
1 to 4 hours (depending on how big your garden is)

Objective
To prepare the garden beds for spring planting.

Materials Needed
Spades, shovels, rakes, digging forks, sticks and strings for marking off beds, yard stick or measuring tape, mulch material for the pathways (straw, seaweed, leaves, boards, carpeting, stones, etc.), compost and manure (if properly decomposed).

Vocabulary
Double Digging, garden bed, raised beds.

Procedure
The garden should be rototilled by now and all pre-planting soil amendments added. Compost (if it is ready) and aged manure (aged for at least six months) can be worked into the soil as you make your beds.

You and your students are going to prepare the garden beds for planting. This can take a few days and is a lot of hard work, yet very satisfying. Your students may not be able to complete the task in the available time so be sure to have some volunteers lined up to help finish the task if you think this will be the case. Use the Garden Layout you sketched in February to decided where to build the garden beds.

Deliver the following information to the students.

"We are going to prepare our garden for planting by making garden beds and people paths. The garden beds are for the plants and the pathways between the beds are for people. All of our vegetables will be planted in beds. A garden bed is an area where the soil has been prepared to provide plants with the very best growing condition possible. In a garden bed, the soil is loosened to allow the roots of plants to grow easily and to let air and water into the soil. Why is it important for plants to have air and water?"

Choose one of the following methods to make your garden beds. In both methods the area that is to be the planting beds must be marked off with stakes and strings. Each bed should be three feet wide. Any wider and it will be difficult to reach the middle from the pathways. The pathways should be at least three feet wide also. This will allow plenty of space for the students to move through the garden with tools and wheelbarrows.

Raised Beds
Raised beds are simply mounded-up garden soil (see diagram). Using raised beds are helpful when your soil is heavy and where drainage is a problem, because water collects in the lower paths around the beds instead of around plant roots. Additionally, it is easy for students to determine what is a bed and what is a pathway. Raised beds are easier to make than double digging beds. The garden must be tilled or turned over and loosened before you can start making these beds.

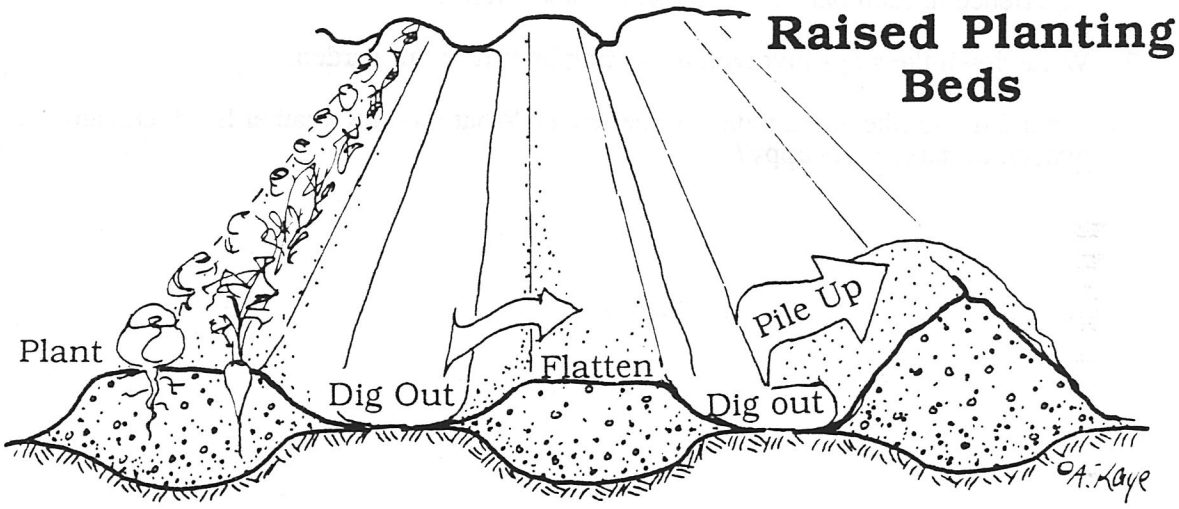
Have the students work in small groups to complete the steps involved in making raised beds.

1. Use a yard stick, string and stakes to mark off the areas you want for beds. The remainder will be the paths.

2. Use a shovel to remove the soil from the paths and pile the soil on the marked off beds. When removing soil from the paths do not dig deep enough to throw subsoil on the beds, but do remove as much of the topsoil as possible. Work in compost or aged manure if your soil is shallow.

3. Rake the beds into mounded or flat-topped beds.

4. Mulch the paths with leaves, seaweed, or straw to prevent weed growth. You could cover the paths with carpeting, boards, stones or whatever is available to keep weeds and mud to a minimum.



Double Digging

Double digging is best used in tight soils where plant roots have a difficult time growing down very far. Double digging improves drainage, making subsoil minerals available, allowing deep root growth and increasing your soil's resistance to drought. It is hard work and time consuming but well worth it. Each time you double dig the same area, the job becomes easier and easier (see diagram).

1. Mark off the areas you want for beds.

2. Dig out a trench across the width of one end of a bed about one foot deep and one foot wide. Remove the dirt from the trench to the opposite end of the bed. Do not pile the dirt on the bed. It will be used later.

3. Take a spading fork and loosen the layer of soil in the bottom of the trench. Work the soil as deeply as you can, but do not remove it from the trench. When this soil is loose, mix in a healthy amount of compost or aged manure if available.

4. Dig another trench right next to the first one. This time fill in the first trench with the dirt you removed from the second trench.

5. Loosen the subsoil in the second trench and add compost or aged manure if it is available.

6. Repeat these steps all the way across the bed. Do not walk on the bed once you have finished digging because your weight will compact the soil.

The area you double-dig will probably gain several inches of height over surrounding areas.
Have volunteers finish what the students started.

Journal Suggestions

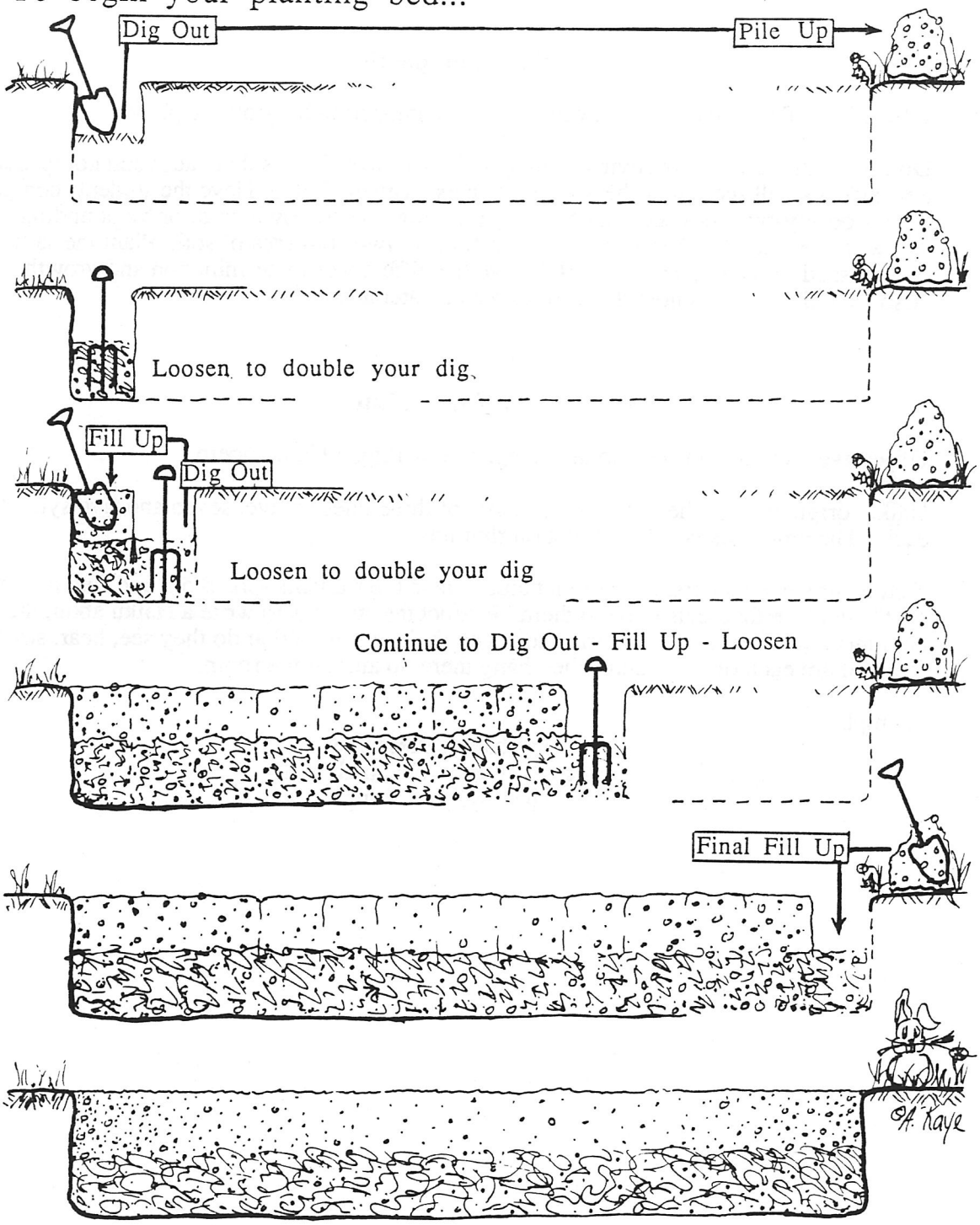
1. Imagine you are a young seedling trying to grow your roots in a compacted pathway. Then imagine growing in a raised bed or a double-dug bed. Write about your growing experience in each place. Which was easier? Why?

