Leader's Guide

4-H Plant Science Unit 2

INDOOR GARDENING

PENN STATE
College of Agricultural Sciences
Cooperative Extension
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Welcome to *Indoor Gardening*, the second unit of the Plant Science series. This is an introductory level (11-12 years of age) unit to familiarize youth with some of the more common houseplants, their care, propagation techniques, transplanting, and pest management.

*Indoor Gardening* is a six lesson project book which supports the 4-H program. 4-H is an educational program designed to help develop attitudes, values, and skills that will help to make young people become productive members of society.

The 4-H emblem represents the head, heart, hands, and health which correspond with educational, moral, work, and health ethics. One purpose of 4-H is to provide "hands on" experiences and opportunities to youth for developing their highest potentials in these areas. Specific goals supported by this project are:

1. Developing youth's concern for society and the larger world.
2. Increasing youth's understanding of science and appreciation for nature.
3. Developing good consumer skills.
4. Developing life skills:
   - creative use of leisure time
   - desirable interpersonal relationships
   - leadership
   - responsibility
   - marketable attitudes and skills leading to a career
   - responsible citizenship
   - communication skills

**Understanding Youth Needs**

In order to fulfill the objectives of the 4-H program, it is important to have an understanding of the common needs of youth. These basic needs which must be met in order for youth to progress to adulthood in a healthy manner include:

- To experience a satisfactory self-concept
- To become independent individuals
- To experience acceptance by peers and adults
- To experience adventure
- To experience success in achievement

Although children develop individual personalities, some characteristics are commonly shared by youth of this 10- to 12-year-old age. Leaders should strive to meet these needs in the following ways.

<table>
<thead>
<tr>
<th>Characteristics of Youth:</th>
<th>Implications for Leaders:</th>
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<tbody>
<tr>
<td>• Look to family for approval, but want to be independent of parents.</td>
<td>• Play up successes, minimizing failures.</td>
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<tr>
<td>• Limited ability to make decisions, need freedom to develop own ideas, interests, attitudes.</td>
<td>• Encourage less dependence on leaders' decision making. Avoid dictating direction, yet still provide reassurance and support.</td>
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<tr>
<td>• Need to develop sense of worth and security within own group. High interest in competition and single sex activities.</td>
<td>• Allow for homogeneous groupings, provide outlets for competitive drives.</td>
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<tr>
<td>• Comparison with others difficult to internalize. Short interest span; interest in varied active experiences; curiosity in concrete learning.</td>
<td>• Compare work with previous efforts. Provide educational activities with tangible results. Give short, simple directions, repeat often.</td>
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To summarize the key concepts outlined above, when working with youth, remember:

• It is important to continue to play up successes, even small ones, and minimize failures.
• Children like to talk to interesting people who bring things they can SEE and HANDLE.
• This is the age during which children like to explore many areas until skills are found that catch their interest and challenge their ability.
• Children prefer to compare their work with their own previous efforts, not their peers'.
• Evaluation by the youngster is desirable. Adults can help determine the improvements they make.
• Adults should be ready to shift the child's life into his/her own hands as soon as they know their ability and are willing to grasp responsibilities.

4-H Educational Experiences

As a leader of this 4-H project, you can increase and maintain interest that is raised by allowing members to help plan and conduct activities and events in their club, classroom, and community. 4-H members gain leadership and group skills by participating in making and carrying out plans. Some ideas you can use are:

Family involvement in a kick-off party for present and prospective members and their parents generates enthusiasm for the new year. Parents' events might include an evening program presented by members, a potluck meeting with a short 4-H program, or a summer family picnic.

Tours and field trips are educational, as well as recreational, if planned ahead.

Demonstrations at local meetings are good preparation for a similar county-wide event. Have youth give demonstrations to community organizations including nursery and garden clubs, parent-teacher associations and service groups, and to nursing and retirement homes.

Decision-making and judging begin by making choices between two or more things and being able to explain the reasons for these choices. Making decisions based on standards of quality is a very useful skill. You can teach these standards by providing opportunities for youth to choose and compare products and plant materials and having them discuss, compare, and contrast the strong and weak points of each. Contact your county extension office for publications such as the 4-H Manual for Flower and Vegetable Judging.

Discussions and problem-solving are an effective way for youth to teach themselves different subjects, to gather experience in presenting their views and opinions to a group, and to learn the art of active listening. As a leader, you can stimulate thinking and problem-solving abilities through many of the hands-on activities. You can also generate discussions by planning thoughtful and thought-provoking questions to youth.

Exhibits used at local events for parents, friends, and community members are an excellent way to recognize these youth and to promote the 4-H program you conduct.

Community service is an integral part of 4-H. Sharing with others allows youth to practice leadership and communication skills, develop commitment to the community and its needs, and also encourages family involvement. This sharing spirit will contribute to a youth's sense of membership in the community. Consult your telephone directory's guide to human services for listings of agencies and centers that might appreciate your 4-H group's contribution. Such activities could include giving presentations to a health-care facility or senior citizen's group, making an audio tape for the blind, or having youth identify activities where they can become involved.
How to Use This Guide
This manual provides additional information to complement the member's guide. You are encouraged to expand, rearrange, and provide innovative lessons to meet the needs of your group, whether it is a community or project club, or school enrichment program.

