PURDUE EXTENSION

4-H-1041-W

Helper's Guide

What's Inside?

Harvest and Storage

Careers

Solutions

Resources

Acknowledgements

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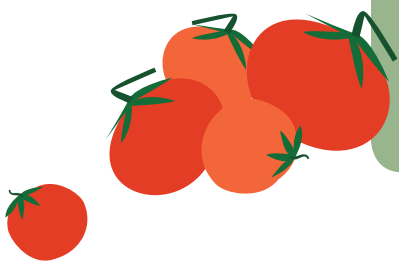


Overview

Congratulations on your decision to serve as an adult or teen helper for the garden project. Your role is critical in providing opportunities for youth to learn and grow in a caring and supportive environment. This guide gives you activities, ideas, and content to help you with this challenging and exciting role.

Many people think you must have a huge plot of land to grow a garden. This isn't true! Youth can implement the garden project in container gardens just as well as on a plot of land.

Gardening is for people of all abilities. This curriculum includes several ideas for gardening with youth who have special needs. In fact, gardening is often used as a therapy and coping mechanism for people of all ages who might have a physical, mental, or emotional disability.

Garden by age

The guide is organized into four levels, which correspond to the age-graded member levels as follows:
Level A: 10-11 year olds
Level B: 12-13 year olds
Level C: 14-16 year olds
Level D: 17-18 year olds

Content

This guide contains:

- Additional background information not found in the youth manuals
- An easy-to-use reference table
- Group activities that use the experiential learning model and can be done at club meetings, project workshops, or school or camp programs.

Activities in this guide supplement the youth manuals. They are organized into six general categories that allow you to choose a broad topic related to what youth are currently learning about in their manuals. The categories are:

- Plant science
- Garden planning
- Planting a garden
- Garden care
- Harvest and storage
- Careers

Other features include answers to questions asked in the youth manuals (Solutions, page 71) and additional information, ideas, and support (Resources, page 80).

Developing project and life skills

The garden curriculum is designed to help youth develop both project skills and life skills. Project skills are specific to the garden subject matter, such as learning how to plant seeds or make a compost pile. Life skills relate to the process a member undergoes when doing an activity and are useful long after the member completes the project. One such example is decision making.

Project skills

The content of this curriculum has a broader focus than in previous versions. The curriculum primarily focuses on skills related to vegetable gardening, but it is also designed to help youth develop project skills across the six general categories listed under Content.

Life skills

The life skills involved in this project are grouped into three major categories: competency, coping, and contributing. Levels A and B focus primarily on developing competency and coping life skills. Contributory life skills are introduced in Level C and expanded in Level D.

Life skills learned through 4-H

Competency	Coping	Contributing
Acquiring knowledge Using scientific methods Mastering technology Making career decisions Managing resources Communicating	Recognizing self-worth Relating to others Making decisions Solving problems Dealing with change	Applying leadership skills Taking community action Volunteering Conserving the environment

Experiential learning

"Learning by doing" is one of the main reasons 4-H is so widely recognized and respected in the field of informal education. The garden curriculum follows an experiential learning model. Experiential learning is more than just doing activities. It involves discussing the activity, drawing conclusions from it, and applying them to the real world.

Activities in the youth manuals are designed to help the 4-H member work through the entire experiential learning process as they do each activity and record their answers. Group activities in this leader/helper's guide list each step along with what to do and sample questions to ask. This is useful as you help members do and process the activity.

How it works

Do

1. **Experience** – Begin with a concrete experience. This can be an individual or group activity that involves doing something.

Reflect

2. **Share** – Next, get the group or individual to talk about what they experienced when they were doing the activity. Share reactions and observations. Talk freely.

   Sharing questions:
   What did you do?
   What happened?
   How did you feel to…?
   What was most difficult? Easiest?

3. **Process** – Discuss how the activity creates questions.

   Processing questions (use information generated from sharing questions):
   What problems or issues seemed to occur over and over?
   What similar experience(s) have you had?

Apply

4. **Generalize** – Find general trends or common lessons in the experience. Identify the important points that apply to the "real world."

   Generalizing questions:
   What did you learn about yourself through this activity?
   What did you learn about making decisions (or other life skills)?
   How do the major themes or ideas relate to real life and not just the activity?
   How did you go about making your decision?

5. **Apply** – Talk about how the new information can be applied to everyday life or sometime in the future.

   Applying questions:
   How can you apply what you learned (making decisions) to a new situation?
   How will the issues raised by this activity be useful in the future?
   How will you act differently in the future as a result of this activity?

Youth learning characteristics

The following characteristics are common to children in four age-graded levels. However, children develop at their own pace, and all characteristics are not observed in all children at the same age. We hope you find this outline helpful as you work with youth of

different ages. *(Written by Judith Myers-Walls, associate professor, Child Development and Family Studies, Purdue University, and adapted from* Ages and Stages of Child and Youth Development *by Judith Myers-Walls and Jeanne Kerns.)*

10-11-year-olds

- Active, full of energy, and anything but quiet. Activities should encourage physical involvement.
- Interests may change often, jumping from one thing to another. Activities divided into small pieces or steps work best.
- Fairly concrete thinkers; tend to be more attentive if they have an opportunity for hands-on learning (seeing and doing, rather than just listening).
- Just beginning to think logically and symbolically, and are beginning to understand abstract ideas. As they consider an idea, they think it is either right or wrong, fun or boring—little middle ground.
- Look for adult approval and have a strong need to feel accepted and worthwhile. Adults should provide lots of encouragement and recognize even small successes.
- Prefer individual evaluation over group competition. Instead of comparing success with others, youth prefer to know how much they have improved and what they should do better next time. They are easily embarrassed about doing either better or worse than their friend.
- Beginning to move out of the stage in which the satisfaction of completing a project often comes from pleasing the leader or parent rather than from the value of the activity itself.

12-13-year-olds

- Growth spurts might begin at this age with girls maturing faster than boys. These rapid changes make some teens uncomfortable with their changing body images.
- The approach of puberty begins a rollercoaster ride of hormones and emotions, presenting a major challenge to a young person's self-concept.
- Faced with so many changes, they hardly know who they are. They begin to test values and identities, and seek adults who are accepting and willing to talk about values and morals.
- Wanting a sense of independence from parents, they are concerned about being liked by friends. Peers' opinions on dress, music, and activities become more important than those of parents and other adults.
- Moving from concrete to more abstract thinking. They often reject ready-made solutions from adults in favor of finding their own. Small groups provide opportunities to test ideas.
- Adults should continue to avoid comparing young people with each other, being careful not to embarrass them. They want to be part of something that is important and that provides an opportunity to develop responsibility.
- Justice and equality are important issues. Judging of projects is viewed in terms of what is fair. They see ribbons as reflections of the individual's self-worth instead of feedback on a specific project.

14-16-year-olds

- Concerned with themselves and their peer group. Relationship skills become a priority. Many begin dating, and acceptance by members of the opposite sex might become important.
- Since many are becoming aware of their own special abilities and talents, this is a good time for introducing them to leadership roles.
- As they begin to think about the future and make realistic plans, their vocational goals often influence the activity they select.
- Mastering abstract thinking, they imagine new ways of doing things that sometimes challenge adults.
- They set their goals based on feelings of personal need and priorities, and likely reject goals that others set.
- Can initiate and complete tasks without supervision. Leader's role should be as advisor/coach.

17-18-year-olds

- Finishing up high school and moving on toward post-secondary opportunities.
- Future plans are important as they begin making the transition to adult life. Their goals for the future influence which activities they continue.
- In most cases, they determine their own schedule, and only general directions are needed when they are assigned familiar tasks.
- Close relationships develop as they become preoccupied with their need for intimacy.
- They make and carry out serious decisions, but still need adults for support and guidance.
- Adults no longer control their activities but should serve as resource people, helping to stimulate teens' thoughts.

Overview of Content in the 4-H Garden Curriculum

Level A

- When, where, and what to plant
- Make a plan and layout design for a garden or container
- Types of soil
- Cool- and warm-season vegetables
- Mark off a plot
- Soil preparation
- Soil mix for containers
- Sowing seeds – spacing and depth
- Rows vs. hills
- Thinning
- Seed germination/ parts of a seed; testing for germination; plant needs
- Plant parts: leaf, stem, and root form and function
- Garden tools/Safety
- Watering
- Weeding
- Mulching
- Garden friends and foes
- IPM
- When to harvest
- Using the harvest (eat, store, preserve – drying pumpkin seeds)
- Selling the harvest
- Tool care
- Clearing up for winter
- How plants are used (other than as food)
- Greenhouse/garden center (workers and manager)

Level B

- Changing plans to expand a garden or use a larger container or patio garden
- Seed varieties
- Similarities in family crops
- Rotation crops
- Seeds vs. cultivars
- Developing planting calendars
- Starting seeds indoors
- Transplanting cultivars
- Hardening off
- Protecting transplants from wind, too much sun, and frost.
- Plant properties (phototropism, geotropism)
- Plants from parts (bulbs, tubers, stems, leaf)
- More garden friends/ pests
- Preventive measures for pest control
- Composting
- Fertilizer (manure tea)
- IPM
- Specialty harvest (largest, most interesting, etc.)
- Storing crops
- Selling the harvest
- Preservation (freezing fresh and prepared foods)
- Using excess harvest (what to do with too much)
- Horticulture careers
- Farmer (including truck and roadside stands)

Level C

- Consider the value of broadcast planting
- Consider the value of succession planting
- Planning an herb garden
- Plant companions
- Extending the season
- Soil structure/texture/ drainage
- Improving soil
- Broadcast planting
- Succession planting
- Herb companion planting
- Hybrids vs. standard forms
- Planting herbs
- Soil nutrients/organic fertilizers
- Soil management (conditioning/modifying pH)
- Flower form and function
- Self- and cross-pollination
- Photosynthesis
- Chlorophyll/Chromatography
- Soil pH/plant needs
- pH indicators
- Identifying insect damage
- Identifying weeds
- Other ways to water plants
- Dealing with animal pests
- Keeping records
- IPM
- Harvesting herbs
- Selling the harvest
- Preservation (canning vegetables, pickling; drying/freezing herbs)
- Storing/saving seeds
- Keeping records
- Growing vs. buying vegetables ($)
- Horticulture-related careers (soil scientist, entomologist, ecologist, etc.)
- Education/teaching
- Food industry careers related to vegetables

Level D

- Consider the value of intercropping and double-cropping
- More on vegetable companions
- Computer garden planning programs
- Space-saving ideas (raised beds, vertical garden, patio garden, shelving, square foot, etc.)
- Greenhouses
- When and how to plant by intercropping and double-cropping methods
- Cultivar trials to increase production
- Small garden strategies
- Intensive gardening/ square foot gardening
- Pollution/acid rain/ greenhouse effect
- Biotechnology/genetic engineering/plant breeders
- Diversity/seed banks
- Hydroponics/food in space/NSCORT
- Identifying plant diseases
- Nutrient deficiencies
- Sources of nutrients
- Organic vs. chemical fertilizers
- Power garden tools
- Pesticide safety
- Pest management plan
- IPM controls
- Financial records; determining profits/ losses
- Selling the harvest/ plan your own business /bank credit
- Preservation (pressure canning, drying vegetables)
- Winterizing power tools
- After the frost plan
- Botanist (cultivar trials with resistant varieties)
- Basic vs. applied research
- Self-analysis profile
- Skills vs. traits
- Using career resources
- Exploring interests

Helper's Guide

- Planning a garden
- Soil basics
- Making the most of garden space (broadcast, double-cropping, succession, and intercropping planting methods)
- Buying seeds, transplants
- Soil preparation for garden plots and containers
- Planting, thinning, watering, and seeds
- Transplanting cultivars for garden plots and containers
- General planting hints
- Summary of plant science: seeds, growing plant needs, plant cycle, roots, stems, food change, diversity
- Hydroponics
- Soil fertility
- Garden equipment
- Garden safety (equipment and supplies)
- IPM
- Managing weeds (mulching, cultivating, chemical)
- Managing plant diseases: noninfectious and infectious agents (cultural and chemical control)
- Managing insects (preventive practices, insecticides)
- Harvesting hints
- How to store vegetables
- Selling the harvest
- Ways to preserve vegetables
- Summary of careers related to gardening

Overview of Activities in the 4-H Garden Curriculum

Level A

Year 1

First You Plan	Planning a garden
Gardening Safely	Caring for yourself and your tools while gardening
Seeds Up Close	Parts of a seed, what they do
Plant It	Garden soil preparation
Take Time for TLC	Garden care – weeding, watering, mulching, inspecting
Is it Ready?	Harvesting the garden