2. Write down the steps involved in making beds for your garden.

3. What did you like about today's experience. What was the weather like? Did anything happen to make you happy?

Double Digging a Planting Bed

To begin your planting bed...



The finished planting bed.

Soil Compaction

Objective: To demonstrate the effect of soil compaction on growing plants.

Discuss with the students environmental and man-made factors that cause soil compaction. Set aside a small section of the garden as an experimental plot. Have the students compact a two-foot-by-two-foot section of soil by jumping up and down on it, or by pounding the soil with their hands. Aerate another two-foot-by-two-foot area of soil. Plant the same type of seed in the two test plots. Observe the differences in germination and growth. Also have the students note the differences in water absorption.

Spring Haiku

Objective: To tune into seasonal changes by writing a Haiku poem.

Haiku, originated by the Japanese, consists of three lines of five, seven and five syllables each. The emphasis is syllabic, not on rhyming.

Take your students outside to a quiet area. Have the students spread out and find a "magic spot"—a place that feels good to them. Instruct the students to write a Haiku about the beginnings of spring. Tell them to focus on their senses. What do they see, hear, smell, feel? Share each other's poems then hang them up around the room.

Example:

The bare leafless trees
Beginning to sprout small buds
The days grow longer

April

Lesson 3: Move 'Em Out—Move 'Em In
Hardening-off / Transplanting / Direct Seeding

Time Frame
The objectives will be taught over a one-week period.
Objective one—15 minutes
Objective two—1 hour
Objective three—30 minutes

Objectives
1. To harden-off seedlings.
2. To Transplant seedlings into the garden.
3. To direct seed into the garden.

Materials Needed
Cold frame, seedlings to transplant, seeds to direct-seed (See the "When to Plant Vegetables for a Spring Garden" chart), trowels, hoes, rake, watering cans, season extenders may be necessary (see the following section "Season Extenders"), string, stakes.

Vocabulary
Hardening-off, cold frame, season extenders, sow.

Procedure

Hardening-Off

All of the seedlings that you started indoors will have to be hardened-off one to two weeks before transplanting them in the garden (See "When to Plant Vegetables for a Spring Garden" chart).
Share the following information with your students then move your seedlings out to the cold frame.

"Your seedlings are almost ready to be set outdoors. However, since they have been pampered with warm inside temperatures they may be shocked by suddenly placing them outdoors. That is why gardeners who start plants indoors put them through a process called "hardening off." Here is how it works.

One to two weeks before you plan to set your plants outside, put the plants in a small cold frame. A cold frame is a small greenhouse heated by the sun. It creates a new environment in between the warmth of your classroom and the cold of the outdoors. It will allow your plants to adjust slowly to outside temperatures."

1. One to two weeks before you plan to set your plants outside, move them to the cold frame. Leave your plants in their pots. On warm days, open up the cold frame so that the plants do not receive too much heat. **Close the cold frame again at night.**

2. Leave a few plants outside the cold frame. Compare them with the ones inside. Observe the stem, leaves, and general condition of the plant.

3. Record the temperature of the air outside the cold frame and inside the cold frame. Why are they different?

If you do not have a cold frame yet, you can "harden-off" plants simply by carrying them outside during the warmest part of the day. Bring them inside at night. Gradually increase the time they spend outside and their exposure to the sun.

Transplanting

Refer to the "When to Plant Vegetables for a Spring Garden" chart to decide when to transplant the seedlings into the garden.

Transplanting seedlings into the garden is one of the most important, yet hazardous, stages of a plant's life. It is hazardous because you are taking a plant out of a protected and pampered environment and sticking it into the open environment of your garden. The change in growing conditions can produce a shock capable of killing your seedlings. Always try to transplant on a cloudy day, early in the morning or late in the afternoon, so that the sun will not damage tender plant roots.

During transplanting, it is important to handle seedlings as little as possible and to handle them properly. Follow the steps below to transplant your seedlings. Have the students work as partners. Assign a certain portion of a bed to each set of partners. Demonstrate the proper way to transplant then have the students try it. Go through the first transplant together, step by step. Check the students work after each step. Water the seedling flats one hour before transplanting to reduce damage from tearing roots. Make sure you plant your seedlings at least six inches from the edges of the beds. Larger plants like broccoli, cauliflower, and Chinese cabbage should be planted in the center of the beds.

1. Prepare a hole for the plant in the garden bed. The hole you dig should be wide and deep enough to allow good root spread. It should also be deep enough so that the plant can be buried up to its first set of "true leaves." (The "true leaves" are those resembling the species, and are different from those known as "seed leaves" which appear first.). Show the students where the "true leaves" are on a plant (see the diagram). If compost is available, mix it into the soil at the bottom of the hole.

2. Water the transplant hole. Fill the hole full of water then let it drain out. Now the seedling is ready to be planted.

3. Slide a wooden or plastic pot label all around the edges of the cell the seedling is planted in to loosen the soil ball. A kitchen fork works well for this too. Do not lift the seedling by the stem. This is the weakest part of the plant. Gently poke one or two fingers down the side of the cell and under the bottom of the soil ball. Gently lift the seedling out of the cell. Hold the seedling by the tips of their leaves, or by the soil ball. Some of the roots will be torn away as they are lifted from the cell—this can't be helped. Take as much of the soil with you as you can. Roots should not be exposed to the open air and sunlight.

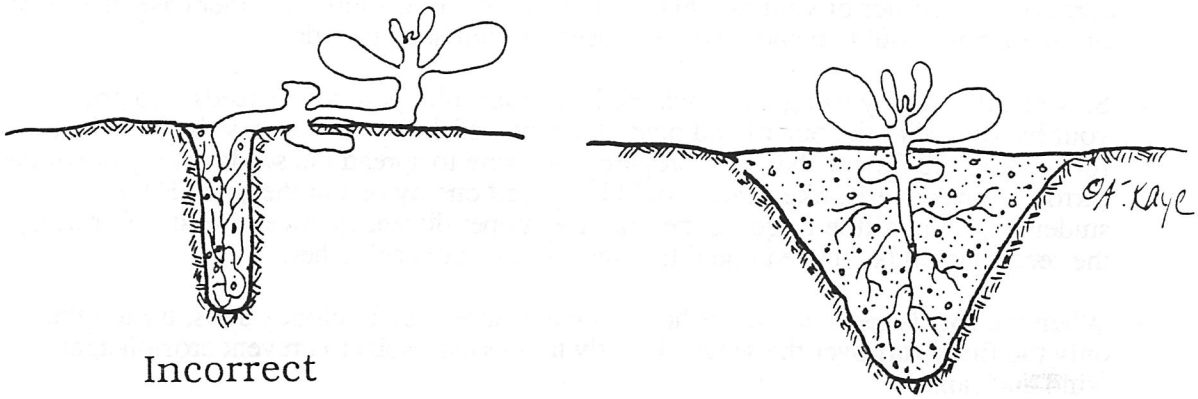
4. Hold the seedling in your fingers at the proper depth in the hole, and with the other hand press the soil firmly around the roots. The roots must be thoroughly covered and the stem buried up to it's first set of true leaves—this will provide the best kind of support for the young plant. Air spaces around the roots are fatal. The root hairs must come in close contact with the soil.

5. Pack the soil loosely around the plant. Do not pack too tightly as this will reduce the inflow of water and air.

6. Water the plants after transplanting to help settle the soil, to eliminate excess air and to provide water for growth. Plants should be kept moist after planting until they have established themselves in the garden.

7. Measure the correct planting distance between plants then make the next hole. Use the "Planning Your Garden Chart" in the February / Early March section to establish correct distances between plants.

Transplanting into the Garden



Incorrect

Correct

Season Extenders
Season extenders are structures that can be used to protect your tender seedlings against very cold nights. Season extenders can be made from a variety of materials; cut-off plastic gallon milk jugs, paper bags, newspaper hats, and even plastic buckets turned upside down.

During the first two to three weeks out in the garden, cover your seedlings with a season extender if there is a threat of frost or very low night temperatures. Make sure the leaves of the seedlings are not touching the sides of the container, and that you remove the season extenders early in the morning. The leaves of the seedlings could burn if the container is left on during the day.

Commercial materials are sold for use as season extenders. We have had success with a product called Reemay—a spun-bonded polyester. Reemay is a lightweight material that is designed to hold in heat while allowing light and water through to the plants. It does not require the support of wire hoops and can be left in place for days. Reemay can be purchased through greenhouse and nursery supply centers.

Direct Seeding
Vegetables that are not well-adapted to transplanting, or that are very hardy, are planted directly in the garden soil as seeds. These include the root crops, which are most susceptible to damage during transplanting (beets, carrots, radishes, turnips), and hardy plants like corn, beans, peas, cucumbers, squash and melons.

Row planting is a common method of seed planting and is easy for children to follow.

1. Make sure the seedbed has been smoothed with a rake. Put stakes in at the ends of the bed so that the line between the stakes match where rows are drawn on your garden plan.

2. When stakes are in place, tie a stout cord to one stake and wrap the loose end around the stake at the opposite end of the seedbed. Pull the cord tight enough to be lifted free of the ground. This will ensure that the row is straight.