The leader's guide is divided into sections that will help you organize a lesson on each of the six topics in the member's guide. Each topic in this guide has five major parts:
I. Topic introduction
II. Purpose and objectives
III. Teaching aids
IV. Procedures
V. Looking ahead

More information regarding project resources, materials, and 4-H events may be found in the Meet The Plants leader's guide.

Indoor Gardening, the second unit of the Plant Science series, incorporates the use of the Scientific Method into the experiments these youngsters should complete. The Scientific Method should be explained each time they conduct the Experiments in Lessons 3, 4, and 5. After one or two experiments have been completed, these youngsters may be able to repeat the steps of the Scientific Method without further explanation. Upon completion of each experiment, have youngsters match steps of the experiment to the steps in the Scientific Method.

The Scientific Method steps are:
1. Formulate a hypothesis—Put forth an idea or proposal about something that interests the researcher, or that the researcher believes to be factual. An example is "A seed will sprout more quickly at 85° than at 65°."
2. Design an experiment—Construct a real-life simulation that will prove or disprove the hypothesis. The researcher designs an experiment which will test the hypothesis. This step involves the use of deductive reasoning—using general facts or knowledge to arrive at specific instances or facts. In our example hypothesis, the researcher knows plants generally grow more quickly at 85° than at 65° and, therefore, seeds should also sprout more quickly. The researcher sprouts two sets (replications) of five bean seeds in paper towels kept constantly moist, and at the two temperatures (85° and 65°) which are kept constant.
3. Collect data—Scientific information is gathered to support or deny the hypothesis. Record periodic observations from the experiment to provide evidence and facts.
4. Draw conclusions—Based upon the evidence and facts which have been gathered, conclude whether the hypothesis has been proven or disproven.
Lesson 1. FLOWERING AND FOLIAGE PLANTS

I. Topic Introduction
Gardeners value houseplants for their foliage and flowering characteristics. These characteristics developed and evolved as a means of competing for light and moisture. The majority of houseplants are from tropical rainforests where lush growth occurs in layers. Tall trees and high climbing vines form a canopy while other plants form a carpet on the ground. Other plants live in the crevices of trees and cliffs. Therefore, gardeners have houseplants that creep, hang, vine, and grow upright. Some require a lot of light, while others require little.

One of the differences between flowering and foliage plants is the unique environmental conditions they each require. These have come about primarily through the evolutionary process mentioned above and also through the science of plant breeding.

The common names of many flowering and foliage plants are derived from some physical trait or characteristic of that plant which may not be peculiar to just one plant. Hence, a scientific name in Latin is given to each individual kind of plant. Many times the Latin words used in the scientific name may resemble the common name used for that particular plant based upon a physical feature or characteristic.

II. Purposes and objectives
The youth will be able to:
• identify names of houseplants by associating them with physical features
• identify differences between flowering and foliage houseplants
• demonstrate decision-making skills while shopping for houseplants
• identify standards for judging good quality plants

III. Teaching aids
Materials each member will need:

Activity 1. Plants Need a Name Too (as pictured)
See Member's Guide
If possible, samples of these plants should be brought to the meeting place.

Activity 2. Guess the Plant's Latin Name (as pictured)
See Member's Guide
If possible, samples of these plants may be brought to the meeting place.

*Mangifera indica* mango
*Ficus elastica* rubber plant
*Lilium longiflorum* Easter lily
*Citrus limon* lemon
*Daucus carota* carrot
*Mentha spicata* mint
*Setcreasea purpurea* purple heart

Activity 3. Houseplant Hunting Fieldtrip
See Member's Guide
This activity—a fieldtrip—should be taught in combination with Activity 4 (below). If this is not practical, youth may be encouraged to complete this activity on their own, with their parents or other family members, or with a few members of the club or class.
Activity 4. *Smart Shopping Fieldtrip*
See Member's Guide
If this activity can't be done as a fieldtrip, bring samples to the meeting place for evaluation.

IV. Procedures

Activity 1. *Plants Need a Name Too*
You might begin this activity by asking the youngsters if there is anything unique about their last names. For example, the last names "Smith" (tin smith, black smith, etc.), Shoemaker, Miller, Baker, and Brewer at one time had an occupation, trade, or skill associated with them. To prevent confusion, people with the same last names are given a different first name. Ask if any of them know two people with the exact same last names? Were their first names different?

For example, the lemon tree (*Citrus* — genus; *limon* — species) has the same first name as the orange tree (*Citrus*— genus; *sinensis*—species). The first name—*Citrus*—is always capitalized (the genus in the plant kingdom) and the second name—*limon* or *sinensis*—is always written in small letters (the species). We call all of this group of trees "Citrus" which includes oranges, lemons, limes, grapefruit, and tangerines.

Activity 2. *Guess the Plant's Latin Name*
What do these Latin words mean? *Aqua* (water) ; *E pluribus unum* (from one, many) ; *agricola* (agriculture).