Year 2

The Second-Year Garden	Cool- vs. warm-season crops
Change It Up	New planting methods
Beyond the Stem	The parts of a plant and what they do
Check Out the Veggies	Identifying vegetable products at the store
Use It Up	How to use harvested vegetables
Planting Your Career	Exploring careers, specifically those at a greenhouse

Level B

Year 1

Plant a Transplant	Planning to use transplants in a garden
Plan It Bigger	Creating a planting calendar
On the Move	How to plant transplants
Starting from Scratch	Starting seeds indoors
A-Maze-ing Plants	Plant responses to the environment
More Than Seeds	Growing plants from plant parts

Year 2

Wiggly Farm Acres	Benefits of worms in the garden, building a worm box
Let It Rot	Composting, making manure tea
One of a Kind	How to judge vegetables
Too Much to Eat!	Methods of preserving excess produce
On Your Own	Selling produce
What's in a Name?	Exploring careers in the field of horticulture

Level C

Year 1

Broadcast Your Garden	Using broadcast planting method
Stretch It Out	Planning for succession planting
Don't Forget Herbs	Planting herbs in a container
What's Under Your Feet?	Soil analysis
Keep on Planting	Planting a garden using succession planting
Thyme for Planting	Planting herbs in the garden

Year 2

Acid Basics	The impact of pH on the garden
Getting Green	Experimenting with photo-synthesis
Flower Power	Flower parts and cross-pollinating
Be a Bug Buster	Identifying insect damage
When Animals are Pests	Identifying animal pests
What's With Weeds?	Helping younger gardeners identify weeds

Year 3

Garden Cents	Keeping garden records
Lead the Way	Planning an educational event for younger gardeners
Let's Preserve	Various food preservation methods
Grow Your Career	Exploring more careers in horticulture
Are You a Teacher?	Planning a garden-related lesson plan; teaching as a career
Making Contacts	Jobs in the food industry

Level D

Year 1

Tight on Space	Intensive gardening techniques
It's In-Between	Intercropping as a planting method
All in the Row	Planting a garden with inter-cropping
Double Your Crops	Planning for double-cropping
Double Your Fun	Planting a garden with double-cropping
Garden in Your Computer	Exploring computer garden design technology

Year 2

The Air Up There	The effects of air pollution
Look Ma — No Soil!	Using hydroponics
Designer Genes	Genetically engineering plants
Looking Closely	Identifying plant diseases
Talk About It	Understanding fertilizers
Taking Action	Exploring integrated pest management, using pesticides

Year 3

Profit or Loss	Preparing garden finances
Save the Best	Exploring even more preservation methods
Growing A Business	Creating a business
All About You	Understanding personalities and careers
Research Plant Science	Exploring careers in plant research
Is It for Me?	Investigating a specific career

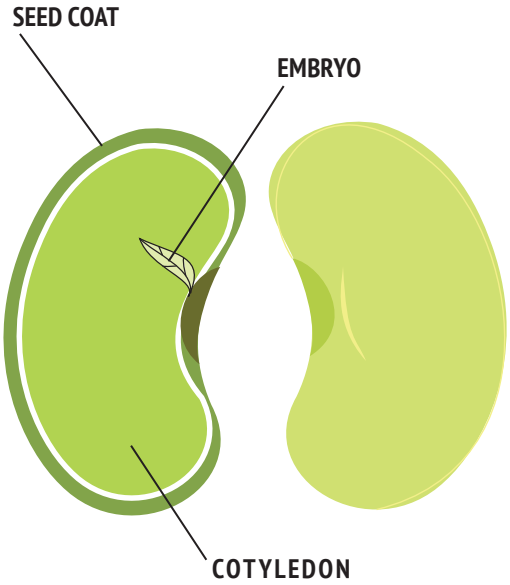
Plant Science

Background

About seeds

Basic components of seeds:

- Embryo – a tiny plant, complete with leaf, stem, or root parts
- Seed coat – protects the embryo



Seeds have a temporary food supply to nourish the embryo until the seedling grows leaves and the plant can make its own food. This food supply can be:

- Packed around the young plant, in which case it is called an endosperm
- Stored in special leaves called cotyledons

Most seeds are either monocots (one cotyledon) or dicots (two cotyledons).

When conditions are right for seeds to begin growing, the seed germinates. To germinate, all seeds require:

- Oxygen
- Water
- Proper temperature

Oxygen and water (for moisture) are initially taken in through the seed coat, through a tiny opening called the hypocotyl. Later, the root has this function. The embryo's cells begin to enlarge, and the seed coat breaks open. The root emerges first, followed by the shoot, which contains the stem and leaves.

Seeds have specific temperature requirements and/or preferences for germination. For example, tomatoes require warm temperatures of 70-75°F, but lettuce germinates better in cooler temperatures of 45°-65°F.

Seeds might need proper light conditions to germinate. Some seeds require light, but light inhibits others from germinating. A seed packet provides this information.

How seeds are treated during germination affects their chances of survival.

- If small seeds are planted too deeply, the young plants use up their food supply before reaching light (which the plant needs to make its own food) and die.
- Seeds planted in soil that is too dry might not get enough moisture to germinate.
- Seeds planted in soaking-wet soil might not get the oxygen they need to germinate, or the excess moisture might cause the seeds to rot.

Some seeds have hard seed coats. They germinate more quickly after being soaked or scarred (nicked) to allow water to enter the seed.

Some seeds fail to germinate. The reasons why include:

- Soil temperature is too low or too high.
- Soil has dried out.
- Seeds were planted too deeply.
- Seeds washed away during watering.
- Seeds were old and/or improperly stored.
- Poor soil-to-seed contact.
- Damping-off disease.

In Level A, Seeds Up Close, youth explore seed germination and identify the parts of a seed.

Basic plant needs

All living things have basic needs, and plants are no different. To thrive and grow, plants need:

- Light
- Water
- Mineral nutrients
- Air (carbon dioxide and oxygen)

Mineral nutrients are derived from the breakdown of rocks and other materials in the earth. Plants take these minerals from the soil (dissolved in water) or through fertilizers that people apply. Too much of a good thing can be as harmful as too little.

- Too much light during germination delays the process for certain seeds that prefer darkness.

- Too much water can prevent oxygen from reaching roots.
- Too much fertilizer can burn plants or cause plant cells to grow too quickly, resulting in weak, spindly, or dead plants.

In Level A, Beyond the Stem, youth explore what happens when a plant leaf cannot get sunlight.

Plant parts

Roots and stems help most green plants meet their basic need for nutrients and water. They form a special partnership.

Roots

Function

Roots are important in enabling plants to meet their basic needs because they:

- Provide support
- Anchor the plant
- Absorb necessary water and nutrients
- Might store sugar and their carbohydrates, which the plant can use (example, a potato plant with tubers)

Roots also have a special partnership with soil by:

- Assisting the long process of soil formation by breaking off tiny pieces of rock as plant roots grow through cracks in rocks
- Aerating and loosening soil when a plant's roots are alive
- Providing tunnels for burrowing insects and animals
- Contributing to the rich humus component in soil when the plant's roots are dead and decomposing
- Helping to protect topsoil from erosion (the wearing away of soil by the action of ice, water, or wind)
- Helping to absorb and recycle water when it rains

Sweet potatoes, carrots, beets, turnips, and radishes aren't just nutritious food sources for humans and other animals; they are plant-food storage roots. One-fifth of the world's sugar comes from the roots of sugar beets.

In Level A, Beyond the Stem, youth grow a carrot plant from the root instead of from seed.

Structure

There are two basic types of roots.

- Some plants have a primary *taproot* with a few smaller, hairy roots. Such long, strong roots reach deep into the soil to pull up nutrients and water from far below the surface. Carrots, sweet potatoes, beets, radishes, and turnips are taproots that expand in size and store sugars and starches.
- Other plants have a *fibrous root system*, a network of smaller roots and root hairs branching off the primary root. These networks can be extensive with more than a million branching roots covered with billions of root hairs. Beans and tomatoes have fibrous root systems.

Basic need	Purpose
Light	Required for photosynthesis so plants can make sugar (food). Triggers certain changes, such as flowering (photoperiodism) in certain plants.
Water	Carries dissolved nutrients into the plant through the roots. Required in photosynthesis. Helps plant release energy from stored food when needed (in respiration). Helps support stems and leaves by water pressure in plant cells, which are 65-95% water. Transports nutrients and gases into, around, and out of the plant.
Mineral nutrients (major nutrients—nitrogen, potassium, and phosphorus)	Used for growth, repair, and proper functioning.
Air	Required in photosynthesis (carbon dioxide is necessary to make food). Required in respiration (oxygen is necessary to release energy from a food).

In both types of roots, the tiny root hairs provide surface areas for absorbing water and nutrients. They bridge the root and the water with dissolved nutrients in the soil. That's why transplanting young seedlings or transplants carefully is so important. A plant with damaged root hairs has difficulty meeting its water and nutrient needs. It's also why certain seeds should be planted outdoors when the ground warms up instead of started indoors for transplanting

in warmer weather. The roots of some plants, like beans and cucumber, are more fragile than others, like tomatoes.

Motion

Roots normally grow downward to meet a plant's nutrient and water needs. Roots are sensitive to gravity, and their downward growth from whatever their original position is called geotropism. In Level B, A-Maze-ing Plants, youth explore how to influence the direction of root growth or geotropism.

Stems

Stems are vital in enabling plants to meet their needs, because they:

- Link plant leaves and roots, enabling all plant cells to be within reach of water and nutrients
- Transport water and minerals, taken in by the roots, to leaves to help produce food
- Transport food produced in the leaves to other parts of the plant
- Support the plant if it's aboveground, allowing leaves to reach the light necessary to make food (photosynthesis)
- Serve as food storage sites

Water and dissolved nutrients move upward in stems against the force of gravity. Water moving into the roots pushes water up into the stem. When water evaporates (transpiration) through leaf openings (stomata), water is "pulled up" in stems. In Level A, Beyond the Stem, youth explore how the plant transport system works.

Structure

Stems come in many shapes and sizes, and they can be either soft or woody. However, they all serve the same type of transport functions. Not all stems grow above the soil. Underground stems (stolons) in potato plants also store food in tubers. In Level B, Not From Seeds Only, youth explore growing plants from plant parts, including potato tubers and garlic cloves.

Motion

Just like roots, stems respond to their environment to enable plants to meet their basic needs. Plant stems and leaves generally respond to light by bending toward it, which is called positive phototropism. Roots grow away from light, which is called negative phototropism. Some plants also can grow away from the light, but vegetables usually do not. This movement is triggered by a concentration of plant hormones called auxins. When light hits a plant, the side of a stem away from the light accumulates auxins. This causes cell growth on that side to lengthen and the stem to become longer; the plant stem bends toward the light.

Auxins are concentrated in the tip of the stem. When this growing point is cut (or pinched) off, the auxins allow the lower branches of the plant to grow. That is why pinching off tomatoes at the growing points encourages bushier growth. This is also a good practice with herbs so they grow bushier with more leaves instead of tall and leggy.

In Level B, A-Maze-ing Plants, youth explore how to influence the direction of stem growth or phototropism.

Leaves

Leaves have a critical function—they make food. They convert the energy in sunlight, together with air and water, to make the energy that green plants need to live. Leaves come in many different shapes and sizes but most have these parts:

Leaf part	Function
Stomata	Pores that open and close on the outer surface of most leaves. Allow carbon dioxide and oxygen to enter and leave the plant during photosynthesis.
Veins	Carry water, nutrients, gases, and other materials to and from all parts of a leaf to produce food and use energy. The food that leaves make travels through the veins to the stem and other parts of the plant for use and/or storage. Provide support for the leaf to help position its leaves to receive light.
Chloroplasts	Contain a green pigment, chlorophyll, necessary to trap light energy and allow photosynthesis to occur.

What is photosynthesis?

Photosynthesis is the process by which plants make their own food. Using light energy, plants convert water and carbon dioxide into a simple sugar called glucose. This sugar is the source of food for most plants and the humans who consume them. This is not the only benefit of green plants. Life on our planet would not exist without photosynthesis, because not enough oxygen would be replaced in the environment to support life. Plants produce approximately 100 billion tons of oxygen every year!

Photosynthesis is an ongoing process that takes place in two phases.