3. When the string is in place, make a seed furrow beneath it. For fine seeds, your hoe handle will probably make a furrow deep enough. Larger seeds require a deeper furrow. The corner of your hoe blade can be used for this job. In either case, the depth of the furrow should be about twice as deep as your seed is wide.

4. Sow small seeds by using the pinch method. Carefully pour a few seeds into one of your hands. With the other hand pick up a pinch of the seeds and row them off of your fingers into the furrow that your prepared. Be sure to spread the seeds evenly down the furrow. Large seeds, like peas, should be placed one by one in the row. Have the students use their little finger to measure the proper distance between seeds. For peas, the seeds should be planted one little finger apart from each other.

5. When the row is seeded, rake or hoe soil over the seeds. In cloddy soils, try to rake only the finest dirt over the seeds. Lightly tamp sandy soils to prevent erosion against wind and rain.

6. Water the row with a gentle spray until the soil is moist.

7. Finally, mark each row with a waterproof marker or the empty seed packet.

Thinning

When the new plants reach a height of three or four inches, begin to thin them out. At first, leave as many of the healthiest plants as possible. This is good insurance against possible insect damage. As the plants mature, continue thinning until there is enough space for each plant to reach its full growth.

Journal Suggestions

1. Write three paragraphs to describe the work you are doing in the garden these days.

2. How has the garden changed since the fall? Draw a picture of what it looks like now.

3. Describe the steps involved in transplanting a seedling into the garden. What must you be careful of when transplanting seedlings?

4. Describe the steps involved in direct-seeding a garden. What vegetables did you direct-seed? Why must these vegetables be started directly in the garden?

Root Damage

Objective: To demonstrate the effect of root damage during transplantation.

Materials Needed: four groups of seedlings.

This exercise demonstrates the importance of being careful with the roots of seedlings as they are transplanted. Before transplanting remove part of the root ball from one group of seedlings. With another group, remove the soil but leave the roots intact. With a third group, expose the roots to the air for about an hour or until the roots begin to dry out. Transplant the seedlings. Transplant a fourth group, being careful not to disturb the root system. Water the transplants equally. Have the students compare the four groups, noting the differences in survival, recovery from transplant shock and growth rate.

Watering

Objective: To demonstrate the effects of watering on plants.

Materials Needed: 3 seedlings from four to six inches tall, an open-ended can.

To demonstrate the effects of watering, plant three seedlings in the garden. Place a can, open at both ends, around a healthy seedling. Deliberately over water by filling the can. Repeat this procedure twice daily. Completely withhold water from another seedling. The third seedling should be watered normally. Have the children observe, compare and record the changes in the seedlings. Have them draw conclusions about the amount of water needed by seedlings and the frequency of these waterings.

Natural Scattering and Controlled Planting

Objective: To compare the effects of natural seed scattering and controlled planting.

Materials Needed: Garden test patch, seed.

Set aside a four-square-foot test area. Simulate the natural distribution of seeds by randomly scattering a mixture of the types and varieties of seeds already planted in the garden. Lightly cover the seeds with soil and water normally. As the plants grow, have the students observe and compare the pattern of growth and the growth rate of the seedlings in the test areas and the garden plots. Also have them notice the difference in the general appearance of the two areas. Discuss the ways that seeds are propagated in nature.

From: *Children's Gardens: A field Guide for Teachers, Parents and Volunteers*

Companion Planting

Long ago, gardeners planned their gardens according to which plants "liked" one another. They found that some plants would grow better if planted next to certain other plants. This is called companion planting. Today, people are remembering the wisdom of their ancestors. More and more gardeners are planting "companion gardens." Why do they work? People who are doing research say that:

Some plants with deep roots help plants with shallow roots. The deep roots can increase the amount of minerals brought to the surface of the soil for the shallow roots.
Some plants attract helpful insects.
Some plants enrich the soil around them with nutrients.
Some plants such as mint or garlic contain chemicals which repel insects.

Try some companion planting in your garden. Be sure to plant for dislikes as well as likes.

Companion Planting Chart

VEGETABLE	LIKES	DISLIKES
Beans	Potatoes, Carrots	Onion, Garlic, Beets
Beets	Onions	Pole Beans
Cabbage Family (Cabbage, Broccoli, Cauliflower, Kale)	Peppermint, Dill Beets, Onions, Potatoes, Rosemary	Tomatoes, Pole Beans
Carrots	Peas, Lettuce, Onions	Dill
Peas	Carrots, Radishes, Beans	Onions, Garlic, Potato
Lettuce	Carrots, Radishes	
Onions	Beets, Lettuce	Peas, Beans
Nasturtiums	Used as a trap plant to attract aphids keeping them off of the other vegetables	
Marigolds	Repels pest insects. Plant them anywhere	
Radishes	Peas, Nasturtium, Lettuce	
Spinach	Strawberries	
Turnip	Peas	

From: *Ladybugs and Lettuce Leaves*

MAY

NOW IS THE TIME TO CONSIDER...

1. Gathering mulching material: seaweed, compost, hay, straw, newspaper, etc. (See Lesson 1: Garden Maintenance.)

2. Preparing your students for their research reports (see Lesson 3: Research Reports.) Go to the school library to determine what resources may be available for your students use. Check the public library also.

3. Gathering material needed to make insect sculptures. (See the optional activities for Lesson 2: Insect Study.)

May

Lesson 1: Garden Maintenance
Continued Transplanting / Mulching / Weeding

Time Frame
Continuous throughout May

Objectives
To identify and eliminate weeds in the garden.
To continue to transplant vegetables in the garden.
To explore the properties and uses of mulch materials.

Materials Needed
Seedlings to be transplanted, mulch material: straw, hay, seaweed, leaves, compost, newspaper.

Vocabulary
Weed, mulch, mulching.

Procedure
May is the time of the year to tidy up the garden and focus on the care and maintenance of the plants. You have worked hard to get the garden this far—take a moment to reflect on all that has happened to this point—on all that you have accomplished. Give yourselves a pat on the back, a hug, a smile. Your garden is growing, and will continue to grow with a little bit of help from you.

Now is the time to transplant the seedlings that are not frost tolerant. All of these seedlings will go into the garden after the last spring frost date. On Cape Cod, the last spring frost usually comes around May 19. Call your county extension service and ask them for the last frost date for your area. Refer to the "When to Plant Spring Vegetable" chart to determine what seedlings to transplant in May. Be sure they are hardened-off in the cold frame before they are transplanted.

Weeds—Plants Growing In the Wrong Place

Lead the following discussion with your class.

"What is the first thing that comes to your mind when you think of weeds? Did you ever think that a weed could be a tomato, or a carrot, or even a beautiful flower? All of these things could be weeds! A weed is simply a plant that you have decided you don't want growing in your garden. If there was a perfectly good vegetable growing in your flower garden you would consider that vegetable a weed. In that situation, the vegetable would compete with the flowers for valuable water, nutrients, space and sunlight. The vegetable's roots would crowd the flower's roots. The vegetable's leaves would shade the flower's leaves. You would have to pull the vegetable out of the garden so that the flowers could continue to grow.

Weeds are not bad plants—they are simply plants that are growing in the wrong place. Many weeds are very useful as plants. Common weeds like dandelions, goldenrod, ragweed were considered sacred plants by Indians and early settlers. They were used to heal people, to preserve strength, and to eat in delicious, vitamin-filled salads.

Even though many weeds are useful and pretty they are competing with our vegetables and must be removed from the garden."

1. Before the children begin to weed the garden, collect samples of every kind of weed you find in the garden. Have the students examine them closely. If you can, identify the edible ones.

2. Out in the garden, have the students identify the plants in a bed that are weeds. Make sure they can identify the plants that are the young seedlings too.

3. Once they are sure which plants are weeds, have them pull them up roots and all. If you do not get the roots the weeds will just come back again.

4. Make a weed collection from your garden. Instead of throwing the weeds away mount them on paper. Find a book on weeds and see if you can match what you have with what's in the books. Put the ones you don't use in your compost pile so that they can enrich the soil.

The most important point to remember about weeding is to keep on top of it. Weeds grow quickly and if you let them go it won't be long before they are taking over the entire garden. It is very important to get the weeds before they go to seed. Remember this old saying: "One year's seed means ten years of weeds." Do not throw weeds that have gone to seed in your compost pile.

Mulching—The Great Cover Up

TEACHER INFORMATION

By now you have probably discovered that weeding is not all that fun. One way to reduce new weed growth is to mulch your garden. Mulch is the term used to describe a layer of material such as straw, hay, leaves, compost or grass clippings that has been spread over the garden soil. Mulch is used to reduce weed growth and to keep the soil moist. This means that less time has to be spent on maintaining the garden.

There are many sources of free mulch. It is just a matter of looking for them. Organic mulches can be turned back into the soil to improve fertility and soil structure as they decompose. Here are a few of the organic mulches and their properties as a mulch.

Compost should be spread to a depth of one to two inches when applied as a mulch. Although compost will improve your soil fertility it is not very effective as a weed control since weeds grow in it just as well as vegetables. The best use of compost is beneath another mulching material that has good weed control properties.

Newspaper works great as a weed controller when applied in sheets of 10 to 12 pages. Stones or dirt should be heaped around the edges of the newspapers to prevent the wind from blowing them away. Use only newspaper with black print as colored ink contains lead. Do not use the slick paper stock found in magazines as these papers contain dangerous chemicals. Newspaper will add slightly to the fertility and structure of your soil when it decomposes—which it does rapidly. You may have to make several applications of this mulch during the growing season.