Latin is called a "dead language" because it is not spoken, but it is the source of many English words used today. Although the spelling of Latin words is different from many English derivatives, there remains enough resemblance to identify a closely-related English word. This activity will help youth learn the basics of plant nomenclature (naming) and classification (taxonomy).

Activity 3. *Houseplant Hunting Fieldtrip*
This activity should take approximately 1 hour to complete depending upon how many plants each youngster identifies. A good estimate of the time needed to identify each plant is approximately 2-3 minutes. This is an opportunity for group activity (2-3) as well as for each individual to select a certain number of plants they individually like. This activity is also ideal for generating discussion and problem-solving if you prepare questions ahead of time.

A few examples of questions for discussion might be: "Why did you prefer one plant more than another?" "If you had a choice between . . . (list 3-4 different plants), which plant would you buy 1st, 2nd, and so on? Why?" Questions of this type help youngsters formulate and put forth an opinion based upon reasons they have thought about.

You should contact the manager or owner of the business you will be visiting at least one week ahead of time to obtain permission and to seek their assistance. Make sure that the plants on the Identification List are stocked by the business. This will help you and your youngsters accomplish the purpose of the fieldtrip. Two different businesses are recommended for a variety of experiences for the 4-Hers. You may choose to visit one and have the youngsters visit another one with their parents or friends.

Introduce the manager or owner (if possible) and have them show and tell the 4-Hers about the business. This can provide the youngsters with an opportunity to explore a potential career. Since they are going to be looking at houseplants growing inside a building or structure (greenhouse), alert them ahead of time to notice such environmental conditions as temperature, humidity and light.

Activity 4. *Smart Shopping Fieldtrip*
When shopping for houseplants to purchase, it is important to recognize the standards which
make a quality product. A wise consumer is aware of these qualities and applies this knowledge when shopping for the best buy.

The Smart Shopping Fieldtrip will require approximately the same time as the Houseplant Hunting Fieldtrip. You should demonstrate ahead of time how to fill in the Best Buy Worksheet and take the 4-Hers through one example. They can observe how measurements are taken and see where to record the information asked for in the Worksheet. This is also their chance to ask questions if they don't understand something you have shown them.

Have individual members discuss and explain their results to the group. What stores had the cleanest plants? Where were the best plants? What was the average cost of plants? Again, prepare questions to ask them ahead of time which can be answered using information they have recorded on the Worksheet.

V. Looking ahead (to Lesson 2. STARTING A HOUSEPLANT COLLECTION)
Decide in advance which materials you will supply and which materials members will provide for themselves. Also decide which activities will be done individually at the meeting or at home by the youngsters.

Materials Needed:

Method 1. Whole Leaf Cuttings
• leaves from piggyback plants, bryophyllum, peperomia, or Rex begonias
• 4-inch diameter plant containers (approximate) or large enough to hold leaf with drainage holes
• sharp, clean cutting tools (paring knifes)
• well-moistened (2-3 days before meeting) vermiculite*, perlite*, or commercial potting mix*
• toothpicks, hairpins, or small pea-size gravel (4 per leaf cutting)

Method 2. Stem Cuttings
• 3-4 inch-long stems of coleus, wandering jew, wax begonia, pothos, peperomia, or ivy plants with 3-4 leaves attached.
• 3-4-inch diameter plant containers (approximate) with drainage holes
• rooting hormone*
• well-moistened vermiculite* or perlite*
• clear plastic bags large enough to cover plant containers with cuttings

Method 3. Division
• snake plants, ferns, begonias, peperomias, or ivy plants
• 3-4-inch diameter plant containers (approximate) with drainage holes
• commercial potting mix*
• sharp, clean cutting tools (paring knifes)

Method 4. Layering
• spider plants or strawberry begonia with runners or offsets being formed
• 3-4-inch diameter plant containers (approximate) with drainage holes
• commercial potting mix*
• sharp, clean cutting tools (paring knifes)

*available at local garden center
Lesson 2. STARTING A PLANT COLLECTION

I. Topic introduction
Some youngsters may have propagated plants by rooting leaf and stem cuttings, or by division and layering methods in Meet the Plants. Regardless, beginning a plant collection from a piece of another plant is a lot of fun and very rewarding for youngsters of any age. Many generations of offspring may be produced by these methods which are called vegetative propagation. It is also termed asexual propagation because parts of the plant—roots, stems, and leaves—are used instead of a seed.

Propagation by seed is called sexual propagation. A seed is the result of the union of male and female flower parts. The seed, a dormant embryo, remains in a resting state waiting for favorable environmental conditions to begin growth. Most popular houseplants sold commercially are propagated by asexual methods because the offspring appear exactly like the parent plant and it takes less time for the plant to mature. Many houseplant seeds also require exacting environmental conditions which makes them too difficult to germinate for the average gardener.

II. Purposes and objectives
The youth will be able to:
• demonstrate three of the four methods described for asexual plant propagation
• produce several new plants from one parent plant
• begin a houseplant collection

III. Teaching aids
See page 6 for a list of required materials

IV. Procedures

Method 1. Whole Leaf Cuttings
See member's guide
• The parent leaf will gradually disintegrate as the new plantlets appear.
• New plantlets (immature forms of the adult plant) and their root system will appear in several (2-10) weeks.
• When the root system reaches approximately 1/2 to 1 inch in length, carefully remove the plant and place it into a container of potting mix.
• Be careful not to overwater the new plant and do not put it in bright light for several more weeks.