- The first phase is the light cycle, or light-dependent reactions, because light is required. The plant's leaves absorb light rays, and the chlorophyll traps this light energy. Water (taken up by the roots and transported to the leaves) is split into hydrogen and oxygen using the captured light energy. At the same time, carbon dioxide is taken in from the air through the stomata (leaf pores).
- The second phase is the dark cycle, or dark reactions, because light is not needed. In this phase, the hydrogen that was split from the water combines with the carbon dioxide to form glucose. The leftover oxygen is released into the atmosphere through the stomata. As oxygen is released, the stomata allow more carbon dioxide to enter so photosynthesis can continue.

Photosynthesis can be summarized as:
Carbon dioxide + water (*light* ⟶) glucose + oxygen

In Level B, Getting Green, youth explore photosynthesis and take a closer look at chlorophyll.

Respiration

Before a plant can use its food—stored in the form of the sugar glucose—the glucose must be broken down into a form the plant can use. During respiration, plant cells release the energy from glucose. Respiration is the same process that humans and other animals use. It is a series of complicated chemical reactions, just like photosynthesis.

Plant leaves absorb oxygen from the air and combine it with glucose. Then carbon dioxide is given off through the leaves. The plant can now use the energy released from the glucose. This glucose can also be changed and moved to other parts of the plant for use and storage.

- Individual molecules are combined to form larger, more complex molecules called carbohydrates, including:
  - Sucrose (commonly known as table sugar). This is the form in which carbohydrates are transported around the plant. It can be found stored in the roots of sugar beets and the stems of sugar cane.
  - Cellulose, which makes up the sturdy walls of plant cells. Cellulose is a common ingredient in biofuels like ethanol. Scientists are breeding plants with more cellulose, or cellulose that is easier to break down, to make renewable fuels easier, cheaper, and quicker to produce.
  - Starch, which is stored in plant leaves, stems (white potatoes), or roots (sweet potatoes) and can be broken down into simpler sugars for later use.
- Individual molecules can also be changed into fats and proteins that make up the materials in plant cells (in seeds such as peanuts and soybeans).

Flowers

Although people enjoy flowers for their beauty and fragrance, a flower's function is to produce seeds. All the attributes of a flower—its color, size, shape, smell, and so on—are important in producing seeds.

The transfer of pollen from male to female flower parts is called pollination. Some pollinators are:

- Bees
- Butterflies
- Moths
- Flies
- Beetles
- Birds
- Bats
- Wind

What happens during pollination?

When a grain of pollen lands on the stigma, a tiny tube grows from it and proceeds down the style into the ovary. Sperm cells travel through this tube to an ovule, and fertilization occurs. The fertilized ovule becomes a seed, and the ovary, a fruit. Without pollination and fertilization, fruit and seed production cannot occur in most plants.

The two types of flower are perfect and imperfect.

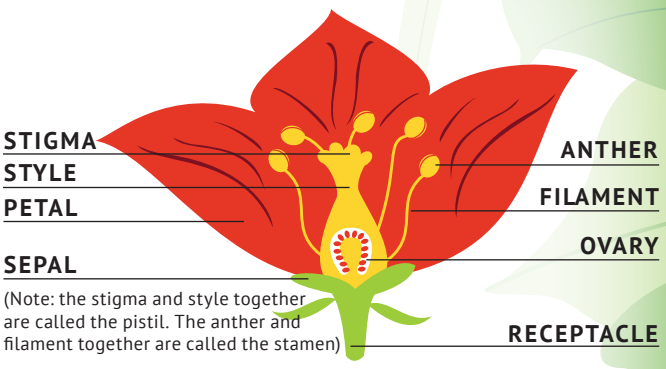
- Perfect flowers have both pistils and stamens. These parts are arranged to keep pollen from easily reaching the ovary of the same flower to

prevent self-pollination. Peas and beans are examples of vegetables with perfect flowers.
- Imperfect flowers are either male or female. Pollen must find a way from the male to the female flower. Cucumbers and zucchini are examples of vegetables with imperfect flowers.

Flower part	Description and function
Pistil	The female organ, generally in the center of the flower
Stigma	The platform at the top of the pistil held up by the tube-like style
Ovary	At the bottom of the style, contains the ovules
Ovules	Inside the ovary, contain female egg cells
Stamens	The male organs that typically surround the pistils
Anther	On top of the stamen and held up by the filament
Filament	Stemlike; holds up the anther and produces pollen
Pollen	Contains male sperm cells
Petals	Often brightly colored to attract pollinators, and broad and flat to provide good "landing pads"
Sepals	Green leafy structures that surround the petals and initially protect the developing bud
Style	A tube-like structure that holds up the stigma and leads directly to the ovary

Flowers encourage pollination in different ways.
- Aromatic nectar (sweet fluid)
- Shapes designed to accommodate specific pollinators
- Designs or "tracks" to guide pollinators to pollen and/or nectar
- Lightweight, petalless flowers for wind pollination
- Structures that resemble other pollinators to generate an aggressive response

In Level C, Flower Power, youth dissect a flower and cross-pollinate squash flowers.



(Note: the stigma and style together are called the pistil. The anther and filament together are called the stamen)

Fruits

As ovules develop into seeds inside the ovary, the ovary undergoes some changes. It swells and becomes fleshy, or it hardens to protect the developing seeds. This part of the plant containing the seeds is called fruit. In addition to protecting the seeds, many fruits are designed to help seeds disperse.

Many foods that are commonly known as vegetables are technically fruits because they contain seeds. In Level B, A-Maze-ing Plants ("Grow What You Know"), youth guess which vegetables are really fruits.

Fruits have many forms but fall into two general types.
- Fleshy fruits include apples, oranges, plums, and berries. They generally have sweet, fleshy ovaries surrounding the seeds. Animals are enticed to eat these fruits, and the seeds are scattered away from the parent plant.
- Dry fruits have ovaries with thin, dry walls. They are not fleshy. Corn, wheat, oats, and barley are examples. In each of these, each fruit is a single dry layer covering one seed. Each grain on an ear of corn is thus a fruit. Other dry fruits, such as beans and peas, have a non-fleshy pod containing a number of seeds. When dry, the pods split open and the seeds drop out.

Plants from parts

In addition to reproduction from seed, plants can grow from roots, stems, and leaves—reproduction from plant parts. Many plants are capable of vegetative propagation (or asexual reproduction) to produce a new, complete plant from part of another one. Unlike reproduction from seed, there is only one parent in vegetative propagation. And because every plant cell contains all the genetic information for that plant, the offspring are genetically the same as the parent plant; they are clones.

Some of the structures that plants use to reproduce vegetatively are:

- Tubers (potato, but not a sweet potato because it is not a tuber)
- Bulbs (garlic)
- Crowns (asparagus)

Plant life cycle

The plant life cycle begins with seeds that sprout. They mature into plants. The plants flower and then bear fruit, which produces seeds.

The key agents in the process of seed production are flowers.

Plant life can be categorized by the type of life cycle it undergoes.

- *Annuals* flower and complete a full life cycle, from seed to seed in one year. Examples include beans, cucumbers, lettuce, peas, pepper, potatoes, tomatoes, many herbs and annual flowers.
- *Biennials* complete a full life cycle in two years. During the first year the plant puts energy primarily into its roots, and it flowers the second year. Examples include certain herbs, beets, carrots, onions, and parsley (although normally these vegetables are planted every growing season).
- *Perennials* continue to flower, produce seeds, and grow for many years. Adaptations like dormancy and dropping leaves help them survive year-round. Examples include asparagus and rhubarb.

Diversity

Gardeners know that no two lettuce plants are exactly alike. There are variations between parents as well as different types of lettuce.

A diversity of organisms in our world is important for a healthy ecosystem.

- Plants supply food for consumers (humans and other animals) and help provide oxygen for the atmosphere to support life on earth.
- Animals die, decompose, and provide materials to support plant life.
- Bacteria recycle nutrients that help maintain healthy plant life.

Having many different kinds of organisms in an ecosystem means less competition for the same resources. For example, some plants have taproots, while others have fibrous root systems.

Humans have used natural genetic diversity to their advantage. Early farmers saved their favorite seed to plant the following year. They purposely selected desirable traits that were beneficial, such as higher yielding varieties. This natural selection required centuries of work by farmers or amateur plant breeders.

Today, however, scientists in genetic technology can design crops to meet specific needs—taste, nutritional value, or harvesting and shipping requirements. For example, tomatoes have been bred for toughness so they can withstand mechanical packing and shipping. As a consequence, however, they also lost flavor.

Hybrids and crossbreeding

Vegetables are available in standard and hybrid forms.

- Standard varieties are called open-pollinated because they are mass-produced through natural pollination by bees and wind.
- Hybrid varieties need controlled pollination, usually done by hand between certain selected parent plants. Different species of the same variety often are pollinated. Although hybrid varieties produce seeds (except seedless varieties), these seeds would not produce the same hybrid plant if saved and planted. The original cross must be made.

A growing concern is that we rely heavily on "high-performance" crops. This dependence makes these special crops open to diseases, with devastating results. For example, when only one variety of a

crop is planted and struck by disease, the entire crop might be destroyed. If people depend on that crop as a food staple, the loss is disastrous. That's what happened when the failure of the potato crop led to the Irish Famine in the 1800s.

Biotechnology

Many vegetables that you find in the grocery store are probably the result of biotechnology. One of the most common characteristics desired in vegetables is a thicker skin that will stand up to rough handling during harvest and shipping. Other sought-after characteristics include disease resistance or different maturity rates. Some commonly modified vegetables include:

- Sweet corn – Many varieties of sweet corn have been modified to be sweeter.
- Tomato – Tomatoes have been modified to help them ripen on the vine, develop a tougher skin so they can be shipped with less bruising, or develop an intense sweetness such as in some cherry tomato varieties. Tomatoes were also the first genetically modified vegetable available in the United States. Flavr Savr was modified so the tomato would ripen on the vine and last longer in the store.

Biopesticides

Several biopesticides are based on natural agents, such as a bacteria or naturally occurring plant oil. They are toxic only to targeted pests and do not harm animals, humans, fish, birds, and beneficial insects. Because biopesticides act in unique ways, they can also control pest populations that have developed tolerance to chemical pesticides. One of the most common biopesticides is *Bacillus thruingiensis*, or Bt. It is lethal only to a specific insect that feeds on that plant, so the plant that once was a food source for the insect now kills it. This process, which has no effect on humans or other species, reduces the use of chemical pesticide sprays to control infestations. A good online resource for information about biopesticides is www.epa.gov/pesticides/biopesticides/whatarebiopesticides.htm

Herbicides

It is possible to use biotechnology to make crop plants tolerant of specific herbicides. The sprayed herbicide kills the weeds but has no effect on the crop plants. This allows the farmer to reduce the number of times herbicides are applied and reduces crop-production costs and environmental damage.

Human impact	Description	Possible pros	Possible cons
Plant selection (selective breeding)	Saving seeds with desirable traits to replant in the next season.	Low labor and cost. Seeds can be saved from year to year. Plants are well-adapted to the environment. Useful new offspring can emerge.	Less uniformity. Takes a very long time to occur.
Hybridizing	People manually cross-pollinate two different plants to achieve a mix of desirable traits.	Offspring often have more uniform quality, are earlier and more disease-resistant, and produce a higher yield.	Other good traits might be lost. More labor cost. Expensive. Dependence on certain cultivars. Diversity of older varieties is lost. Hybridized seeds cannot be saved.
Genetic engineering	Transferring specific genetic material from one organism to another.	Increased human control. Potential for increasing productivity.	Expensive. Other, unknown genetic changes and unknown impact on the environment.

Preserving genetic diversity

Genetic diversity is important because it enables plant breeders to create and maintain new varieties of crops. People today are aware that we cannot rely too heavily on specific crops. It is too easy to lose track of or discard other varieties of that crop. Other varieties might have beneficial agricultural or medicinal qualities; once lost, this valuable genetic information can never be recovered.

To preserve as much genetic variation of crop plants and their wild relatives as possible, two methods of conservation have been established.

- *In situ* conservation preserves wild species within their natural habitat, often in biological reserves.
- *Ex situ* conservation relies on a carefully controlled environment, such as a seed bank, to ensure that the seeds of land races, genetic stock, and obsolete varieties remain usable for decades. Thousands of species are preserved this way.

Protecting original habitats is the most important and successful way to preserve threatened genetic resources. Everyone, not just gardeners, can help preserve genetic diversity.

- Get involved with conservation groups that try to set aside areas representing major ecosystems to protect wild species in their natural habitats.
- Save and exchange seeds of old plant varieties to keep them from disappearing.
- Get involved with local conservation groups that move organisms to captivity. For example, many nature preserves need volunteers to repopulate native species by planting them in the wild.