Leaves should be applied to a depth of two to three inches. Whole fresh leaves will blow away. It is best to use partially decomposed leaves (at least six months old). Leaves can harbor weed seeds also and when soggy attract slugs.

Seaweed makes an excellent mulch when applied two to three inches deep. The material is free of weeds and diseases and adds important micronutrients to your soil. You may want to let the seaweed sit through one rain before applying it, however, only a few plants in the garden will not tolerate the salt content in seaweed: strawberries, beets and spinach.

Straw or hay should be applied to a depth of four to six inches. Both materials will add nutrients to the soil when turned under in the fall. Freshly cut hay may contain weed seeds.

Grass clippings work best as a mulch when spread at a depth of 2 to 3 inches. If the grass is piled on too thick it will start to stink due to lack of air circulation. Grass clippings decompose rapidly adding valuable humus to your soil. Make sure the clippings you collect have not been sprayed with herbicides or pesticides, because these poisons will stunt or kill vegetables.

Involving the Students

Explain the reasons for mulching then have the students cover both the garden beds and the pathways early in the growing season. Try a combination of mulches and see what works best in your garden.

Journal Suggestions

1. Look at any weed in the garden and give it a name. Make up a story telling what the weed can be used for. This is how many good things about plants were discovered, by people using their eyes, ears, nose, and imaginations.

2. Go to the library and get a book on wild edibles. Make a weed cookbook.

3. Describe the jobs that a mulch can do.

Information on weeds and mulches came from: *Ladybugs and Lettuce Leaves*, *Organic Vegetable Gardening*, *The Encyclopedia of Organic Gardening* and *The New Alchemist Journal # 4* (see references).

A good reference book for insect, disease and weed identification is: *Rodale's Garden Insect, Disease And Weed Identification Guide* by Miranda Smith and Anna Carr. Rodale Press, Emmaus, PA. 1988.

Weeds Compete for Water, Space, Sunlight and Nutrients

Objective: To demonstrate the effect of weeds competing with garden vegetables.

Mark off two identical sections in your garden for this experiment. Plant each plot with a variety of seedlings. The type, spacing and number of seedlings must be the same in each plot. A 2-foot-by-2-foot plot is a good size. Keep one plot thoroughly weeded and let the other one go. Water both plots equally. Have the students observe, compare and record the rate of growth, the appearance of the seedlings and the overall appearance of the two plots. Have them evaluate the varieties and types of vegetables by their ability to compete with weeds as shown by their size and overall healthy appearance.

Make a Weed Salad

Objective: To reinforce the lesson on weeding and to identify edible weeds.

Common weeds that are edible include: pigweed, mustard, purslane, lambs quarter, and dandelion greens. Have the children weed their garden and save the seeds as they work. Work as a group to identify the weeds. Once the weeds have been identified point out which weeds are edible. Stress how important it is to never eat a plant unless you are sure it is edible. Make a weed salad and eat it! Add your favorite salad dressing.

Mulching for Moisture Control

Objective: To demonstrate the role of mulch in controlling soil moisture.

Materials Needed: 2 clear quart jars, mulching material, potting soil, water.

Fill both jars two-thirds full of potting soil. Water both jars equally until the soil is uniformly moist, then place them in an area that receives full sun. Mulch the surface of one jar using two inches of manure or compost, or three inches of grass clippings, straw, leaf mold or shredded newspaper. Tape opaque paper around the outside of both jars.

Remove the paper each day to check on the moisture content of the potting soil in the jars. When the soil without mulch appears dry, uncover both jars and remove the mulch. Have the students compare the moisture content and surface texture of each sample. Discuss the benefits of using mulch in the garden.

May

Lesson 2: Insect Study

Time Frame
1.5 hours

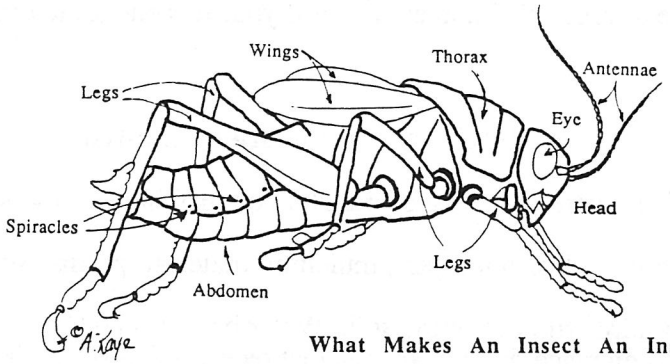
Objectives
To introduce the insect research projects.
To identify the characteristics of an insect.
To explore the world of insects by going on an insect hunt.

Materials Needed
Insect nets, containers with breathing holes to hold insects, magnifying glasses, reference books to help identify the insects (Golden Pond Insect Guides can be found in most book stores and libraries), "Observe An Insect" handout.

Vocabulary
Exoskeleton, thorax, abdomen, metamorphosis.

Procedure
Explain to the students: "For the next few weeks you will be involved in a research project on insects. Before we get into the details about the project we are going to talk about insects in general."

Draw a typical insect like the one in the diagram on the blackboard.



What Makes An Insect An Insect?

Ask: "What makes an insect an insect?" Here you see a common insect on the board. Look at this insect and tell me what characteristics do you see that are common to all insects?"

Lead the students to identify the following characteristics:

Small size: Most insects are very small compared to birds, mammals, reptiles, and fish. Because of their small size they can live in places many other animals cannot. Insects range in length from about 1/100th of an inch to 13 inches.

Exoskeleton: Insects do not have skeletons inside their bodies like we do. Instead they have a hard outer covering called an exoskeleton. It helps to protect their internal organs and prevents them from drying out.

Three Body Parts: All insects have three distinct body parts—the head, the thorax and the abdomen. The eyes, antennae, and mouth are on the head. The legs and wings are attached to the thorax. The abdomen is what is left.

Six Legs: All adults insects have six legs. By looking at an insect's legs, you can sometimes tell where an insect lives or what it eats. For example, praying mantids have grasping legs. Grasping legs are used to capture prey and hold on tight. Grasshoppers and fleas have jumping legs. Where do you think you would find a grasshopper?

Wings: Only adult insects have wings. Being able to fly enables insects to cover large distances to find new places to live, discover new food, escape quickly form enemies, and find mates.

Eyes and Antennae: Most insects have at least two sets of eyes and a pair of sensitive antennae on their heads. Antennae are used to feel, smell, and in some insects, hear. Insects have two types of eyes: compound and simple. Compound eyes are the biggest pair, often covering a large part of the head. Many insects have three simple eyes between their compound eyes. Scientist believe these smaller simple eyes are sensitive to light and dark.

"Is a spider an insect? No, a spider has eight legs. Is a caterpillar an insect? Yes, a caterpillar is an immature stage of a butterfly or a moth. Most insects hatch from eggs and go through several stages of life. The process of changing from egg to adult is called metamorphosis."

Go on an Insect Hunt

Looking at insects close up will stimulate the students interest in their upcoming research projects as well as give them an opportunity to examine and appreciate the smaller forms of life that share our world with us. Equip the students with insect nets, magnifying glasses, and containers to collect insects. Have the students look for insects in a variety of habitat areas around the school. Insects can be found in a lawn, a field, under rocks and logs, on flowers and vegetables in the garden, just about anywhere. Stress that we are only borrowing the insects to learn about their world and will return them to their home unharmed. Have the students use the "Observe an Insect" handout to direct their exploration.

Journal Suggestions

1. Have the students put their "Observe an Insect" handout in their journals.

2. Write a list of all the adjectives you can think of that describe insects. Write another list of all the verbs that could be used to describe the things insects do and ways they move. Use a word from each list to write five sentences about insects.

3. Describe the criteria used to decide if an insect is an insect.

See references for more information about insect activities and field guides.

OBSERVE AN INSECT

1. Draw a picture of your insect.

2. Describe where you found it.

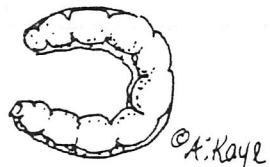
3. Why do you think it is an insect?

4. How does it move?

5. What do you think your insect eats? Look at its mouth parts.

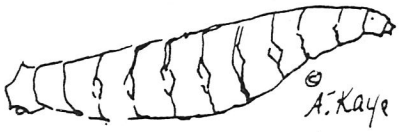
6. Do you think your insect is a friend or an unwelcome guest of the garden? Tell the reasons for your answer.