Method 2. Stem Cuttings
See member’s guide
• Since the plant doesn't have roots, it can’t absorb moisture readily. Air moisture, or humidity, will suffice and can be maintained by placing the container in the plastic bag. Be sure to open it for 30 minutes each day to allow excess humidity to escape.
• To determine if roots have developed, gently pull on the stem. If there is some resistance, then roots are developing. Perform this procedure after two weeks have elapsed.
• Do not place the plant in direct light. It will take about 7-14 days for roots to form.
• Once roots have developed, remove the plastic bag.

Method 3. Division
See member’s guide
Method 4. Layering
See member's guide

Activity 1. Thinking About What I Did
The primary purpose of this activity is to have youngsters consciously reflect upon the activities they have just completed and to review the skills they have just learned. Thinking About What I Did asks the youngsters to compare and contrast each of the four methods of asexual plant propagation. Your role as a leader should be as a facilitator of discussion or questions and answers. The members should be asked individually to express their opinion which they have formulated from the results of their propagation activities.

Activity 2. Recording What Happens
This activity introduces youngsters to the importance of keeping records of plant propagation activities. This is one step of the formal scientific process--gathering and documenting evidence from observations. Keeping records is an important skill they need to develop not only for use in this project, but also for use later in life.

The record sheet shown in the Member's Guide can be used as an example. Youngsters can formulate their own record sheets on binder paper or in a notebook for each plant they propagate. They may even add additional columns for records or observations they might wish to keep. What is most important in this activity is keeping accurate records—not necessarily the format of the record sheet.

Optional Activity. Easy cuttings*

What you will need:
• 3 to 4 inch-long stem of coleus or philodendron with 3 to 4 leaves attached (one large plant may be used for all members)
• small container of water
• clean, sharp cutting tool

What you will do:
1. Allow members to take the stem cuttings from the plants.
2. Each member should have a small container with water so the cutting won't dry out.
3. Members should take their cuttings home and keep a record of their development to report to others at the next meeting.

*Note: This procedure is essentially the same as Method 2 except the cuttings will be rooted in water and not potting mix.

Optional Activity. Pineapple Top*

What you will need:
• green top-growth (leaves) of pineapple with 1 inch of fruit attached
• large container
• clean, sharp cutting tool
• potting mix

What you will do:
1. Remove fruit portion and bottom 1/4 inch of leaves and allow this part to dry for 24 hours.
2. Plant into large container filled with potting mix.
3. Maintain a moist potting mix and place the container in a warm, bright location--but not in a directly-lighted location.

*This is also an excellent opportunity for those who may have never tasted a fresh pineapple to do so. Although the pineapple will take many weeks to grow, there may be some members who would like to do this activity at home and share their experiences with the rest of the group. Have them keep a record of the growth to discuss with the group.
V. Looking ahead (to Lesson 3. LIGHT AND TEMPERATURE)
For Experiment 1. A-Maze-ing Plant Growth, you will need to have germinated either bean, pea, or sunflower plants to the height of approximately 3 inches. If you haven’t already done this, you will need to allow approximately 7-10 days for this to occur. If you desire to have groups of youngsters or individuals do this during the meeting, more or less numbers of plants must be germinated. Shoe boxes with the appropriate-sized cardboard pieces will need to be gathered ahead of time also. The actual assembly may be done during a meeting by groups or individual youngsters.

Experiment 2. Sun Light, Sun Bright, requires enough seedlings (beans, peas, sunflowers, or tomatoes) for members to put in 4 different windows. Each member will need to have 4 identical plants. This activity may be either a group activity or for individuals to take home.
Lesson 3. WHAT PLANTS NEED TO GROW—
LIGHT AND TEMPERATURE

I. Topic introduction
To be successful raising houseplants does not require a green thumb; knowledge, experience, and patience is necessary. In the next three lessons, youngsters will be learning about the environmental requirements of houseplants. This is called plant culture or caring for plants. In particular, they will be learning about the effects and interactions of different environmental factors. Light and temperature is the topic of Lesson 3; water and humidity is presented in Lesson 4; potting mixes, containers, and nutrients are presented in Lesson 5; and Lesson 6 concludes with troubleshooting some of the cultural problems they may encounter.

Energy, in the form of light from the sun, is one of the important driving forces in the chemical process known as photosynthesis. This process is very important for the youngsters to understand. Time should be taken during the lesson to show and explain the process (as depicted below) on a chalkboard or flip chart. For a more detailed discussion, you may refer to the references outlined in the Leader's Guide for Meet the Plants.

\[
\text{CO}_2 + \text{H}_2\text{O} + \text{LIGHT} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 + \text{H}_2\text{O}
\]

carbon dioxide \quad \text{water} \quad \text{sun} \quad \text{sugar} \quad \text{oxygen} \quad \text{water}

Or like this:

\text{carbon dioxide (from the air)} \quad \text{plus water and nutrients (from the soil)}
\text{plus}
\text{chlorophyll (green pigment in leaves) plus energy (light from the sun)}

\text{produces}
\text{sugar + water vapor}

It is important to point out to the youngsters that if the plant has too much or too little of any one of these elements—carbon dioxide, water, or light—photosynthesis may be slowed down or completely stopped. This can cause the plant to stop growing and die, or be weakened and subject to diseases. This concept can be explained by making the comparison to how well human beings take care of their bodies. We need to get enough rest, the proper nutrition, and exercise to remain healthy.