Many organizations are dedicated to saving heirloom or historic seeds. Seed Savers Exchange is a popular organization dedicated to saving seeds that promote genetic diversity of many of our common vegetables, herbs, and flowers. Seed saving is also a hobby for many gardeners with benefits that include saving money on seed purchases. Encourage the 4-H garden project youth to explore seed saving online.

In Level D, Designer Genes, youth explore biotechnology by using one of the most common genetically modified vegetables, corn, to make plastic. More information on seed banks, genetic diversity, and the location of major crop centers in the world can be found in that activity.

Interdependence

All living things depend on one another through many types of relationships, at many levels, and at different degrees of complexity.

- Many plants depend on animals for pollination of flowers and/or dispersal of seeds.
- Animals, including humans, depend on plants for food, fuel, and shelter. Many relationships can be described in terms of a food chain.

Food chains are composed of:

- Producers (plants)
- Consumers (animals)
- Decomposers (bacteria and fungi)

In a food chain, green plants turn the sun's energy into food. This process activates the cycle of nutrients that make life possible on earth. Green plants are the primary producers in food chains. All animals are both consumers and consumed, sometimes by other consumers. All are ultimately consumed by the decomposers.

Decomposers are the final links in food chains; they use dead plants and animals as food. This process releases locked-up nutrients that plants use again. Decomposers include bacteria and fungi (molds, mildews, mushrooms, rusts, and smuts, etc.). Fungi feed on dead materials or act as parasites on living organisms because fungi lack chlorophyll and cannot carry out photosynthesis.

Earthworms help once-living materials decompose in a way that is easy to observe in a garden. They live right in the soil and eat and release nutrients from the soil and organic matter. They recycle materials with immediate impact on plant life. But they, in turn, are eaten by animals, birds, and snakes. In Level B, Wiggly Farm Acres, youth make a worm box and learn the importance of earthworms in a healthy garden.

Composting allows gardeners to control and promote a natural decomposition process. As bacteria break down large amounts of organic matter, heat is produced, and nutrients are released to form a rich, soil-like fertilizer for the garden. In Level B, Let It Rot, youth make a compost pile outdoors or in a container.

Even aphids—insects that gardeners detest—play a part in interdependence. Aphids consume plant nutrients, but are in turn consumed by other animals and insects, including ladybugs.

Humans depend on plants not only for oxygen and food, but also for many forms of:

- Energy
- Medicine
- Clothing
- Building materials

The list goes on and on.

In Level A, Check Out the Veggies, youth explore how plants are used in different ways and look for both food and non-food products made from vegetables in a grocery store.

Human impact

We are all part of the web of life on earth. It is increasingly important that we recognize the impact of our choices and actions on living things. Some of these issues include:

- Land use
- Environmental pollutants
- Waste disposal
- Burning fossil fuels
- Acid rain

As we use natural resources and dispose of wastes, people create and release substances that harm the environment. Because plants are low on the food chain, the impact of damage can be magnified many times. This includes environmental pollutants or toxins like road salt and fertilizer spills or runoff into streams.

Consider these effects:

- Many pollutants weaken plants, making them less resistant to diseases or insect attacks.
- Some air pollutants damage the protective waxy layer on plant leaves; others directly harm plant tissues.
- System insecticides are taken up into plant tissues. Even though the plant isn't harmed, the toxins can harm the animal eating that plant and the human eating that animal.

In Level D, The Air Up There, youth study the effects of pollution on plants. Also in Level D, Taking Action, youth explore ways to address pesticide issues and are encouraged to become active and provide leadership in their community.

Acid rain

The effect of acid rain on plants is extremely complex. Separating acid rain damage from other plant problems like nutrient deficiencies or pest problems is difficult. Other things damage plants as well.

- Some scientists think the harmful effect of acid rain on soil, lakes, and rock is due to changes in pH, rather than the direct effects of a particular acid.
- On the other hand, several scientists report that some plants are helped if the acid rain contains dilute nitric acid because this adds nitrogen to the soil. Nitrates are a source of nitrogen. Likewise, sulfates from sulfuric acid are a source of sulfur for soils lacking sufficient sulfur for growth. However, too much sulfur or nitrogen might harm plants.
- Others assume the acid rain activates certain buffers in the soil that can temporarily neutralize the effects of too much acid rain.

Hydroponics

In Level D, Look Ma – No Soil!, youth grow hydroponic plants.

Nutrient solutions do not guarantee successful growth. To do well, plants grown in hydroponic containers still need proper light, temperature, and humidity. Some simple hydroponics setups include:

- Bucket and tray method
- Siphon-feed method
- Pump and timer method
- Recycling drip system

Hydroponics is often defined as soilless gardening—crop production without soil. This includes crop growth in a growing medium, something that will support a plant. Examples:

- Sand – quartz or builder's sand is best. Do not use beach sand, which contains too much calcium for good plant growth.
- Gravel (such as aquarium pebbles) – allows water and fertilizer to drain rapidly, so it's necessary to apply the nutrient solution several times a day.
- Perlite – small particles of expanded volcanic rock.
- Vermiculite – very lightweight and absorbs lots of water.
- Other solid materials such as cotton, paper towels, bark, etc.

Youth might ask you if they can make their hydroponic nutrient solution using soluble houseplant fertilizers such as Miracle-Gro, which are more widely available and cheaper. Houseplant fertilizers are designed for potting soils and do not work as well as hydroponic nutrient solutions because they are missing some of the nutrients that plants need. These nutrients are already present in potting soil, so houseplant fertilizers often contain just nitrogen, phosphorus, and potassium. A hydroponic nutrient solution has all 14 minerals that plants require for optimum growth. There is another problem with houseplant fertilizers. Generally, they have most of their nitrogen as ammonium. Too much ammonium is toxic to hydroponic plants. In soils, bacteria change ammonium into nitrate, but this is not possible in hydroponic solutions. So these solutions have most or all of their nitrogen as nitrate.

Drainage is important in hydroponics. Roots should be submerged in the hydroponic nutrient solution for regular but brief periods. A delicate balance exists among water, air, and nutrients. In large hydroponic greenhouses, feeding and drainage are taken care of mechanically—the nutrient solution is continuously pumped in and out of growing beds.

Containers should not be metal, which can interact with the nutrient solution and harm plants. Vermiculite, gravel, or sand can be used to support the plant and hold moisture but still allow air to get to roots. These materials must be sterile.

In hydroponics, the plant's roots are surrounded by 100 percent water. Unlike soil, there are no solids or air spaces. Most hydroponic plants must get oxygen from the nutrient solution. However, water holds only a small amount of dissolved oxygen, which the roots quickly consume. To give roots enough oxygen, air is constantly bubbled through the nutrient solution to replenish the oxygen supply. This is called aeration.

Some setups include an aquarium pump to provide air for the plant's roots and an air breaker to break the flow of air from the pump and disperse it gently in the water. Pumps and air breakers are available where aquarium supplies are sold.

Air pumps were not readily available in the 1930s. Early hydroponic growers provided oxygen to roots by keeping about half the roots above the nutrient solution. The hydroponic reservoir was just half full. The roots above the solution remained wet from the moist air in the top half of the reservoir.

Well-watered soil in the field is approximately 50 percent solids, 25 percent air, and 25 percent water, by volume. Well-watered potting soil in a container is approximately 15 percent solids, 15 percent air, and 70 percent water.

The air-filled pores are important because they act as air tunnels. Air above the soil can flow into the soil and to the roots through the air-filled pores. Air contains 21 percent oxygen by volume. All plants require oxygen to respire. If soil is overwatered, not enough pores are filled with air. Roots suffer from lack of oxygen. In addition, microbes produce toxic chemicals that harm roots.

Plant Science activity 1: Garden Talk Games

Supplies: for Garden Search (option 1), copies of Garden Search handout

Time required: 20-30 minutes

Preparation

Choose a garden game or a combination of games. This activity has four game options for use with youth in Level A and Level B. Activity 2 has more ideas. Choose vocabulary words that fit the youth's ability but also challenge them.

Experience

1. Tell youth that this activity is about learning garden vocabulary in a fun, easy way.
2. Give instructions for the game you selected.
3. Select two or more teams, if desired, and play the game.
4. Review what the youth learned at the end.

Share

Describe the game that you just played.
What did you like the most about this activity? Like the least?

Process

How do you communicate with others when you're playing a game?
In what ways do people communicate without speaking?

Generalize

When is it important to communicate well?
What other ways can you communicate something to be learned?

Apply

How will you use your communication skills to teach someone how to do something, like how to play a game?
You've probably heard someone say, "It's a communication problem." What does this mean?

Option 1, Garden Search

Instructions: Give youth a copy of the Garden Search handout. Let them work in small groups or individually to circle the garden vocabulary words they find. The 20 words are horizontal, vertical, or diagonal, and some are written backwards (in reverse). The Garden Search handout is on page 22.

Option 2, Where Do They Grow?

Instructions: Discuss where vegetables grow—on vines, underground, and aboveground. See categories below.

- Divide youth into two teams.
- Give each player the name of a vegetable. The player must identify where that vegetable grows. If the player misses, he or she goes to the opposing team.

On Vines	Underground	Aboveground
Summer squash (zucchini)	Carrots	Lettuce
Winter squash	Potatoes	Cabbage
Pumpkin	Radishes	Peas
Cucumber	Rutabagas	Beans
Watermelon	Turnips	Tomatoes
Cantaloupes	Kohlrabi	Eggplant
Gourds	Onions	Green pepper
	Sweet potatoes	Broccoli
	Garlic	Cauliflower
	Beets	Asparagus
	Parsnips	Spinach and other greens

Option 3, Name a Veggie

Instructions: Discuss how vegetables are categorized—as a root, cool- or warm-season, leafy, stem, fruit in disguise, etc. Give examples of some possible categories from the chart below.

- Divide youth into two teams, and have them stand on opposite sides of the room.
- Ask each player, in turn, to "Name a vegetable that is…." from the categories below. If the player misses, he or she goes to the opposing team.

Root crops
Beet
Carrot
Celeriac
Horseradish
Jerusalem artichoke
Parsnip
Radish
Rutabaga
Salsify
Turnip

Pod and seed vegetables
Okra
Sweet corn
Peas
Snow or snap peas
Pole and bush beans
Broad beans
Lima beans

Fast-maturing crops
Cress
Herbs (most)
Lettuce
Mustard greens
Onion (scallion)
Oriental greens
Radish
Spinach
Sprouts
Turnip

Bulb vegetables
Garlic
Leek
Green onion
Shallot
Onion

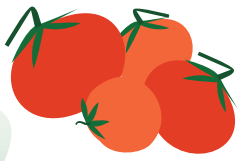
Stem or shoot vegetables
Artichoke
Rhubarb
Celery
Fennel
Asparagus

Vegetables that are fruits in disguise
Tomato
Eggplant
Sweet pepper
Hot pepper

Squash vegetables
Zucchini
Cucumber
Cantaloupe
Honeydew
Pumpkin

More than one edible part
Beets
Chicory
Kohlrabi
Onion
Pumpkin
Rutabaga
Turnip

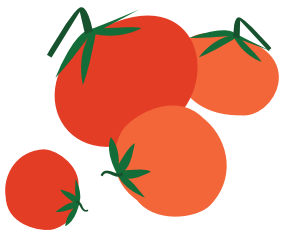
Vines and sprawlers
Beans (some)
Cucumber
Gourds
Jicama
Melon
Peas (some)
Pumpkin
Southern peas (some)
Sweet potato
Tomatillo
Tomato
Watermelon



(continued on next page)

Leafy vegetables (or vegetables used for greens)
Endive
Cress and watercress
Cos lettuce
Red-leafed lettuce
Spinach
Mustard
Chicory
Celery leaves
Loose leaf and head lettuce
Romaine lettuce
Bibb lettuce

Warm-season vegetables
Pole beans
Bush beans
Chicory
Collards
Corn
Cucumber
Eggplant
Herbs (most)
Jerusalem artichoke
Jicama
Melon
Okra
Pepper
Pumpkin
Southern peas
New Zealand spinach
Squash
Sweet potato
Tomatillo
Tomato
Watermelon



Prolific producers
Beans
Brussels sprout
Cucumber
Herbs
Jerusalem artichoke
Mustard greens
Oriental greens
Peas
Radish
Spinach and New Zealand spinach
Sprouts
Squash (some)
Tomato

Cool-season vegetables
Artichoke
Asparagus
Beet
Broccoli
Brussels sprout
Cabbage
Cauliflower
Celery
Collards
Cress
Endive
Garlic
Kohlrabi
Leek
Lettuce
Mustard greens
Onion
Oriental greens
Parsnip
Peas
Potato
Radish
Rhubarb
Rutabaga
Salsify
Shallots
Spinach
Swiss chard
Turnip

Option 4, What Parts Do We Eat?
Instructions: Explain to youth that this game relates vegetables to the parts of them we eat. Give examples from the categories below.