7. Watch your insect for a few minutes. Make up a name for it based on how it behaves.

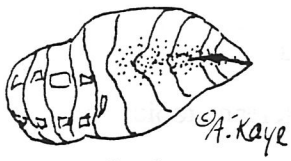


Cut Worm

Aphid

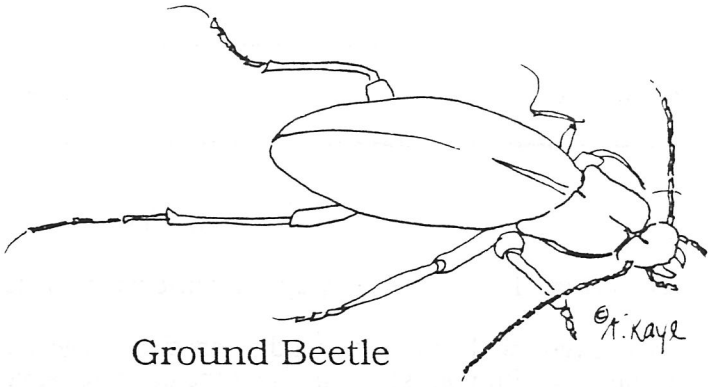


Root Maggot

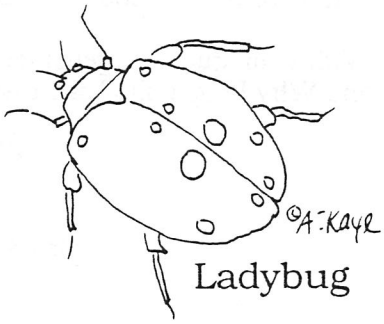


Leaf Miner

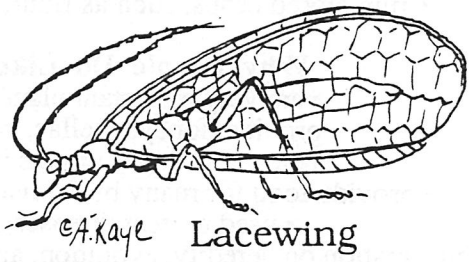
Pest Insects



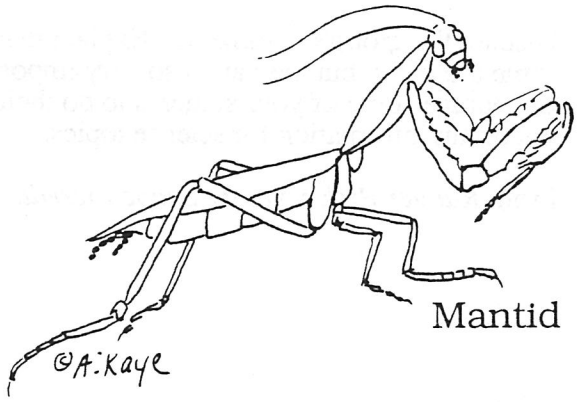
Ground Beetle



Ladybug



Lacewing



Mantid

Beneficial Insects

Insects: Friends or Foes?

Objective: To explore the ways that insects are beneficial.

This activity will help to dispel the negative image students have about insects. Lead a discussion with your students about the positive ways that insects have influenced our society and the reasons they are so important to people and all other living things. Stress that there is no "good" or "bad" in nature.

With your students, generate two lists on the blackboard: Why People Don't Like Insects, and Why People Do Like Insects. The lists could look something like this:

Why People Don't Like Insects
- attack and eat important crops
- spread plant diseases
- transmit diseases to people and other animals
- infest households as pests
- bite, sting, stink, etc.
- ruin stored crops, such as flour, popcorn, rice, etc.

Why People Do Like Insects
- are very important plant pollinators
- provide honey, shellac, wax, and silk
- help control pest insects in the garden
- provide food for many birds, fish, and other animals
- used to treat diseases in people
- provide information on heredity, evolution, and other important science topics
- are good indicators of water pollution
- are pretty, they come in many colors
- are interesting to watch

Discuss the group's comments. Explain that insects do create problems for people and some are pests, but they are also very important and of great value for a lot of reasons. Encourage some of your students to do their report on ways in which insects have provided important information for science topics.

From *Ranger Rick's Nature Scope Incredible Insects*

Insect Sculptures

Objective: To make an insect sculpture from homemade modeling clay.

Before starting discuss the main characteristics of insects. Instruct the students to create an insect with the modeling clay. It can be an imaginary insect or a real one as long as it has all of the characteristics of an insect.

Give each student a lump of modeling dough and put the other materials in piles around the room. Have them roll and mold the dough into a head, thorax, and abdomen. They can use a toothpick to carve lines or dots on the insect's body and make eyes, wings, and legs with dough. You may want to have them try using pipe cleaners or twigs for legs and antennae, wax paper or plastic wrap for wings, and beans for eyes. When the models are dry (two to three days), they can paint them with acrylic or tempera paints.

To make the dough, mix the following ingredients in a saucepan:
2 cups flour
2 tablespoons oil
1 cup salt
4 teaspoons cream of tartar
Vanilla or peppermint flavoring to make it smell nice

Cook over medium heat, stirring until the mixture starts boiling or forms a ball (about two to three minutes). Remove from the heat and let cool until it can be handled.
Knead the dough like bread until smooth and supple. To store the dough, keep it in a plastic bag in a cool place. (Makes enough for six to eight kids)

From: *Ranger Rick's Nature Scope: Incredible Insects*

Lesson 3: Insect Research Reports

Time Frame
On-going for a month

Objectives
To learn the process involved in doing a research report.
To give the students an opportunity to learn a great deal about one particular subject.
To present a report orally.
To cooperate in small groups and to share information.

Materials Needed
Reference material, material for products, *My Notes, Product Ideas, Evaluation Forms
*Provided in manual.

Vocabulary
Research report, bibliography, references.

Procedure
Explain to the students that they are going to prepare a research report on an insect of their choice, or a subject that relates to insects and gardening. The report must include a written comment, a visual component, a bibliography and an oral presentation. Students can work independently or in small groups (tow or three). The oral presentations will be given on the day of the Harvest Festival. Parents and friends of the family will be invited to listen.

Follow the structure below or design one suitable for your students.

1. List the steps involved in doing a research project on chart paper:

a. Choose a topic.
b. List questions you want to answer.
c. Find information. Take notes. Keep list of resources.
d. Decide on a product.
e. Create your product.
f. Write up the bibliography.
g. Presentation of project.

2. With the class, brainstorm a list of possible topics. Post the list. Give the students time to choose the subject of their report. They may want to look through some library books and discuss their ideas with you and their classmates.

3. Once everyone has a subject, brainstorm a list of possible questions that they will want to answer through their reports—"What do you want to find out about your subject?" Post this list. Ask the students to identify the questions on the list that deal with basic needs, and star these (food habits, protection, habitat, life cycle, etc.).

4. Discuss with the class the possible sources of information that they might use. They will doubtless immediately say "Encyclopedia." But an encyclopedia is not usually a very useful resource for children this age. The reading level is too high, and the information is too technical. Stress the use of other books, check in the children's section of the library for magazines like "Ranger Rick's Nature Scope" and "National

Geographic World." The county extension service, science museum, or a local insect expert or hobbyist are all excellent sources of information. Once students start delving into the resources available, more and more will turn up.

5. If students have not taken notes before, give them a note taking lesson. One suggestion is to show a filmstrip with captions. Frame by frame, have the class decide what the key word or main idea is, and write that as notes. Then have students reconstruct the gist of the filmstrip in the form of sentences or paragraphs. Students should never be allowed to copy verbatim from a book. They need to learn how to take notes and use their own words. Provide each student with a notebook or booklet made of copies of the note-taking page following. Make sure that they list the sources for all notes. You might do a sample bibliography and explain its purpose.

6. Don't discuss what form their project will take right now. Otherwise, students will tend to gear their research toward a specific product, rather than doing general information gathering.

7. Go back to the list of steps, and work out a schedule with the students. Now they know their topic; they have questions; they have ideas about where to look for information; they know how to take notes. Set a deadline for finding information, and let them get started.

8. Some students will need to write letters or make telephone calls to get information. You can either help them individually as the need arises, or conduct mini-lessons with the whole class on writing a businesslike letter, or conducting a telephone interview. It's a good idea for students to write out ahead of time what they want to say or ask on the telephone prior to making the call.

9. Four or five days before the deadline, have a discussion about possible ways the students might present what they have learned. At this age, research reports should not be just written reports. There are many interesting and valid ways to show information that are much more hands-on. Review the list of possible "product ideas" following this section. One suggestion is that the report include a written comment, a visual component (poster, model, diagram, mobile, diorama) and a bibliography, and that students have an opportunity to present their reports orally.

10. The final step is evaluation. It's very important for students to evaluate themselves, for you to evaluate them, and for them to understand that the purpose is to help them improve the next time. Forms are included here that can be used, or you can develop others to suit your own criteria.

Journal Suggestions

1. List the steps involved in doing a research project.

2. What is your project topic? Why did you choose this topic?

3. Keep notes of your progress on the report. Write about how your report is coming along, the new things you are learning, and the problems you are having.

My Notes

Resources I have used for the notes on this page:

Author Title

1.

2.

3.

Notes

Subjects that my notes on this page are about:

PRODUCT IDEAS

Design a crossword puzzle
Make a comic book
Write and produce a play
Create a film
Design and make costumes
Create a collage
Design a plaster of paris model
Make a mural
Prepare and do a survey
Design an animated movie
Write and tape a conversation
Prepare a TV program
Design an experiment
Make a diorama
Make a clay sculpture
Create a paper mache object
Create a painting
Draw a chart
Tape an interview
Make a riddle
Create a slogan
Make an insect habitat
Write a short story
Write a computer program
Design needlework
Construct a photogram
Make a game
Make an etching
Create a word-play game
Create a radio program
Create a bulletin board
Create a slide show
Teach a lesson to another class
Make a startling discovery
Write a new law
Make transparencies
Write a book
Plan a newspaper
Write a poem
Create a filmstrip
Create an advertisement
Make a mobile
Make a collection
Make a simulation game
Create a puppet show
Make a photograph album
Write a "Letter to the Editor"

Student Self-Evaluation

Name _____ **Topic** _____

While working on this research report, I used my time wisely.