II. Purposes and objectives
The youth will be able to:
\• identify high, medium, and low light conditions
\• identify houseplants that require high, medium, and low light conditions

III. Teaching aids

Experiment 1. A-Maze-ing Plant Growth
See member's guide page 12 for a list of required materials.

Experiment 2. Sun Light, Sun Bright
See members guide page 13 for a list of required materials.

Activity 1. Being a Light Detective
IV. Procedures

Experiment 1. A-Maze-ing Plant Growth
This activity asks youngsters to use the steps of the Scientific Method in an experiment. Take a short period of time to explain the four steps in the Scientific Method. Make sure to include specific examples of each of the four steps.

Ask them to formulate the hypothesis for this experiment by asking the question "What will we be trying to prove in this experiment?" (Hypothesis: Plants grow toward a light source) The explanation of the importance of light to plants (pages 10-11) should be brought into the formulation of the hypothesis. In this instance, you may have to lead them into proposing the correct hypothesis until they become more skilled at this concept.

The second step of the Scientific Method, designing the experiment, has already been completed. Guide them through the actual construction of the maze.

Collecting data is the third step of the Scientific Method. This is the purpose for the space on the bottom of page 12. Remind them of the importance of keeping accurate, neat records.

At the bottom of the page, they are asked to draw conclusions based upon their observations. After growing for 21 days, discuss the growth characteristics of the bean plants. A plant's tendency to bend its stem and leaves toward a light source is due to a process called phototropism. The shoots grow toward the light hole in the box (positive phototropism). Roots grow away from the light (negative phototropism).

Ask the members why they believe the plants grew as they did (around the rectangle barriers). A plant's response to light—phototropism—is also the reason to occasionally rotate a houseplant's position relative to a light source.

The maze-building activity should be done in the meeting and the record-keeping activities may be performed at home. At the conclusion of the experiment (21 days), members (or groups) should share their results with others in a short presentation or demonstration. In the discussion, be sure members compare and contrast their observations with those of other members.

Experiment 2. Sun Light, Sun Bright
In this experiment, it may be necessary to guide the members through the four steps of the Scientific Method again. There are several hypotheses to be tested in this experiment however:

- Hypothesis #1—The quantity (high, medium, and low) of light will affect plant growth.
- Hypothesis #2—The quantity of light will affect the air temperature around the plant.
- Hypothesis #3—The window direction will affect both light quantity and air temperature.

Specifically, the following generalizations (deductive reasoning) will help you interpret the outcomes of the experiment and help to formulate the members' hypotheses:
A. Plants will stretch (longer stem length between leaves) in low-light conditions.
B. Higher air temperatures will occur in west- and south-facing windows.
C. More intense light will come through west- and south-facing windows.
D. Combining B and C will give higher air temperatures and more intense light coming from west- and south-facing windows.

Other points or questions that you can bring to the attention of the members include:

How do the size of leaves, the quantity of light, and air temperature affect plant growth?

What are some comparisons and contrasts between color of the leaves and other physical characteristics of plants in different light conditions?

Have members who used the same types of plants discuss their results among themselves and report to the groups who used different types. Be sure to point out the similarities and differences (comparing and contrasting) between the findings and conclusions of each group. They can draw conclusions about each type of plant, requirements that each have, and how they are different.
Activity 1. Being a Light Detective
This activity is intended to have youngsters observe many different houseplants in various settings and environments. The locations suggested are recommended because they should be able to observe houseplants that are well cared for and growing under ideal environmental conditions.

This activity may be used as either an introduction for the youngsters to the concepts of light and temperature or as a follow-up to the experiments in this lesson. In either case, discussion of their observations should center around the concepts presented on pages 10-11. Be sure they have mastered the concepts of high, medium, and low light requirements of plants and that they can identify several examples of plants in each category.

V. Looking ahead (to Lesson 4. WATER AND HUMIDITY)
For Experiment 1, A Big Gulp, you should decide well ahead of time whether each member will need materials or, if this is to be a small group activity, each group may be made responsible for supplying the materials. Youngsters must determine ahead of time which Treatment they wish to perform so that they can plan for materials needed.
Lesson 4. WHAT PLANTS NEED TO GROW—
WATER AND HUMIDITY

I. Topic introduction
Water is a component of all living plant cells. The amount varies from 3% in shelled peanut seeds, to 40% in dormant wood, and up to 95% in succulent fruits such as the watermelon. Water is the medium by which everything is transferred within a plant. Water also maintains the pressure or turgor inside a plant to keep it upright and growing.

The loss of an excess amount of water results in the plant stopping growth and its eventual death. This may occur quite rapidly under hot, dry conditions in plants that are not structurally adapted to prevent water loss. The houseplants we are learning about in Indoor Gardening are usually not adapted to these conditions because of their original natural habitat.