- Divide youth into two teams.
- Have the teams stand facing each other.
- Team 1 names a plant that is used for food. Team 2 tells which part of the plant is eaten. If correct, Team 2 names a plant for Team 1 to identify.

Stem or Shoots
Artichoke
Rhubarb
Celery
Fennel
Asparagus

Roots
Carrots
Turnips
Beets
Radish
Sweet potato
Rutabaga

Leaves
Cabbage
Spinach
Lettuce
Kale
Collards

Seeds
Peas
Beans
Corn

Flowers
Broccoli
Cauliflower
Pumpkin

Garden Search

C Z T M S F S K P E G W W Z C
Y O E N L E S O G O N E A X M
M T M O A U K A I T I E T M V
S U W P S L N A E L T D E V F
O E L Y O I P D T I N I R M A
R V U C A S P S F S A N O V A
J A W R H X T C N F L G E N S
X F D T U B E R J A P M U M T
J A N I H T G R O W R X D D A
A E U E K B O J H A F T R G K
N L J F Q L V T G T Z P U B S
C U L T I V A R V C O W P D P
D Q K G V E R U N A M O E F G
C O H Z O U T S P I O E R L G
T T H K F W E I Z A S T U E A

Words used:

Compost
Cultivar
Drainage
Flower
Grow
Leaf
Light
Manure
Mulch
Planting
Root
Seeds
Soil
Stakes
Stem
Thin
Transplant
Tuber
Water
Weeding

Plant Science activity 2:
More Garden Talk Games

Supplies: pencils, copies of Garden Bingo handout; flip-chart and markers for Garden Tic-tac-toe (or chalkboard and chalk); words from the glossary in this manual

Time required: 20- 30 minutes

Preparation
- Choose a game or combination of activities.
- For Garden Bingo, make a copy of the Garden Bingo handout for everyone. Select 24 vocabulary words and definitions from the glossary or the Level C or D manuals. Make a list of the words to hand out, or read them aloud to the group.
- For Garden Tic-tac-toe, select nine vocabulary words and their definitions.

Games can teach concepts and skills to any age group. They are not only fun but also make issues and concepts clearer and easier to understand. Games can be used to motivate youth and/or to review and assess their understanding of the subject matter.

Games allow for:
- Active learning
- Opportunities for youth involvement and participation
- Youth working together regardless of ability levels
- Individual preferences and differences
- An experience of success, especially for those who do not experience it often

Both options in this activity can be repeated using different vocabulary words.

Experience
1. Tell youth that this activity is about learning garden vocabulary words in a fun, easy way.
2. Explain the instructions for the game.
3. Select two teams, if desired, and play the game.
4. Review what was learned at the end.

Share
How did you feel about doing this activity?
What new words did you learn?

Process
How does playing a game help you learn more easily?
What were other members in your group feeling as all of you were playing the game?

Generalize
What other benefits, besides being fun to do and easy to learn, do games provide for the players? *Everyone can be involved and ability level is not important.*

What are other things you do that make you feel good about yourself?

Apply
In the future, how will you try to learn new things?
If you were to teach younger youth an activity, how would you make sure they experience success?

Instructions for Garden Bingo
- Give youth a copy of the Garden Bingo handout.
- Have them write each vocabulary word you say in any of the blank spaces on the handout; youth are designing their own bingo card.
- Explain that they need to listen to your definitions—one for each of the vocabulary words. If they recognize which word the definition identifies, they place an "x" through the box (but not covering the word completely). The winner is the first person to reach "Bingo" (four in a row horizontally, vertically, or diagonally, plus all four corner boxes).
- Have youth raise their hand when they get a Bingo. Then say the vocabulary words you read the definitions for and check the winning Bingo sheet. After a winner is declared, play continues until the whole sheet is covered.
- If you wish, play a new game with the same vocabulary list or a different list and a new Garden Bingo sheet.

Garden Bingo

		Free Space		

Garden Bingo

		Free Space		

Instructions for Garden Tic-tac-toe

- Divide the group into two teams. Or two youth can play.
- Draw lines on the flip chart or chalkboard to represent the familiar tic-tac-toe diagram. Write it large enough so everyone can see it easily.
- Using the nine words you selected from the glossary, write one word in each of the spaces.
- Explain that one player will select a word he/she knows and then say the definition. If the answer is correct, the youth goes to the flip chart, crosses off the word and writes his/her team's symbol in the space, either "X" or "O." If the answer is incorrect, no change is made on the diagram, and the other team takes a turn.
- A player from the other team now takes a turn. Play continues until one player or team has three symbols in a row horizontally, vertically, or diagonally—or until the teams reach a stalemate and neither can win.

Hybrid	**Stamen**	**Genetic engineering**
IPM	**Photosynthesis**	**Seed bank**
Phosphorus	**Biotechnology**	**Pistil**

Garden Planning

Background

Preparing for a vegetable garden

Planning is the first step in growing a vegetable garden. Planning a garden on paper helps the gardener decide how much seed and how many plants to buy. It also helps avoid problems and makes garden care easier during the growing season. Planning ahead for some vegetables is also important because garden centers rarely carry seeds for unusual vegetables; however, you can search online for companies that sell unique vegetables.

Steps to follow in planning a vegetable garden:

- Choose a site (place).
- Decide what size garden you can easily care for.
- List vegetables to grow.
- Decide how much of each vegetable to grow.
- Plan on paper where to plant each vegetable.
- Make any changes necessary to fit everything in the space.
- Decide which cultivars (cultivated varieties) to plant.

The best place for a garden is on level, well-drained ground and in full sun. However, a good garden can be grown on a less-than-perfect site, which might be ideal for raised beds or containers of your own good soil. Most vegetables need at least six hours of direct sun daily. Avoid planting them close to trees and shrubs, which compete for light, water, and nutrients. Locate a garden at least 50 feet from walnut trees, whose roots contain a toxin called juglone that kills tomato, potato, eggplant, and pepper plants.

The quality of garden soil is important. It should be well-drained, loose, and fertile. Heavy clay or sandy soils need organic matter like well-rotted animal manure or compost worked into them. This helps increase the amount of air, water, and nutrients the soil holds.

When planning a vegetable garden, make a scale drawing of the garden plot in which 1/2 inch equals 1 foot (1/2″ = 1′). 4-H members can help younger youth design their gardens with a garden-design software program. Levels C and D include activities in which youth explore and use such programs.

Always check the seed packet for specific cultivar spacing. It is best to start out small. Gardening chores such as weeding, watering, and harvesting take time. A 50-foot x 20-foot garden requires at least one hour of care per week, not including planting and harvesting. Help youth plan a garden that is manageable in size. The garden can always "grow" bigger next year.

To help decide which vegetables to grow, see the chart on page 29. Group the selected vegetables according to their growth requirements, such as size and growing season.

- Vegetables receive maximum sunlight if rows are oriented east to west.
- Place tall vegetables like sweet corn, pole beans, peas, and tomatoes to the north end of the garden to avoid shading plants during the growing season.
- Cool-season plants like broccoli, lettuce, and radishes should be grown as spring and fall crops.
- Warm-season plants such as tomatoes, pumpkins, and corn should be grown from late spring through early fall.
- Plant sweet corn together in three or more short rows rather than in long, single rows to allow better pollination.

Once the vegetables are grouped together, decide how much of each to grow. Check the seed packets for suggested spacing requirements and planting dates for each crop. Write this information next to each vegetable on a garden-planning sheet. (See the sample.) Allow at least 3 feet between rows if a garden tiller will be used to control weed growth. Otherwise, use the spacing recommended for each plant. Try to rotate crops so the same plants are not in the same location year after year. This helps prevent disease and insect problems. See Level B, Plant a Transplant, for a sample crop-rotation plan.

Garden Planning Sheet	
Vegetable List	***Garden Plan (20 by 50 feet)***
Spinach Lettuce Radishes Beets Onions Carrots Snap beans Tomatoes Corn Broccoli Cabbage	Spinach (Mar. 20, ½ oz.) → ← Lettuce (March 20, 1 pkt.) → ← Radishes → ← Beets (Apr. 1, ½ oz.) Onions (Apr. 1, ½ lb. sets) → ← Carrots (Apr. 10, ¼ oz.) Snap beans (May 10, 1/4 lb.) → ← Snap beans (May 25, ¼ lb.) Snap beans (June 10, ¼ lb.) → ← Tomatoes (May 15, 8 plants) Corn (May 10, ½ pkt.) → ← Corn (May 25, ½ pkt.) → ← Corn (June 10, ½ pkt.) Corn (May 10, ½ pkt.) → ← Corn (May 25, ½ pkt.) → ← Corn (June 10, ½ pkt.) Corn (May 10, ½ pkt.) → ← Corn (May 25, ½ pkt.) → ← Corn (June 10, ½ pkt.)

Don't be surprised to find youth need to grow less than they planned or to enlarge the garden.

- If garden space is limited, look for compact cultivars such as bush-type squash and patio tomatoes.
- Gardens can also be grown in containers such as wooden barrels, planter boxes, bushel baskets, and tubs.
- Several gardening techniques can stretch the available space. The activities in Level D, Year 1 explain many of these techniques.
- Stretch the harvest of most vegetables by planting in succession instead of all at once. For example, sow carrots on April 10 and again every two weeks for a continuous supply.
- When cool-season crops are ready for harvest, be prepared to plant a vegetable that can be grown during summer and/or as a fall vegetable. For example, after spring peas are harvested, plant carrots or beans. Cool-season plants can be replanted in August and September for a fall harvest.

Making the most of garden space

Planting crops in single rows is mainly for ease of care and harvest. However, this is not the only method of planting vegetables or herbs. Others include:

- Broadcasting
- Succession planting
- Double-cropping
- Intercropping

These maximize the garden space. Gardeners can experiment to determine which crops grow well with each planting method.

Broadcast

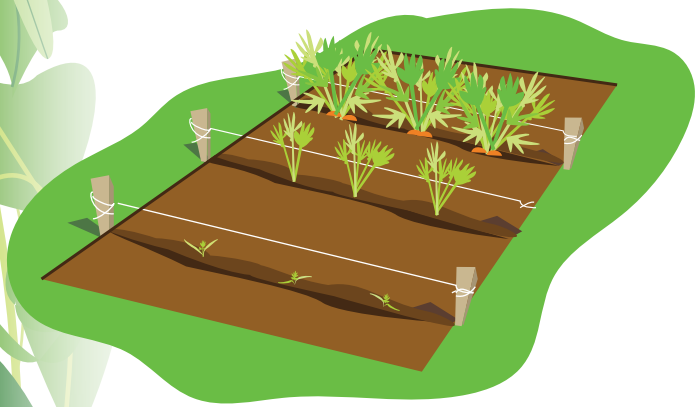
For ease of planting, block out a wide row about 2 to 3 feet across, and broadcast or scatter seeds within this area. Broadcast planting is used for crops that can be eaten when very young. Give particular attention to thinning plants properly. For example, lettuce, spinach, radishes, and onions need to be thinned shortly after they germinate. The thinnings of all these vegetables can be tossed into a salad.

Succession planting

Planting in succession or succeeding intervals is a good way to stretch harvests so a small quantity of vegetables matures throughout the growing season. Almost any crop can be planted in succession. Try vegetables that are grown for fresh use, such as radish, cabbage, carrot, bean, sweet corn, squash, and melon. Plant at intervals of 7 to 14 days.

Advantages:

- Turning under a second and/or third crop after harvest creates more organic matter for earthworms and soil life.
- Soil does not sit idly in the sun. New growth shades the soil so it retains moisture and blocks out weeds, too.
- It avoids some pests and diseases that prefer cool soils.
- Crops like carrots, beets, turnips, and rutabagas are easier to store late in the season because they mature when it's already cool.
- A gardener might have time to give extra attention to second and third crops that isn't available in the busier spring.
- Getting a new crop of beans or broccoli when other gardeners wish they had some to pick is satisfying.



Double-cropping

Double-cropping is growing two or more different crops in the same spot in one growing season. For example, a spring crop of peas, lettuce, cauliflower, or broccoli matures and can be harvested by early summer. After the harvest, remove and discard the plants. Fertilize the soil again with 1 to 2 pounds of 12-12-12 fertilizer (or similar analysis) per 100 square feet. Cultivate, and sow a warm-season crop like summer squash, beans, Swiss chard, or carrots. Select cultivars that mature quickly for the summer planting; their growing season is not quite as long as for vegetables planted mid-spring.