_____ Most of the time _____ Some of the time _____ Seldom

I completed my:	YES	NO
research	_____	_____
bibliography	_____	_____
product	_____	_____

I am pleased with my product.

_____ Yes _____ No _____ It's O.K.

I could have made it better by:

_____

_____

_____

_____

I was prepared for my class presentation and was pleased with the presentation.

_____ Yes _____ No _____ It was O.K.

Three new things I learned while doing this study:

_____

_____

_____

I think my next research report will be better if I:

_____

_____

_____

PROJECT EVALUATION

NAME_____

PROJECT TITLE_____

EVALUATOR: _____Teacher _____Friend _____Researcher

Read each question and circle the number that best describes your opinions about this project.

	A LITTLE			A LOT
1. Does the researcher really understand the topic?	1	2	3	4
2. Did the researcher use a variety of resources?	1	2	3	4
3. Did it hold my attention?	1	2	3	4
4. Is it imaginative and creative?	1	2	3	4
5. Does it show high quality work?	1	2	3	4
6. Is it well organized and easy to follow?	1	2	3	4
7. Did it answer the major research question?	1.	2.	3.	4.

Comments:

_____

_____

_____

_____

I especially liked:

_____

_____

_____

_____

JUNE

NOW IS THE TIME TO CONSIDER...

1. Planning the Harvest Festival.
   Write letters to the parents inviting them to the Harvest Festival. You may want to contact the local newspapers and have them take pictures of the event.

2. Making summer plans for the garden.
   Unfortunately, just when things really start taking off in the garden, school ends. There are ways to continue the garden program through the summer. Below you will find a few suggestions. If you cannot find a way to keep the garden going in the summer, it must be prepared with a mulch or a cover crop before you leave the school at the end of the year.

   The worst thing you could do is to let the garden go to weed during the summer. The weed seeds will cause problems for you the next growing season. Heavily mulching the garden will do a lot to prevent weed growth. Use a mulch that is readily available.

   Cover cropping during the summer not only will keep the weed growth down it will also do much to improve your soil fertility. We recommend that you use buckwheat or soybeans as a cover crop for the summer.

   Buckwheat is readily available at Agway stores and other local farm supply centers. Remove all weeds then apply two to three ounces per 100 square feet. Rake the seed in lightly. In the fall, lightly till the residue in and plant winter rye.

   Soybean is an excellent cover crop to use, especially if you are going to follow it up with rye in the fall. Soybean fixes nitrogen and will produce a thick green crop during the whole summer. In order for soybean to fix nitrogen you must apply a soybean legume inoculant to the seed. Soybeans, the inoculant and instructions are sold through Johnny's Selected Seeds, Foss Hill Road, Albion, Maine 04910 (207) 437-9294.

   Alternative Plans For The Summer

   a. One teacher, a few parent volunteers, and a handful of interested students can keep the garden growing during the summer. Ask around and see if the interest is there. If you plan well you would only need to meet four or five times throughout the summer for a few hours. Think of all the fresh vegetables with which you could grace your table all summer!

   b. Link up with a summer program that already exists and is staffed with paid people. Parks, recreation departments, 4-H, Blue Birds and Scout troops are all possible interest groups. They could take over the garden project and benefit from all the produce grown. Make sure that their practices are aligned with yours (keep it organic).

c. A few neighborhood families might appreciate a garden spot. Turn the school garden into a community garden during the summer.

3. Evaluating the year.
This is a vital part of the program. Gather together with all of the teachers involved and discuss how things went this year—What worked well and what did not work? What new things will you plan for next year? Can you plan now to get the cold frame built? Can you improve on your indoor growing center? If possible, make a budget for next year and hand it to the principal so that your garden needs will be taken care of early.

June

Lesson 1: Harvest Party

Time Frame
3 hours

Objectives
To finish mulching and weeding the garden.
To harvest vegetables.
To present the research reports.
To celebrate the success of all your hard work.

Materials Needed
Eating utensils, refreshments for a crowd, sun-tea, coolers, harvest baskets, benches or chairs, game equipment, anything else needed for a party.

Vocabulary
Harvest, celebrate.

Procedure
The Harvest Party is a time of celebration and reflection. You have worked hard to grow your garden and it is now time to share your pride and harvest with friends and family. A Harvest Party can be anything you want it to be. Plan it out with your students. Have them make the invitations to send home to their families, principals, school board members and friends.

We have always used the Harvest Party to wrap up the program. The students begin the day by showing off the garden to our guests. They walk parents through the garden naming vegetables and pointing out the flowers that they planted. We then all do a bit of work. We weed a little, mulch a little and simply spend some time feeling and appreciating the garden.

This is always a good time for singing. *The Garden Song* by Dave Mallet is very appropriate. The students begin practicing the song a week before then we sing to and with our guests on the day of the great harvest. The words to the song follow this section.

Presentations of the research reports come next. We set up chairs and benches in a semicircle under a tree. A device to tape or push pin posters and other visual aids comes in handy. We use a picnic table turned on its side. This can also be used to stage puppet shows.

Each group is given five minutes to present their project. A brief question and answer period follows each presentation. If you and/or your students are evaluating the projects you will need the evaluation forms.

Harvesting comes next. We go off to the garden with harvest baskets to collect the vegetables for a salad. One year, a women who worked in the school cafeteria prepared a kale soup from the garden produce. Any special dishes like that delicious kale soup, made in advance, are a real treat for the students and the quests. You could ask parents to bring in a dish.

The students wash and prepare the vegetables for a salad. You can have them mix everything into one huge salad bowl or serve up the goodies in the form of a salad bar. A salad bar with its many choices is a lot of fun for the students. Make up your favorite salad dressings and provide extra toppings like croutons, bean sprouts, cheese, and olives.

Eating comes next! We have lots of cold sun-tea on hand and some kind of special desert like watermelon or ice cream to round out the meal. Everyone brings their own bag lunch.

Clean-up and games follow. Whatever you do on this day makes it joyous and fun. It is our hope that the students feel good about their year with the garden project and continue their connection with the earth far beyond school.

Journal Suggestion

1. Write a short story about today's Harvest Party. Include the things you did, your favorite research report, what you ate, and something that will always remind you of today.

2. Draw a picture and describe your next garden. Where will it be? What will you grow?

3. Think about what you learned this year and describe your favorite part of the Green Classroom program. Go over your journal notes to help your memory.

Games and Activities For The Harvest Party

The Garden Song

Chorus: Inch by inch, row by row
Gonna make this garden grow
All you need is a rake and a hoe
And a piece of fertile ground.
Inch by inch, row by row
Someone bless these seeds I sow
Someone warm them from below
'Til the rains come tumbling down.

Pulling weeds, Picking stones
We are made of dreams and bones
Need a place to call my own
For the time is near at hand.
Grain for grain, sun and rain
Find my way through nature's chain
Tune my body and my brain
To the music of the land

Plant your rows straight and long
Temper them with prayer and song
Mother earth will make you strong
If you give her love and care.
An ole crow's watching hungrily
From his perch in yonder tree:
In my garden I'm as free
As the feathered thief up there!

Repeat the chorus after each verse. By Dave Mallet. On his album, Dave Mallet (c) Cherry Lane Music. All rights reserved. Also on Pete Seeger's Circles and Seasons and a John Denver album.

Chords: C FC/F C/
F CAm/ D G
Repeat chorus ending DG C

Go On a Scavenger Hunt

Go on a scavenger hunt to find natural objects. The items on your list should require the student to think creatively or to look very closely.

Sample Scavenger List

Collect only things that you can return safely and without damage.

1. Something just beginning to grow
2. A seed dispersed by the wind
3. Three different kinds of leaves
4. One camouflaged animal or insect
5. Something round
6. A sun trap*
7. Exactly 50 of something
8. Something fuzzy
9. A chewed leaf, (not by you!)
10. Something beautiful
11. Something that is of no use in nature**
12. Something that reminds you of yourself
13. Something that makes a noise
14. A flower with three different kinds of insects on it
15. Something you can eat
16. Follow a butterfly and count how many flowers it visits in two minutes
17. A decomposer
18. Something good for the compost pile
19 A pest insect in the garden
20. Your favorite garden plant (Just describe it)

* A sun-trap is anything that captures the sun's heat (plants, rocks, water, animals)
** Everything in nature has a function.

Adapted from: *Sharing Nature with Children* by Joseph Bharat Cornell

New Games

The New Games Book and *More New Games* by the New Games Foundation is full of noncompetitive exciting games that are perfect for a Harvest Festival. Below you will find two examples. Check the books out of the library or buy them to add to your own collection.

Smaug's Jewels

The object of Smaug's Jewels is to avoid the deadly touch of the formidable dragon, Smaug, and to snatch his treasure.

One person chosen as Smaug stands guard over his jewels. (A handkerchief placed on the ground is a less glamorous but eminently more practical substitute.) Everyone else forms a circle around him and tries to steal the treasure without being tagged. A good roar and some fancy footwork on the part of the dragon can be nearly as impressive as death breath and thunderbolt tails.

Smaug the Mighty can range as far from his jewels as he dares. If you get touched by him, you are instantly frozen in place until the end of the game. But don't worry; it's a rare dragon that reigns for more than thirty seconds.