The amount of moisture in the soil that is beneficial to plants has definite limits. Too much water is not toxic itself, rather it is the lack of oxygen in waterlogged soils that causes damage. That is why it is so important when top- or bottom-watering to make sure that any water remaining in the saucer under the plant container is removed soon afterwards. It should be noted that most houseplants suffer from too much tender-loving care—too much water—and therefore suffer from "wet-feet" or roots that are waterlogged.

Humidity can be a problem when growing houseplants indoors. In general, low humidity is likely to result in dessication (drying out) and wilting of some plants with papery thin leaves such as ferns. High humidity, on the other hand, favors the development of decay especially if the temperature is high. Humidity also becomes more difficult to control as air circulation increases. This can present difficulties with houseplants in environmentally-controlled offices and buildings.

II. Purposes and objectives
The youth will be able to:
• determine a houseplant's need for water and humidity by performing the soil touch test
• correctly water a houseplant
• construct a temporary self-sustaining environment for plants

III. Teaching aids

Experiment 1. A Big Gulp
See member's guide page 17 for a list of required materials.

Activity 1. Mini-Greenhouse for Vacations
See member's guide page 19 for a list of required materials.

Activity 2. High Humidity Home for Houseplants
See member's guide page 19 for a list of required materials.

Activity 3. What Did You Learn
Answers for this activity appear in the following Procedures Section.

IV. Procedures

Experiment 1. A Big Gulp
Each member or group of members should choose one of the four treatments to perform. Again, this experiment involves the use of the Scientific Method. Each of the four treatments has a different hypothesis to be developed and is shown in the paragraph dealing with each in boldface italics.

They should also be able to state what the design of the experiment is to be for each
treatment. At the next meeting they should report their findings and be able to draw a conclusion based upon the study questions which are found on page 18. Each group completing the same treatment should compare and contrast results. A summary of the experiment may also be presented by comparing and contrasting results of the various treatments.

**Treatment A:** Thin-leafed plants store less water and therefore need more replenishment from soil moisture. *The second sample (thin-leafed plants) will require more frequent watering.* Members can examine leaves from Group I with fleshy, thick leaves to see how plants have evolved to store large amounts of water.

**Treatment B:** When receiving proper amounts of light, plants undergo the process of photosynthesis. Water is used and lost (transpired) into the air as vapor. *The houseplant placed closer to the light source should require more frequent watering.*

**Treatment C:** The smaller the container, the less water it can hold. People often make the mistake of giving too much water to large potted plants. If the pot isn’t in proportion to the plant, too much water may kill the plant. *The houseplant in the smaller container in this treatment should need more frequent watering.*

**Treatment D:** Clay is a porous material so it loses moisture to the air easily. People who tend to over-water their houseplants should use clay pots. *The houseplant in the clay pot should require more frequent watering.*

**Activity 1. Mini-Greenhouse for Vacations**
This is a useful way to keep plants watered for up to 2 weeks. It should not be used to replace regular watering techniques. Evaporation of water from the leaves of a plant is the result of transpiration. Why does moisture appear on the inside of the plastic? The transpired water vapor from the plant’s leaves condensed on the plastic. This condensation can cause plant diseases due to a lack of air circulation for prolonged periods of time. If leaves remain in contact with the plastic, they are likely to rot also.

**Activity 2. High Humidity Home for Houseplants**
The purpose of the container of water is to increase humidity to the houseplants sitting on it. If the houseplants sitting in the container require additional water vapor, individual cells on the underside of their leaves, called stomates, can absorb this vapor.

It is important that plant containers be sitting on the gravel and not in the water. The purpose is not to bottom-water the plants, but to provide a higher level of humidity. Plants will still require normal watering and the soil touch test is a good method of determining when to water.

**Activity 3. What Did You Learn**
The answers needed to fill in the blanks to the paragraphs are shown below. There are other words that can be used which you may find appropriate. These are the most correct answers.

Plants are **90%** water. Water carries nutrients from the soil to other parts of the plant.

Houseplants grow best when their roots remain slightly **damp** all of the time.

A general rule for watering is to feel the **soil** just below the surface.

This rule is called the **Soil Touch Test**.

How often you have to water depends upon the **temperature** in your home, the size and type of **container**, and the type of **plant** you are growing.

The amount of water vapor held in the air is called **humidity**. Plants can lose water through their leaves in a process called **transpiration**. If this happens too quickly and they lose too much water, plants can **droop** and lose their leaves.

Be sure to spend some time with the members reviewing this lesson if their self-evaluation score is not satisfactory. You should encourage them to ask questions about any of the concepts
contained in this lesson they do not understand.

**V. Looking ahead (to Lesson 5. POTTING MIXES, CONTAINERS, AND NUTRIENTS)**

It would be well worth the effort to inform as many different people as possible, including members, about the need for saving plant containers. If you are not already familiar with some examples, look on page 22 of the Member's Guide to give you an idea of what can be used and whom to ask to save these containers. Otherwise, members are going to be responsible for providing these plant containers.