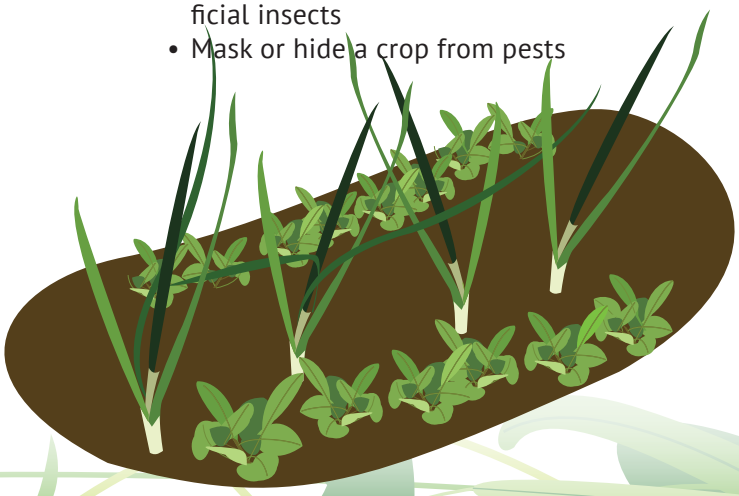
Intercropping

Intercropping is the practice of planting two different vegetables within a row. Usually one vegetable matures quickly and is ready for harvest by the time the other needs more room to grow.

Lettuce matures quickly and is a good vegetable to plant between onions, cabbage, broccoli, peppers, eggplant, and many other vegetables. Many leafy crops and/or root crops can be successfully intercropped. Leafy vegetables require space aboveground while root crops need belowground space.

Companion planting is related to intercropping. Herbs and flowers like marigolds are mixed in with vegetables plants. Such plant companions might effectively repel pests or attract pests away from vegetables. How this works isn't exactly known or scientifically proven by research, but companion plantings might:

- Produce odors that confuse or deter pests
- Serve as trap crops that draw pest insects away from other plants
- Create a habitat with food and protection for beneficial insects
- Mask or hide a crop from pests



These vegetables have something in common

	Warm season	Cool season	Bush	Vine	Pole climbing	Cabbage family	Gourd family	Nightshade family	Root crop	Underground crop	Used for greens	3 feet tall
Beans	X		X*		X							X
Beets		X							X			
Broccoli		X				X						
Brussels sprouts		X				X						
Cabbage		X				X						
Carrot									X			
Cauliflower		X				X						
Cucumber	X		X*	X*			X					
Eggplant	X							X				
Endive		X									X	
Kale		X				X					X	
Kohlrabi		X				X					X	
Lettuce		X									X	
Muskmelon	X		X*			X						
New Zealand spinach	X										X	
Okra	X											
Onions										X		
Parsnips		X							X			
Peas		X			X							X*
Pepper	X							X				
Potato		X						X		X		
Pumpkin	X						X					
Radish		X				X			X			
Rutabaga						X			X			
Spinach		X									X	
Squash, summer	X		X*	X*			X					
Squash, winter	X		X*	X*			X					
Swiss chard	X										X	
Sweet corn	X											X
Tomato	X							X				X
Turnips		X				X			X			
Watermelon	X		X*	X*			X					

* Certain varieties have this characteristic.

Garden planning group activity 1:
It's Your Garden

Supplies: paper, pencil, index cards or small pieces of paper, container for cards or paper

Time required: 20-30 minutes

Preparation

- Write one discussion question per index card. Add other questions you want to discuss with the group. Some possible discussion questions are included with this lesson.
- Consider having two or three older youth available for role-playing with younger youth.

Sample discussion questions

Why do you want to have a garden?
What do you think you will learn by growing a garden?
What do you already know about gardens?
Who do you know who has a garden?
What makes a garden?
What special needs do gardens have?
Where should a garden be placed?
How will you decide what to plant?
Where can you purchase seeds?
How will you decide which cultivars to purchase?
Where can you purchase mulch and fertilizer?
How often does your garden need tended?
Who will weed and water? How?
How can you keep rabbits out of the garden?
What other animal pests can be a problem for the garden?
Who could be called if you need help (for example, identifying a plant disease)?
What garden tool and supplies are needed?
Where can your purchase garden supplies?
Where will you store tools?
Who cleans up the garden tools?
How much time will you and your family devote each day to taking care of a garden?
What will you do with the vegetables you harvest?
If you go on vacation, who will take care of the garden?
If you forget to weed or water, who will take care of your garden?
What should you do if frost is predicted and your plants are growing?
What are some safety ideas you should think about when gardening?

Experience

1. Tell youth that this activity is about understanding and accepting the responsibilities that come with taking care of a garden.
2. Start the discussion by having youth choose one question card and asking others for a response.
3. If there is time, consider having pairs of youth role-play how brothers and sisters might argue about something related to the family garden. Ask each pair to discuss a different question for 3-5 minutes. Others can observe the role-plays; remind them they may smile and laugh but not talk during them.
4. Review some rules for healthy disagreements:
   - Talk honestly about what is bothering you; do not attack the other person.
   - Start talking about what is bothering you before you get angry about it.
   - If anyone is really angry, take time to cool down.
   - Try to be a good listener, and listen extra hard to hear what the other person is saying.
   - Stay on the topic or problem. Do not veer off to other topics that have nothing to do with the problem being discussed.
   - Realize that you're not always right. If you're wrong, simply admit it and go on.

Share

How did you decide who would have the main responsibility for taking care of a garden?
How did you feel when you talked about doing daily chores in the garden?

Process

What responsibilities are involved in taking care of a garden? Who is responsible?
What happens when a person does not follow through on his or her responsibilities?

Generalize

How will taking good care of the garden every day help you become more responsible?
What other kinds of decisions have you made that involve taking responsibility? What happened?

Apply

The next time you make a decision, what will you do differently?
How can you gather information to make a decision in the future?

Garden planning group activity 2:
Not Just in Summer

Supplies: paper, pencil, regular one-year calendar, Garden Management Practices handout, 12-Month Garden Calendar handout

Time required: 30 minutes

TRY THIS

Project skill: Making a yearlong calendar plan

Life skill: Making decisions

Preparation
Make enough copies for everyone to have a Garden Management Practices handout and a 12-Month Garden Calendar handout.

An organized person gets things done better than a person who waits until the last minute. A garden might seem like something to take care of only in the growing season. But proper garden management throughout the year is important to the garden's soil fertility and productivity.

Experience
1. Tell youth this activity is about developing a garden calendar, a valuable tool in managing a garden as well as keeping the gardener organized.
2. Have youth check the practices they already follow in the Garden Management Practices handout.
3. Discuss how to fill in the 12-Month Garden Calendar. When and where will youth complete the garden practices they checked?

JANUARY	FEBRUARY	MARCH
APRIL	**MAY**	**JUNE**
JULY	**AUGUST**	**SEPTEMBER**
OCTOBER	**NOVEMBER**	**DECEMBER**

Share
What did you learn about planning a calendar? What did you like and dislike about making decisions and planning ahead?

Process
Why is it important to plan ahead for your garden? What could happen if you didn't plan ahead?

Generalize
What would cause you to change your plan and/or start a new one?
What are some other activities that you need to plan for in advance?

Apply
How will you use what you learned in this activity about making decisions?
How will you use your garden calendar in the future?

Garden Management Practices

Plan the garden

___ 1. Know the first and last frost dates.
___ 2. Know how many growing days your harvest must be ready before your exhibit or show.
___ 3. Decide which vegetables you and your family might like to eat. You might want to grow vegetables that you can preserve for winter.
___ 4. Count back on the calendar from when you want the vegetables ready to pick—the number of days for each cultivar. Allow one week more. If you plan to exhibit your vegetables or herbs, count back from the date of the show.
___ 5. Use the publications in the resources section of your 4-H garden manuals to determine planting dates and quantity of seed for the various vegetables you want to grow. Also check the seed packet for information on days to maturity and planting guidelines.

Know the garden's soil type

___ 1. Identify the texture and components of your soil. Use a soil textural triangle to determine if it's clay, sandy loam, clay loam, etc.
___ 2. Send a soil sample to a lab for analysis.
___ 3. Follow the recommendations from the lab analysis report, such as adding certain soil amendments.

Soil amendments information

___ 1. Make a compost pile.
___ 2. Know the various types of mulch and where to purchase them.
___ 3. Understand when to add compost, mulch, and fertilizers.

Seed information

___ 1. Decide whether to buy packets or bulk seeds.
___ 2. Decide which seeds to start indoors.
___ 3. Purchase transplants from a reputable source.
___ 4. Know the variety name, and record it in a garden journal or on paper so it will not be lost.
___ 5. Purchase seeds or transplants from seed catalogs, garden centers, feed stores, greenhouses, or farmers markets.
___ 6. Check the resources section of your 4-H garden manual for information on the quantity of seeds and transplants to purchase.

Fertilizer information

___ 1. Know that fertilizer packages may have three numbers (example, 5-10-5) that show the amount of nutrients—nitrogen, phosphorus, and potassium, respectively. Nitrogen is good for growth and green leaves; phosphorus, for roots and fruit development; and potassium (or potash), for overall plant functions.
___ 2. Know the different between organic and inorganic (chemical) fertilizers.
___ 3. Decide if you need rapid-grow formulas for transplants.
___ 4. Use the fertilizer that best fits your needs. But don't use too much, which can harm a plant and stunt its growth.

When to plant

___ 1. Know how to identify when the ground is workable.
___ 2. Be aware of when the ground warms up.
___ 3. If you covered the garden after the last growing season, remove the garden cover.
___ 4. Refer to 1 and 2 in Plan the garden, above.

Garden safety

___ 1. Follow the safety tips for equipment, tools, and supplies in your 4-H manuals.
___ 2. Refer to the owner's instruction manuals for power machinery.

Weather conditions

___ 1. Understand how weather affects the garden.
___ 2. Know what to do for frost conditions, cold nights, rain, wind, and hot and dry weather.

Pest program

___ 1. Use the information about insect pests, animal pests, and plant diseases in your 4-H manuals.
___ 2. Understand how to implement integrated pest management (IPM). A healthy garden is the best defense.

Harvest time for the exhibit or show

___ 1. Complete your record sheet and have your leader sign it.
___ 2. Check your county or state exhibit guidelines to know what to show.
___ 3. Know how many of each vegetable to exhibit.
___ 4. Refer to "Suggested 4-H Garden Exhibits" for guidelines on displaying your produce (4-H 970-W available from Purdue University Cooperative Extension Service).

End-of-season management

___ 1. Clean garden of leftover debris.
___ 2. Clean tools before storing them.
___ 3. Cover the garden.

12-Month Garden Calendar

Year _____

JANUARY	FEBRUARY	MARCH
APRIL	MAY	JUNE
JULY	AUGUST	SEPTEMBER
OCTOBER	NOVEMBER	DECEMBER

Planting a Garden

Background

Soil basics

Soil is a complex system, composed of living and non-living materials. It helps provide plants with:

- Support
- Nutrients
- Water
- Air

Non-living components: Minerals

Soil takes a long time to develop. Making 1 inch (2.5 cm) of topsoil can take up to 20,000 years because rocks must be broken down into smaller and smaller particles. Living and nonliving components interact, combine, and change over the years to form soil.

The particles of rock present in soil range in size from large, coarse sand to fine clay. The proportion of these different-sized particles affects the amount of air, water, and nutrients available in the soil and determines how the soil "behaves."

Living components: Organic matter

In addition to minerals in soil, organic matter is just as important. It includes the remains and waste products of living things. Bacteria, fungi, and other decomposers in the soil continuously decompose plants and animals.

The once-living remains of plants and animals must be returned to the earth to provide nutrients for new life. When completely decomposed, these materials form humus. Humus is dark, crumbly, and spongy-textured. It functions to:

- Provide most nutrients plants use
- Help retain soil moisture
- Provide good aeration, drainage, and a loose crumbly structure for plant roots to grow and thrive in

Plant roots also help make soil by:

- Exchanging nutrients
- Slowing water loss
- Aerating soil particles

Many animals, including ants, earthworms, and mice, also play important roles in the soil ecosystem by adding nutrients from their waste and loosening and mixing the soil.

The ideal soil for growing most plants contains a balance of different-sized particles (sand, clay, and silt) along with a high proportion of organic matter. This type of soil is called loam. Unfortunately, not all soils are similar to loam. Adding organic matter can help soil with either too much clay or too much sand.