A popular strategy for treasure-snatching is to sneak up behind and reach between the dragon's legs to grab the jewels. Or you might catch Smaug unaware. And then there's always the mass charge where most get sacrificed but one gets the treasure. This at least gives everyone the opportunity to confront a new dragon, for the old one is replaced by the treasure-snatcher.

Blob

The Blob begins innocently enough as a mere individual playing a game of tag. As soon as she catches someone, she joins hands with him. Now he is a part of the Blob, too, and they both set out, hand-in-hand, in search of victims. Everyone the Blob catches (only the outside hand on either end of the Blob can snatch at players) joins hands with it and becomes part of the lengthening protoplasmic chain. And thus the insidious Blob keeps growing.

The Blob is not content merely to ooze along, seeking its prey. It gallops around the field, cornering stray runners and forcing them to join up. (You'll have to agree on boundaries for this game; some people will go to any lengths to avoid meeting an untimely end at the hands of the primordial slime.)

The Blob can split itself into parts, and with its superior communal intelligence, organize raiding parties on the lone few who have managed to escape. The climax occurs when there is only one player left to put up a heroic last ditch stand on behalf of humanity. But alas, there is no defense against the Blob, and humanity succumbs. The last person caught starts the Blob for the next game.

From: *The New Games Book*

GLOSSARY

Abdomen -n.- The last of the three body parts of an insect. *The bee's stinger is in its abdomen.*

Abiotic -adj.- From or caused by non-living things. *Rocks and sunlight are abiotic factors.*

Acid -adj.- Having too much acid - a below 7 pH level. *The soil was very acidic.*

Adapt -v.- To adjust or change to fit a specified use or situation. *The Pilgrims had to adapt their lifestyle to survive in the New World.*

Adaptation -n.- A change in structure, function, or form that allows a plant or animal to better adjust to its environment. *The adaptation of a maple seed for better dispersal is its "wings".*

Alkaline -adj.- Having too much of an alkali - an above 7 pH level. *They used lime to make the soil more alkaline.*

Ancient -adj.- Very old, aged. *Ancient people may have learned about farming by accident.*

Autumn -n.- Fall, the season between summer and winter. *I n the autumn, we often see brightly colored leaves.*

Bacteria -n.- Any of many one celled microorganisms which can be seen only with a microscope - there are beneficial and harmful varieties. *During decomposition, bacteria help to break down organic matter.*

Bibliography -n.- A list of sources of information on a given subject. *He put a bibliography at the end of his report.*

Biotic -adj.- From or caused by living things. *Birds, aphids, and vegetables are biotic factors.*

Camouflage -n. or v.- The process of disguising, concealing, or hiding. *The polar bear's camouflage is his white fur which allows him to hide in the snow.*

Carbon dioxide -n.- A colorless, odorless gas which passes out of the lungs in respiration and is absorbed by plants. It is used in a plant's food production. *We breathe carbon dioxide into the air.*

Carnivore -n.- A flesh-eating animal. *The carnivore ate the deer.*

Carrying tray -n.- A tray used for carrying containers of planted seeds. *A carrying tray helped us move all our six packs to the green house.*

Chlorophyll -n.- The green coloring matter in plants. *Chlorophyll makes most leaves look green.*

Civilization -n.- A group of people having developed an organized culture. *The Egyptian civilization had a highly developed knowledge of math.*

Climate -n.- The average weather conditions of a place as determined by the average yearly temperature and rainfall. *The climate in the desert is considered hot and dry.*

Cold frame -n.- A small greenhouse that can be opened or closed and is often used to harden-off new plants. *Our cold frame was made from old storm windows.*

Community -n.- A group of people living in the same area and under the same government. *Falmouth if the second largest community on Cape Cod.*

Compost -n.- A mixture of decaying organic material, such as leaves and manure, which is used as fertilizer. *We will put compost around our plants to help them grow better.*

Coniferous -adj.- Having cones and frequently evergreen. *The cedar is a coniferous tree.*

Cool season vegetables -pl. n.- Plants that can tolerate low soil and air temperatures. Theses plants can survive a frost without dying. *Radishes , peas and spinach are cool season vegetables.*

Cotyledon -n.- Each half of a seed where the food is stored. *We looked at the cotyledon under a microscope.*

Cover crop -n.- A crop, such as winter rye, which is partially grown and then turned under to fertilize the soil, improve its texture, and help prevent soil erosion. *In the fall, we planted sweet clover as a cover crop.*

Criteria -pl. n.- The standards, rules, or tests by which a judgment of something can be made. *The criteria for choosing which apple to buy were the color, size, and taste.*

Cycle -n.- A series of events that regularly repeat themselves. *The cycle of growing peas is predictable.*

Deciduous -adj.- Falling off or shedding at a particular season. *The deciduous oak tree lost its leaves every fall.*

Decomposer -n.- An organism that causes organic matter to break down, decay, or rot. *The primary decomposer in our compost pile is bacteria.*

Decomposition -n.- The act or result of rotting or decay. *The decomposition of the dead leaves gave us fertilizer for new plants.*

Dispersal -n.- The distribution or sending in different directions. *The dispersal of seeds happens by many different methods.*

Distribution -n.- The act of dividing up, delivering, or passing out - the marketing of goods such as food. *Using several trucks made the distribution of his fresh corn faster.*

Double digging -n.- A method of preparing the garden soil by turning over the soil, loosening the sub-layer and adding compost or aged manure. *Double digging our garden gave a richer soil with better drainage.*

Energy -n.- The ability to do work, often powered by resources such a oil, gas, electricity or the sun. *"The truck's energy was powered by gasoline."*

Environmental factors -n.- All the factors that surround and influence an organism. The environmental factors is a garden may include soil, air, temperatures of soil and air, water, weather, etc. *We sometimes need to control one or more environmental factors in our garden to help the crops grow better.*

Exoskeleton -n.- The hard outer covering of an insect. *The ant's exoskeleton protects its internal organs and prevents it from drying out.*

Fibrous roots -pl. n.- Roots which have many thin, stringy parts. *We looked at the fibrous roots on a the lettuce plant.*

First leaves -pl. n.- Miniature leaves that form within the seed. *When you split apart a seed, you can often see the first leaves.*

Flat -n.- A shallow container used for starting seeds. *We planted three flats of geraniums.*

Food chain -n.- The cycle in which an organism is always the food for another organism. *In the food chain, a fly may be eaten by a bird who, in turn, is eaten by a cat and so on.*

Food web -n.- The interrelationship between all organisms as they each serve as food for various other organisms. *The food web is the basis of all life.*

Frost dates -pl. n.- The first expected day of frost in the fall and the last expected day of frost in the spring. *We must choose plants which will grow between the frost dates.*

Frost tolerant -adj.- The ability to survive a frost without dying. *There are some crops which are frost tolerant.*

Garden bed -n.- The area in a garden where the soil has been prepared to provide plants with the very best growing condition. *Walking between our garden beds we could observe all our plants.*

Germinate -v.- To begin to grow or develop. *The seeds began to germinate.*

Glacier -n.- A huge mass of moving ice formed when the rate of snowfall constantly exceeds the rate at which the snow melts. *Cape Cod was formed from the debris left by a melting glacier.*

Graph -n. or v.- A drawing that shows the relationship between two sets of factors. *The graph showed us that the temperature went down for six months.*

Growing season -n.- The time or part of the year when crops will grow. *The growing season in this area is from about May 15 to Oct. 15.*

Habit -n.- Something done often. *I have a habit of walking to school the same way every day.*

Habitat -n.- The region where a plant or animal naturally grows or lives. *The frog's habitat was the pond.*

Hardening-off -n.- The process of allowing seedlings that have been started indoors to gradually adjust to the cooler outdoor environment. *Hardening-off of our plants took two weeks.*

Harvest -n. or v.- The picking or gathering in of a crop. *The harvest of beets was large this year.*

Herbivore -n.- A plant eating animal. *The cows are herbivorous animals.*

Horizontal -adj.- Flat, from side to side. *The horizontal line on the graph showed the months of the year.*

Hypothesis -n.- An unproven guess. *We wrote a hypothesis about how fast we thought the seed would germinate.*

Local -adj.- Relating to a particular place. *We tried to buy only local vegetables.*

Metamorphosis -n.- In insects, the process of changing from an egg to an adult. *The metamorphosis from caterpillar to butterfly is fascinating.*

Migration -n.- The act of moving from one place to another often on a regular basis. *The class studied the migration of the Monarch butterfly.*

Minerals -n.- Any naturally occurring organic substance. *The minerals in the soil provided nutrition for the crop.*

Mulch -n.- A substance put on the soil to protect crops, to prevent water evaporation, to retard weed growth, to slow soil erosion, and to maintain a moderate soil temperature. *After putting mulch on our garden we had fewer weeds.*

Mulching -v.- Putting mulch on the soil around crops. *The are mulching the radish bed.*

Niche -n.- A place particularly suited for a thing or organism. *The bird found his niche in the old tree.*

Nitrogen -n.- A colorless, odorless gas found in all living things. *We found that there was not enough nitrogen in our soil to make our plants grow well.*

Nocturnal -adj.- Being most active at night. *The bat is a nocturnal creature.*

Nutrient -n.- Anything that provides nourishment to plants or animals. *It is important to be sure the crops have enough nutrients.*

Nutrient cycle -n.- The recycling of nutrients - when plants and animals die and decay, the nutrients that they took out of the soil in growth are released back into the soil to be used again by other living things. *The nutrient cycle provides nourishment to be used over and over again.*