For *Activity 1. Transplanting a Potbound Plant*, you will need to decide whether this is to be done by one individual or group of members. If it will be an individual activity, then each person is going to need to have a potbound plant and a larger container.

For *Activity 2. Investigating Fertilizers*, make sure that you contact the guest speaker far enough ahead of time to insure their participation. Depending upon who is invited, give yourself plenty of time and allow about two weeks. Don't forget to have the youngsters prepare some questions about fertilizers ahead of time to send to the guest speaker. That is part of their assignment.

For *Experiment 1. Beans With and Beans Without*, you will need to have prepared, either for individuals or for small groups of members, enough bean seedlings for the experiment.
Lesson 5. WHAT PLANTS NEED TO GROW—
POTTING MIXES, CONTAINERS, AND NUTRIENTS

I. Topic Introduction
In order for houseplants to grow new leaves and stems, their roots require sufficient space to grow so that they can support these new leaves and stems. Topsoil found in the garden is an unsuitable growing medium for houseplants for several reasons. It may have a bacterial content that can cause problems for houseplants in an indoor environment. Nor does garden topsoil contain the proper amount of organic matter required by houseplants for growing in shallow plant containers. The shrinking of dry soil and swelling of dampened soil can result in serious problems for the roots of houseplants.

Potting mixes are soil-less mixtures, not like the soils we know from the garden. They are excellent substitutes because they allow good air space for plant growth. This is accomplished by using artificial, inorganic substances such as vermiculite (the gold-colored particles) which is expanded mica and perlite (the white-colored particles) which is expanded volcanic lava. Other ingredients in soil-less mixes may include different proportions of peat moss, sand, and sterilized soil.

Page 22 of the members guide illustrates the variety of containers that can be used for houseplants. Many household containers that might ordinarily be discarded can be adapted by members for use in growing their houseplants. These containers must be cleaned of all residues from their parent materials especially if they contained substances harmful to plants (bleach, etc.).

It is extremely important that these containers be properly adapted to provide adequate drainage for excess water from the soil. This can be accomplished by simply insuring there are one or more small drainage holes in the bottom of the container. Most commercially-available houseplant containers have drainage holes in them when they are manufactured, but check these too.

Materials that supply nutrient elements to plants are known as fertilizers. The primary objective of fertilization, the addition of nutrients to the houseplant, is to achieve an optimum plant response. This means the production of leaves for foliage houseplants and flowers for flowering houseplants.

Fertilizers that supply nitrogen (N), phosphorus (P), and potassium (K), the three major plant nutrients, are called complete fertilizers. The fertilizer analysis is the percent of nitrogen, phosphorus, and potassium respectively. Thus a 10-10-10 analysis of fertilizer would contain 10% nitrogen, 10% phosphorus, and 10% potassium. A fertilizer analysis is found on all commercially-available houseplant fertilizers.

Fertilizers may be classified either as natural organics, which are derived from living organisms or as chemicals, which are synthesized from inorganic minerals. The nutrients in natural organic fertilizers undergo gradual chemical changes into available forms houseplants can readily use.

A houseplant's individual response to fertilization is related in part to the environmental factors discussed in previous lessons, such as light and temperature, and water and humidity. Thus, a houseplant requires a favorable environment for all of its parts—roots, leaves, and stems. Generally, nitrogen is primarily responsible for the dark green color of a houseplant's foliage or leaves. Phosphorus is required for the production of flowers and potassium is necessary for strong and vigorous root growth.

II. Purposes and objectives
The youth will be able to:
• identify and adapt four different types of plant containers recycled from their homes
• transplant or repot a potbound plant
• explain the purpose of fertilizers
• properly fertilize houseplants

III. Teaching aids

Experiment 1. The Water Tower
See member’s guide page 23 for a list of required materials.

Activity 1. Transplanting a Potbound Plant
See member’s guide on page 24 for a list of required materials.

Activity 2. Investigating Fertilizers
See member’s guide on page 25 for a list of required materials.

Experiment 2. Beans With and Beans Without
See member’s guide on page 25 for a list of required materials. Purchase a liquid or powdered houseplant fertilizer which will dissolve in water. A high chemical analyses (for N, P, and K) will provide a quicker response by the beans will be noticed sooner and more easily by the youngsters.

IV. Procedures

Experiment 1. The Water Tower
This experiment reveals an explanation about several scientific principles youngsters need to understand. One principle is that gravity affects the ability of soil to retain or hold water. To relate this scientific principle to a youngster’s everyday life, one example of a question to ask might be "What prevents a body or any object from floating off into space?" Not only does gravity exert a downward force or pressure on them, it also puts a similar pressure, or force, on the water found in the sponge which represents soil. When the water-saturated sponge is held over the large bowl flat side down, it will drip much less water than if it is held either vertically or horizontally. When the sponge is held vertically, it holds even less water than when it is held horizontally. Of course, this is due to the force of gravity. The taller or deeper the container of soil used, the greater the effect of gravity, or pressure, on water held in the soil. Commercial houseplant growers discriminate between various sizes of containers by calling those that are deeper than wide pots, and those that are about as wide as deep pans.