Rock particles	Characteristics in soil
Sand	Largest, coarsest soil particle. Allows for large pore spaces between particles. Water and nutrients drain through sand very quickly.
Clay	Extremely fine particles. Allows little pore space between particles, so they cling together. Water and nutrients move through clay very slowly, so drainage problems might occur.
Silt	Particle size is in-between sand and clay. Water and nutrients move through slowly.
Soil with too much:	**Might have these problems:**
Clay	Slow warming in the spring. Poor drainage, resulting in lack of air for roots. Slow seed germination because of heavy soil texture. Poor growth because of poor root penetration.
Sand	Poor growth because nutrients and water drain too quickly.

Experts recommend using a special potting mix for indoor gardens. Potting mixes serve some of soil's functions. They are good for indoor growing because they have many advantages of soil without some of the drawbacks. The biggest advantage is that they are sterile; no live organisms or disease organisms are present.

Most commercial potting mixes consist of:

- Peat moss to hold moisture
- Perlite and/or vermiculite to provide good drainage and a texture lighter than most soils
- Supplementary nutrients (fertilizer), because garden soil usually contains more nutrients

Buying seed

Vegetable seeds can be purchased at local garden centers or from seed companies either online or through a catalog.

- Garden centers usually sell a variety of seeds and transplants.
- Online or catalogs offer many more options than a local garden center, but you need to order early to allow time for delivery. Some seed companies do not ship until the last average frost date for your area.
- Order fresh seed each year. Old seed or seed saved from last year's garden might not be dependable.
- Purchase recommended disease-resistant cultivars whenever possible.

Buying transplants

Many vegetables such as carrots, beans, and sweet corn can be planted from seed directly into the garden. Others like tomato, broccoli, cabbage, cauliflower, eggplant, and pepper take too long to grow from seed in the garden. Most gardeners therefore buy transplants from their local garden center or grow their own.

- Buy only sturdy, healthy transplants of known cultivars.
- Stocky, short plants make better transplants than tall, leggy ones.
- Remove plants grown in plastic or clay pots from their containers before planting. Those in individual peat pots can be planted pot and all, because the peat breaks down in the soil. Poke a few holes in the bottom of the peat pot, be sure it is moist when planted, and cover it completely with soil.

Soil preparation

Preparing garden soil is important for an abundant, healthy crop.

- Work up the soil in the fall or early spring. Fall preparation is preferred if the garden site isn't subject to severe erosion.
- Be sure the soil is dry enough to work before getting started. If a soil ball crumbles with your fingers, it's ready to work. If it clings, it's too wet. Working soil that is too wet can leave it hard and cloddy for weeks.
- A garden can be plowed, disked, rototilled, or spaded. To spade, shatter and slice each shovelful so the soil is crumbly. Finish by leveling and smoothing with a rake.
- Make final soil preparation, including fertilization, just before planting a crop in the area you have planned for it. This spreads out the work and ensures the soil is soft and easy to plant. This is especially true if soil is worked up in the fall. Wait until spring to apply fertilizers.

To fertilize, spread half of the fertilizer application over the garden. Work the fertilized soil 6-8 inches deep. Then apply the other half of the fertilizer and disk or rake lightly. (Hint: To help measure fertilizer, remember that 2 cups of dry fertilizer equals 1 pound.) Heavy clay or sandy soils pose special problems. Improve soil by rototilling 4 inches of well-rotted manure, compost peat moss, or other organic matter into the garden soil.

For container gardening

Good "soil" for container gardening differs from typical garden soil. The growing medium must provide excellent drainage and aeration. Garden soil is too compact for containers and doesn't provide the best conditions for root growth.

Prepare "soil" for gardening in containers by thoroughly mixing equal volumes of:

- Garden soil
- Organic matter such as sphagnum peat moss
- Fast-draining material like vermiculite, perlite, or sand

Also include fertilizer in the mix—1/2 cup of 10-10-10, or 5-15 cups composted manure per bushel of mix.

Many commercial potting mixes with some of these components are available, but they usually lack soil. So a gardener could make a growing medium mixture using one-third soil and two-thirds commercial potting mix.

Planting and thinning

Mark the row to be planted by stretching a heavy cord between stakes at either end of the row. Make a furrow using the hoe handle for fine seeds or the blade for larger seeds. Refer to the resources section of the 4-H manuals for where to find information on proper seed depth and spacing, or read the seed packet. Planting seeds too deep is a common error.

- Small seeds should be barely covered.
- Larger seeds should be planted two times deeper than their largest diameter.

Consult the planting plan for the correct distance between rows for each crop. Sow seeds evenly and slightly thicker than the plants will finally stand. Then gently cover with soil.

If the garden soil has a lot of clay, crusting might prevent seedlings from emerging. To help keep the soil moist and prevent crusting, apply vermiculite or finished compost directly over the seed. This also helps mark the row.

Rows are only one way to plant a garden. Crops may also be planted by:
- Succession
- Intercropping
- Double-cropping

See "Making the most of garden space" on page 27 of this manual.

Once seeds begin to germinate, they must remain moist. If enough rain doesn't fall to keep the soil moist after seeding, water the seedbed or cover it with weathered straw, plastic, or a board to retain moisture and help germination. Do not leave this cover on too long; it could have the opposite effect and kill the seedlings.

For container gardening

Planting in a container is similar to conventional garden planting.
- Depending on the size and shape of the container, seeds may be placed in rows or clusters.
- Spacing can be closer than in a typical garden, but avoid crowding too many plants together.
- Soil dries out faster in containers than in gardens in the ground, so check frequently for dryness.

With regular and frequent watering and fertilization, a large plant can grow with a relatively small root system compared to the same plant in a conventional garden.

Seeds need to be thinned after they germinate for proper spacing. Correct spacing allows plants to have maximum benefits of light, moisture, and soil nutrition—all needed for plant growth.

Thin plants when they are small and when the soil is moist. Prevent injury to other plants by grasping the plants to be thinned at the soil line and pulling gently. Do not pull up the roots if it might damage other vegetables; simply use scissors or a knife to cut off the plants to be thinned at the soil line.

Transplanting

Plant transplants in late afternoon or early evening when it's less windy.
- Mark the rows as for planting seeds.
- Dig a hole for each plant about two times wider and deeper than the soil ball.
- Set each plant slightly deeper than it grew before.
- Cover the top of the pot for transplants growing in peat pots so the rim doesn't act like a wick and dry out the root zone.
- Put soil around the roots. Make a starter fertilizer solution by dissolving 1 tablespoon of a high-phosphorus, water-soluble fertilizer in a gallon of water. Add 1 cup around the roots.
- Finish filling the hole. Leave a small soil basin around each plant.

If the next few days call for sun, cover the new transplants with newspaper tents to prevent wilting. When frost is predicted, cover tomatoes, peppers, and eggplants with newspaper tents, cardboard boxes, or blankets. Do not cover plants with metal containers, glass jars, or plastic sheets, which conduct cold and can damage them.

Watering

Vegetable plants need water regularly throughout the season. Provide water if it doesn't rain. The most common way to water is with a hose and sprinkler.
- Water thoroughly so roots develop deeply in the soil.
- Vegetables require 1 to 1-1/2 inches of water per week. Plants in sandy soils should be watered more frequently.
- Water in the morning or early afternoon so plant foliage dries by evening. This helps prevent leaf diseases.
- Use a rain gauge, or mark cans 1 to 1-1/2 inches from the bottom. Place these in the garden when running the sprinkler so you know how much water was applied. Or dig down 6 inches to see if water has penetrated to that depth.

A more water-efficient way to water is with a drip, trickle, or soaker hose system. These under-plant systems have these advantages:
- Reduce water loss due to evaporation because they do not wet the entire soil surface and the plants
- Place the water right on the plant roots
- Reduce disease problems by keeping the plant leaves dry

For container gardening

- Choose the right container. There are few limitations on what you can use, but consider the final weight. You don't want to fill a large barrel with soil and then try to move it to the growing location. It will be even heavier if it has just been watered.
- Make sure the container has good drainage. If it doesn't have any holes, drill a few in the bottom. Cover the holes with landscape fabric, small rocks, or broken pottery to prevent soil from draining out. Don't put packing peanuts or an upside-down container in the bottom, however; they take away valuable growing space and reduce the water-holding capacity. The container will dry out more quickly than container gardens already do.

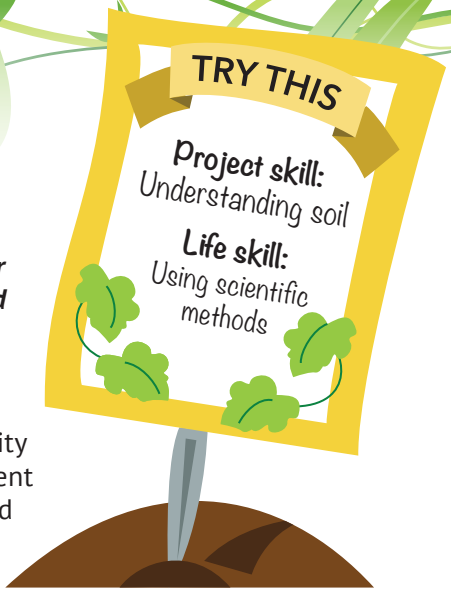
A container must have a drainage hole in the bottom to allow excess water to move away. Vegetables in containers require more frequent watering than similar plants in a conventional garden.

- For small containers, water thoroughly, or until water begins to run out the bottom drainage hole.
- Larger (especially deeper) containers may be well-watered before any water drains out, but avoid light watering that only wets the surface of the growing mix. Be sure water penetrates the mix 8-12 inches with each watering.

Helpful Planting Hints

Buy top-quality seed of well-adapted species and cultivars.	• The use of well-adapted, disease-resistant cultivars is the simplest and most efficient method of controlling many diseases. • In general, gardeners should not save their own seed. Purchasing seed from reputable seed dealers is better, because seed produced on garden vegetables might not reproduce desirable characteristics.
Buy treated seed for protection against wet and/or cold soil prior to germination.	• A seed packet states if the seed has been treated. • Use gloves when handling treated seeds.
To start plants early indoors, plant seeds at the proper depth and spacing in a light, well-drained, pasteurized soil mix.	• Avoid overcrowding and planting seeds too deeply. • Do not overwater seedlings. This might cause damping-off disease, which can kill them.
Buy disease-free, vigorously growing plants from a reputable seller.	• Look for newly formed buds, leaves, or shoots. • Transplants should be free of yellowing, brown or black spots, and any leaf or stem injuries. • Roots should be white, not mushy, brown or black.

Planting a Garden group activity 1: Soil Stuff



Supplies: two measuring cups, container with holes in the bottom for draining, 2-3 cups of soil samples (including clay, sand, humus, potting soil, etc.), organic matter (optional), newspaper, water, paper, pencil, stopwatch or watch with a second hand

Time required: 30 minutes

Preparation

- Gather different soil samples.
- Let youth know ahead of time they can bring in a sample of their garden soil, if possible.

Soil is a complex living system made up of living and non-living materials. This activity investigates the particles of rock in soil and how they affect soil texture. The particles range in size from large, coarse sand to fine clay.

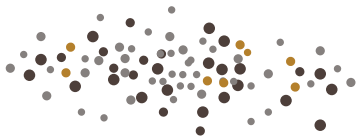
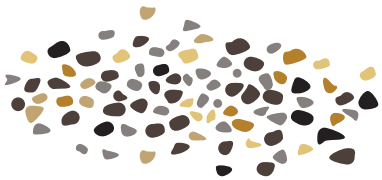
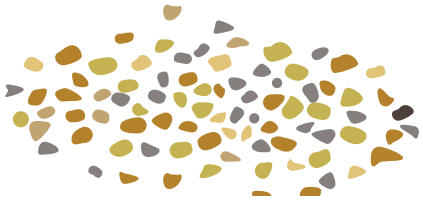
The proportion of the different types of particles—sand, clay, and silt—affects the amount of air, water, and nutrients available in a soil. For example:

- Sand is the largest and coarsest soil particle. The pore spaces between sand particles are large, so water and nutrients drain through quickly. Soil with a high proportion of sand feels gritty and crumbles easily.
- Clay particles, on the other hand, are extremely fine and cling together. The pore spaces between clay particles are so tiny, water moves through very slowly. Nutrients move even more slowly. Soil with a high proportion of clay feels heavy and is slippery when wet. It sticks together and makes a tight ball.
- Silt particles are between the sizes of sand and clay particles. Silt's properties fall between those of sand and clay.