Omnivore -n.- An animal which eats plants and flesh. *Man is an omnivore.*

Organic fertilizer -n.- A fertilizer made from decomposing plant and animal material or natural rock. *We used organic fertilizer to enrich our garden.*
Organic matter -n.- Substances derived from living organisms.. *We put only organic matter in our compost pile.*

Oxygen -n.- A colorless, odorless gas given off by plants as they make food. *Animals and people breathe the oxygen in the air.*

Palisade cell -n.- A long sausage-like cell underneath the topside of a leaf which traps sunlight. *We saw a diagram showing the palisade cells of a leaf.*

pH -n.- A measure of how acidic or alkaline a material may be. *Plants grow best in a soil with a pH of 7.*

Phosphorus -n.- A chemical element found in nature. *We needed more phosphorus in our garden soil.*

Photosynthesis -n.- The process of combining light with other ingredients to make plant food and oxygen. *Photosynthesis is a complicated process.*

Planting depth -n.- The depth a seed must be planted in the soil. *The planting depth for those seeds is 1 inch.*

Potassium -n.- A mineral found in nature. *Bananas have a lot of potassium.*

Predator -n.- An animal which hunts another animal. *The predator was stalking the mouse.*

Prey -n.- An animal being hunted by another animal. *The rabbit was the prey of the eagle.*

Raised beds -pl. n.- Mounded-up garden beds. *Raised beds gave better water run-off in our garden.*

References -pl. n.- Materials or persons that can offer information on a subject. *She used pamphlets and encyclopedias as references for her report.*

Research report -n.- A report on a particular subject using various sources of information. *The research report was on automobiles.*

Root hairs -pl. n.- Very thin, hair-like threads on roots which absorb water and minerals from the soil. *Using colored water, we could see water moving through the root hairs.*

Root tip -n.- The pointed end of the seed from which the roots will grow. *The root tip on the Lima bean seed was easy to see.*

Season extenders -pl. n.- Structures that can be used to protect tender seedlings against very cold nights. *We used inverted plastic milk bottles as season extenders.*

Seed coat -n.- The skin or coating of a seed. *The seed coat helps to protect the tiny plant and its food.*

Seedlings -pl. n.- Small plants grown from seed. *Our seedlings were now three inches high.*

Six pack -n.- Type of planting container that is divided into six compartments. *We planted our celery seeds in a six pack.*

Soil fertility -n.- How good the soil is for growing plants. *Our soil fertility was high, and we grew excellent plants.*

Soil-less potting mixture -n.- A material used for planting seeds made of perlite, vermiculite, and sphagnum peat moss. *The seeds were planted in a soil-less potting mixture.*

Sowing -v.- To scatter or plant seeds for growing. *The children were sowing radish seeds.*

Stem -n.- The main stalk of a plant which supports the plant and transports water and minerals from the root to other parts of the plant. *The brocoli's stem was thick and strong.*

Stomata -pl. n.- Tiny openings on the underside of a leaf through which carbon dioxide enters the leaf. *One inch of leaf surface may contain 250,000 stomata.*

Tap root -n.- One thick, long, main root. *A carrot is an example of a tap root.*

Thorax -n.- In an insect's body, the middle of the three main body segments. *The legs and wings of an insect are attached to its thorax.*

Transportation -n.- The act of moving something from one place to another. *The company used trains for the transportation of its product.*

True leaves -pl. n.- The first real leaves that sprout from the seed. *The true leaves reached up through the ground toward the sun.*

Vertical -adj.- Upright, up and down. *The vertical lines on the graph showed temperatures.*

Weather -n.- The daily condition of factors such as temperature and rainfall. *Today's weather is warm and humid.*

Weathering -v.- Exposing something to the action of the weather. *Weathering the rocks made them smoother.*

Weed -n.- An undesired plant; one growing in the wrong place. *We took the weeds out of our garden.*

Wild edibles -n.- A wild plant which is fit to be eaten safely. *The native blueberries were wild edibles.*

Winter solstice -n.- The shortest day of the year. The time in the Northern Hemisphere when the sun is farthest south of the equator; December 21 or 22. *It gets dark very early on the winter solstice.*

A Basic Supply List For A School Garden Program

SUPPLY LIST	PRICE
Indoor growing center per class	60.00 - 469.00
1 bottle seedling fertilizer per class	8.00
1 box of plant labels	2.92
1 seedling watering can per class	10.00
2 garden watering cans	21.25
3 cubic ft potting soil	9.60
6 permanent markers per class	3.90
25 carrying trays	9.48
50 feet of garden hose	23.50
100 six packs (planting containers)	6.82
Garden twine	6.99
Reemay	33.00
Safer's Insecticide Soap per class	4.99
1 soil thermometer per class	10.04
*Cover crop	45.00
*Seeds per class	35.00
*Soil amendments	50.00
Tools	
2 bow rakes	37.00
5 hoes	92.50
5 small digging forks	139.95
5 small shovels	114.95
10 cultivators	37.50
10 hand trowels	37.50
Books	
Corn Is Maize	4.95
Seeds Pop Stick and Glide	4.95
The Reason For a Flower	7.95

Add 20% to 30% to the total for contingencies.

Notes

* The prices for these items will vary depending on your needs.

The price of your indoor growing center depends on the system you use. A simple one might cost around $60 per class. A Grow Lab from the National Gardening Association for one class will cost $469.00.

Small sized tools are easier for the students to use. Get children's or flower bed tools. Make sure you get good quality tools that will last a long time.

Prices will vary from supply center to center. Buy in bulk to bring the price down whenever possible.

Resources and References

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Organic Vegetable Gardening. Bob Percival, 1984. TAB BOOKS Inc.

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Rodale's Garden Insect, Disease and Weed Identification Guide. Miranda Smith and Anna Carr, 1988. Radale Press, Emmaus, PA.

The Encyclopedia of Organic Gardening. The staff of the Organic Gardening Magazine, 1978. Rodale Press, Inc.

School Gardening Curricula

Children's Gardens: A Field Guide for Teachers, Parents and Volunteers. Elizabeth Bremner and John Pusey. University of California Cooperative Extension Common Ground Garden Program. Phone (213) 736-2445.

Growing Classroom, Life Lab Curriculum. Life Lab Science Program, 1156 High St., Santa Cruz, CA 95064.

Ladybugs and Lettuce Leaves. Project Outside/Inside, 1982. Center For Science in the Public Interest, 1755 S Street, N.W., Washington, D.C. 20009.

The Youth Gardening Book. Lynn Ocone with Eve Pranis, 1983. National Gardening Association, 180 Flynn Avenue, Burlington, VT 05401.

Gardening Supply Centers and Services

Griffin Greenhouse and Nursery Supplies, 1619 Main Street (Rt. 38), P.O. Box 36, Tewksbury, MA 01876. Phone: (508) 851-4346.

"Let's Get Growing." A catalogue of supplies for the Life Lab Curriculum and other school garden projects. General Feed and Seed Co., 1900-B Commercial Way, Santa Cruz, CA 95065.

Necessary Trading Company, P.O. Box 305, New Castle, Virginia 24127.

Soil and Plant Tissue Testing Laboratory, Suburban Experiment Station, University of Massachusetts, 240 Beaver Street, Waltham, MA 02254. Phone: (617) 891-0650.

Seed Companies and Catalogues

"Johnny's Selected Seeds", Foss Hill Road, Albion, Maine 04910. Phone (207) 437-9294.

"Stokes Seeds Inc.", P.O. Box 548, Buffalo, New York, 14240-0548.

"Vermont Bean Seed Company, Inc." Garden Lane, Fair Haven, Vermont 05743.

Insects

Coloring Fun with Insects. A coloring book with text. Dr. Edwin W. King, and Joan McFarland, 1983. Entomological Society of America, College Park, Maryland.

Creepy Crawlies: Insects and Other Tiny Animals. Cathy Kilpatrick, 1982. Usborne Publishing Ltd.

Friend, Foe or Escargots? A coloring book with text. Linda Heath and Paula Smith. State of California Department of Food and Agriculture, Integrated Pest Management Program, Environmental Monitoring and Pest Management Unit, 1220 'N' Street, Sacramento, CA 95814.

Insect Pests. A children's guide to insect identification. George S. Fichter, 1966. Golden Press, New York. Many book stores carry the Golden Guide series or order from: Dept. M, Western Publishing Company, Inc., 1220 Mound Avenue, Racine, Wisconsin 53404. $3.95.

Ranger Rick's Nature Scope *Incredible Insects Activity Book*. Judy Braus, editor, 1986. National Wildlife Federation, 1412 16th St. N.W. Washington, D.C. 20036-2266.

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Project Learning Tree. The American Forest Institute, Inc., 1977. 1619 Massachusetts Avenue, N.W., Washington, D.C. 20036.

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Project Wild: An Interdisciplinary, supplementary environmental and conservation education program for educators. Western Regional Environmental education Council, 1985. Salina Star Route, Boulder, Colorado 80302. Phone: (303) 444-2390.

Hands-On Nature: Information and Activities for Exploring the Environment with Children. Jenepher Lingelbach, 1986. Vermont Institute of Natural Science.

The New Games Book. Andrew Fluegelman, editor. New Games Foundation, P.O. Box 7901, San Francisco, CA 94120.

More New Games. Andrew Fluegelman, editor. New Games Foundation, P.O. Box 7910, San Francisco, CA 94120.