Another principle shown in this experiment is that a good potting soil, like the sponge, can hold many times its own weight in water. This is primarily due to the ratio of solid particles to air and water (50%-50%). If excess water is allowed to drain from the houseplant container, the houseplant's roots will absorb water from the soil’s pore spaces that, once filled with water, will then be filled with oxygen. This is what happens when the sponge is squeezed dry of any remaining water after having dripped its excess into the measuring cup. Theoretically, the soil can hold about 50% of its total volume in water.

Observations and recordings the youngsters have made during this experiment with the saturated sponge should be translated into practical applications about watering requirements, containers, and potting mixes of houseplants. Houseplants in taller containers—pots—will probably need to be watered more often than the same-sized houseplants in shorter containers—pans. Again, this is primarily due to the effect of gravity pushing water down on the column of soil.

Another practical application of the results of this experiment deals with the practice of adding gravel or coarse materials (broken clay pot pieces, rocks, etc.) to the bottom of plant containers. This practice is done to prevent soil from clogging the drainage hole in the bottom of
houseplant containers and to allow aeration of the soil in houseplant containers.

This experiment also provides an ideal situation for the youngsters to practice and refine their use of the Scientific Method. If they have practiced this method of inquiry in the previous lessons, they should be very proficient in the four steps. This is also an excellent opportunity for group activities because there will probably be at least two different hypotheses proposed by the youngsters. Individuals can formulate, propose, and discuss their ideas within their group, come to an understanding as a group, and then put forth their hypotheses to the larger group.

This experiment should stimulate discussion and problem solving. Plan your questions ahead of time from the information provided above. You should be able to lead the youngsters into what the activities of the experiment mean. The three Questions to Think About are meant to provoke thinking and discussion about potting mixes, containers, and watering practices.

Activity 1. Transplanting a Potbound Plant
- Emphasize again that houseplants need good root aeration and water for proper growth.
- Wet, soft, dark roots are a sign of a sick houseplant.
- Healthy houseplants should have white, firm, brown roots.
- Comparisons and contrasts between healthy and sick houseplants stimulate discussion.
- Provide youngsters with feedback and evaluate their performance on this important skill.

Activity 2. Investigating Fertilizers
- Planning is the key to providing a successful learning experience in this activity. Help the youngsters write the questions they want to ask the guest speaker.
- Arrange with the guest speaker in advance exactly which questions are going to be discussed, what materials are required for you to secure, and what they will bring.
- Inform the speaker of the youngsters’ ages so the topic can be presented at the appropriate level. Have the youngsters involved in activities planned by the speaker if possible.

Experiment 2. Beans With and Beans Without
Youngsters should be proficient in using the Scientific Method by this time. This experiment provides another opportunity for them to practice this method of investigation. Individual, as well as group, investigations can be used in this experiment which can be adapted in several ways to show different interactions between soils and fertilizers. Types of soils (potting mixes, washed builder’s sand, etc.), different strengths of fertilizer, and watering schedules will have different effects on bean plants.

Records and observations may be kept by the youngsters for longer than one week. They may wish to discover the long term effects of lack of fertilizer on the beans—differences in leaf color, size of plant, plant development and maturity, etc.—and report back to the group at some later time.

V. Looking ahead (to Lesson 6. TROUBLESHOOTING)
Although this is the sixth and last lesson in Indoor Gardening, it provides many opportunities for youngsters to exhibit what they have learned. There are several activities that can be completed during the last meeting.

For Activity 1. Guess the Pest. Although this is simply an exercise in identifying houseplant pests, it would be even more interesting if you could have an example of each of the pests shown on Page 27. A magnifying glass should also be available to identify each of the pests.
Lesson 6. TROUBLESHOOTING

I. Topic introduction
Being able to recognize conditions that cause houseplant growth problems is also an element of proper plant care. The member's guide shows what can happen to plants with Too much of something or Too little of something.

Some members may possess a better understanding of houseplant growth problems if they take care of the houseplants around their homes. Get the other youngsters to be alert to, and aware of, these types of problems. Ask them to observe symptoms in any of the houseplants they might see around their homes and to bring them in for other members to observe. You should bring some houseplants in for the youngster to use to identify the cultural and pest problems that were described to them in the member's guide.

II. Purposes and objectives
The youth will be able to:
• identify symptoms of unhealthy plants
• recognize common pests of houseplants
• prevent cultural problems
• control for pests

III. Teaching aids

Activity 1. Guess the Pest
A. Aphids
B. Adult Whiteflies
C. Scales
D. Mealybugs

Record and Review
It is very important for the youngsters to complete this activity as it will provide them with an opportunity to think about and reflect on the knowledge and skills they have just learned. Each of the seven questions covers a particularly important topic within a lesson and there is more than one right answer.

When evaluating a youngster's written responses to each of these questions, carefully consider their basic understanding of the concept discussed. The major concepts presented in Indoor Gardening basically parallel each of the headings of the six lessons.

New Word Search
All seventeen words are hidden in the maze of letters in the member's guide.

Sharing With Others and Round-Up Projects
Many different examples of activities to do in small groups, pairs, or individually appear in these two lists. Any of these activities can provide you the opportunity to assess and evaluate the knowledge and skills learned by the youngsters in Indoor Gardening.