Experience

1. Tell youth this activity explores how different soils drain water and the importance of adding compost to soil. Explain that sometimes soil can be hard and compact. Its ability to absorb water is less, so plants do not grow as well. Garden soil needs to be fluffy. Adding organic matter is an easy way to change the soil's texture.
2. Ask youth to look at the soil samples and describe the general appearance, color, smell, and texture (how they feel).
3. Ask youth to predict which soil samples might drain fastest, and have them explain their predictions. Have them write down the predictions.
4. Set up the experiment as shown in the illustration.
5. Have youth pour about 1 cup of water into each soil sample and see how much water drains out of the soil in 2 minutes. Record this amount. Then let water drain out completely.
6. Repeat with other soil samples.

Soil Samples

Clay particles (smaller than .002mm)	***Silt particles*** (.002mm to .05mm)	***Sand particles*** (.05mm to 2mm)
		

Share
What did you expect would happen in this experiment?
You would expect that clay type soils drain the slowest; sand the fastest; and silt, loam and humus in-between.

How did your soil sample from your garden compare with the other samples tested?

Process
What do some soils drain better than others?
The components of each soil sample contribute to its properties. Large particles such as sand allow better drainage, while clay binds soil together because the particles are tiny. Adding organic matter to soil increases its water-holding capacity.

Why would someone want to use potting soil instead of natural soil?
Container gardens require a soilless mix because natural soil is too heavy or compact for container gardening.

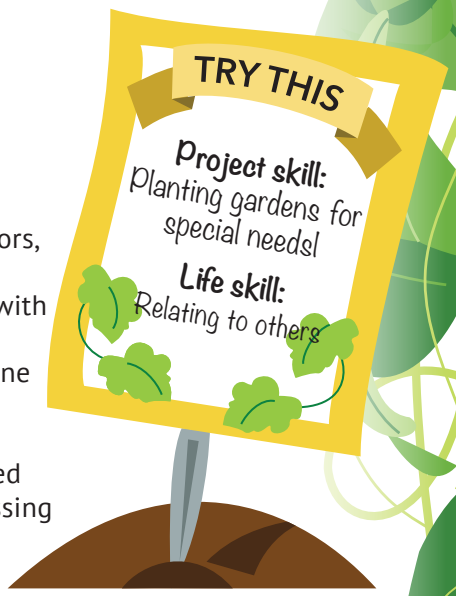
Generalize
What other materials drain well? How are they like soil?
Coffee filters, kitchen colanders, fishnets, sieves, etc. All of these examples have pores or holes so water drains out.

What other experiment using the scientific method can you do to discover something about your garden?
Cultivar trails and different methods for managing insect pests are two examples.

Apply
What will you do with your garden's soil to improve it?
Add organic matter like compost, manure, peat moss, and wood products such as sawdust and ground-up bark.

Describe an experiment that might help you learn something in another area in your life.

Planting a Garden group activity 2:
Anyone Can Garden



Everyone can be a gardener, and everyone's garden will be different. A traditional garden is not the only kind available to those who want to garden. A garden can be tomato plants in a barrel or green peppers in a large flowerpot. An individual's garden depends on the gardener's needs, abilities, and desires.

Gardens can differ in more than size, whether they're indoors or outdoors, or the types of containers they include. How a gardener mixes vegetables, herbs, and flowers in a garden provides endless possibilities. Garden with specific themes provide all sorts of learning opportunities. Some examples are:

- A Native American garden, with beans, squash and corn planted together in hills
- A regional or ethnic garden (tomatillos, collards, Bok choy, etc.)
- A nutritional snack-food garden (pumpkins for pumpkin bread; carrots for a low-fat carrot cake; carrots, radishes, celery, peppers, and cucumbers for raw veggies and dip; salads, watermelons, and stuffed tomatoes, etc.)
- An unusual garden (unusual cultivars, such as giant carrots, purple snap beans, and others that have odd shapes, sizes, colors, and aromas)
- An alphabet garden, with different vegetables, herbs, and flowers—one for each letter of the alphabet
- A pizza garden planted in a circle with a "missing piece" and growing tomatoes, onions, peppers, and herbs such as basil, oregano, and thyme.

A community or youth garden might be more practical in some cases, especially if there is little or no suitable space to grow vegetables. Contact your county Extension office to find out if your county has a community gardening program. (If it doesn't, start one!) Many community groups, park departments, and cities operate these programs. The groups develop vacant lots and parkland into fertile gardens. The area usually is divided into smaller plots for families and/or individuals to use, and the soil plowed or

tilled and readied for planting. A small fee might be charged to cover operating expenses like water and electricity.

Some gardeners might be disabled. They might find the following considerations helpful in planning an outdoor garden:

- Location – Is the garden accessible? Easy to tend to? Close to water?
- Size – Is it appropriate size? Largest is not always best.
- Shade/shelter – Does the gardener need shade and/or shelter?
- Slope – Level is best but is not essential. Are stairs a problem?
- Containers – What type of containers provide additional growing space—on the ground or tabletop?
- Support aids – Are handrails, grips, and other aids needed?
- Pathways – Are pathways wide enough for easy movement?
- Water supply – Is it close? Containers or raised beds tend to dry out quickly.

Youth can plan and plant any container garden for this activity. A container garden is adaptable for every youth. It needs no soil, uses very little space, and can be inexpensive. All it needs is six to eight hours of sun each day. One type of container garden, a pillow pack garden, grows plants in plastic bags. The bags resemble pillows when filled with soil.

Supplies for a pillow pack garden: garbage bags, freezer bags, or heavy polyethylene bags (one for each youth); transplants (see step 4); water; premixed growing medium (a combination of sphagnum peat moss, vermiculite, and fertilizer)

A 4-quart bag of premixed growing medium provides enough mix for 15 half-pints. If they wish, youth can mix their own. To make a bushel of mix, combine:

- 1/2 bushel vermiculite, #2 size
- 1/2 bushel peat moss
- 5 tablespoons ground limestone
- 2 tablespoons powdered superphosphate (0-20-0) fertilizer
  OR
  4 tablespoons rock phosphate
  10 tablespoons (4-2-4) fertilizer, preferably organic

Time required: 30 to 45 minutes

Preparation

- If youth are mixing their own potting medium, place the materials on a clean surface or in a large container. Mix thoroughly. Add water until the mixture is wet.

Experience

1. Tell youth they are making a pillow pack garden to grow their plants. Explain that container gardening enables everyone to have a garden.
2. Fill the bag with the growing medium until the bag is moderately firm. Fold and staple the end.
3. Cut holes for the plants in the pillow pack. A 2-gallon plastic garbage bag can hold:
   - One dwarf tomato plant (be sure to choose a dwarf or patio variety, or it will be too big for the bag);
   - Two pepper plants; and
   - Four to six leaf lettuce plants (or, if you don't want lettuce, plant an herb instead)

Explain the following care instructions.

- Water only when the medium appears to be dry, usually at one- or two-week intervals. It depends if the plants are grown indoors or outdoors.
- The fertilizer in the pillow pack supports plant growth for approximately 10 weeks. Additional feeding might be needed if plants are grown for longer. Use a solution of 2 teaspoons water-soluble fertilizer per gallon of water.
- Place the pillow pack on a windowsill, patio, or porch so it gets six to eight hours of sun each day. You can also plant it in the ground, but slit the bottom with a knife so the roots can get to the garden soil for moisture and nutrients.

Share

How did you feel about doing this activity?
What did you learn about a container garden?

Process

Why is it important to understand that different people have different needs when it comes to gardening?
How would you feel if you want to have a garden and couldn't? What could you do to correct that?

Generalize

Why do people need to do the same thing in different ways?
What did you learn about relating to others?

Apply

How can you help someone you know have his or her own garden?
How will you change the way you relate to others?

Gardening with people with special needs

A little ingenuity can make a garden accessible for all children and adults. Gardening has many therapeutic properties and is often used in care facilities like nursing homes. Some people pursue careers in therapeutic horticulture. Work with your 4-H member to see if he or she might assist a person with special needs with gardening.

For people with physical disabilities:

- A person who uses a walker or crutches can be propped up in the garden using secure seating such as a "corner sitter." A corner sitter that supports the person's back and sides can be made out of a sturdy cardboard box cut in half.
- For people with limited use of their hands (dexterity), choose vegetables with big seeds like peas, beans, and squash, or use vegetable or flower seedlings so planting is easier.
- Raise a garden bed to new heights; 18 inches is a good height for someone in a wheelchair. Some garden beds can even be installed on a pulley system to raise and lower the garden to whatever height is needed.
- Try a half-barrel tub or ceramic crockpot as a container garden.
- Use window boxes, especially for lettuce, radishes, herbs, and garden cress. They are the right height for easy care from a chair. Window boxes can be set on 2-foot-high benches for even better access.
- Set a tabletop garden. It's like a giant window box set on a table or wood frame. Fill it with salad vegetables, herbs, or easy-to-grow annual flowers.

For people who are visually impaired:

- Tailor the garden to encourage the use of senses other than sight. Focus on texture, scents, and sounds. Sensory gardens are specifically designed for people with visual impairments. See if your community has one. If not, youth can work with other garden project members and Master Gardeners to install one!
- Clearly define garden boundaries. Use raised beds framed with lumber or brick, and identify walkways with a contrasting texture underfoot.
- While you help plant the garden, encourage the person to feel the differences between certain seeds, like a corn seed versus a pea seed.
- Grow plants with interesting textures. The tiny leaves of woolly thyme hug the ground. The feathery foliage of carrots tickles the hand.
- Plant herbs with distinctive aromas. Encourage youth to crush the foliage of mint, tansy, catnip, and rosemary to release their smell.
- Use a Braille writer to label plants in the garden.
- Add a bird bath so a listener can hear splashing sounds on a warm summer day or identify bird chirps and whistles.

For people with learning impairments:

- Be aware of developmental age as well as chronological age. A 14-year-old might understand at a 10-year-old's level. Adjust activities to the youth's developmental level.
- Allow the youth to complete the project relatively independently so he or she can see the entire process of planting, taking care of, and harvesting the garden as well as preparing the harvest, watching it cook, and eating it.
- Have youth process the experience by drawing a picture each time something is done in the garden. Examples are getting the soil ready, planting seeds, plant growth, weeding, etc. The pictures remind the youth later what happened during the growing cycle. They can be sequenced and a sentence written to explain each one.
- Encourage independence by giving youth responsibility.

Garden Care

Background

Soil fertility

To avoid using too much or too little fertilizer, evaluate the garden site with a soil test. Contact the local Cooperative Extension office for a list of soil-testing services. The soil test report indicates both the nutrients and the amount of acid present in the soil sample. Garden soil pH should be 6.0 to 7.0. Do not add agricultural lime to change soil pH unless the soil test result is below 6.0.

Most garden soils require 2 to 3 pounds of 12-12-12 fertilizer (or similar analysis) per 100 square feet (10′ x 10′). The numbers on a fertilizer package indicate the percentage of nutrients in the fertilizer. For example, the fertilizer analysis 12-12-12 means that 12 percent of the fertilizer is nitrogen, 12 percent is phosphorus, and 12 percent is potassium. These are the major nutrients required for plant growth.

- Nitrogen (N) promotes leafy, green growth.
- Phosphorus (P) encourages root and fruit development.
- Potassium (K) carries out many plant functions.

The several natural sources of nutrients include animal manures, dried blood, and bone meal. Wood ash has some value as a garden fertilizer, but its main effect is to raise soil pH. Wood ash consists of 50 percent to 70 percent calcium or lime. If your soil has a pH of 6.5 or below, 25 pounds of wood ash per 1,000 square feet on home gardens will meet potassium requirements without harming plant nutrition. Avoid using wood ashes if your soil pH is above 6.5.

Garden equipment

A hoe, rake, trowel, shovel, watering can, garden hose, and sprinkler are standard pieces of gardening equipment. Other useful equipment includes:

- Short states and string to mark rows
- Long (7- to 8-foot) stakes for supporting tomatoes or pole beans
- Hot caps, cloches, and fabric row covers to protect from frost
- A long-handled, wheeled cultivator or a garden hoe for weed control during the season
- A good duster or sprayer for pest control, if needed

Plowing or deep tilling are preferred for preparing the garden for planting, but hand-turning the soil with a shovel also works. Garden tillers can be rented in most communities or borrowed from a neighbor. Trowels are useful for setting out transplants.

Garden safety

Garden equipment and supplies

Store garden equipment in a dry and, if possible, heated area to keep it in good working order. The storage space should be accessible, well-ventilated, and well-organized to keep the equipment and supplies from becoming safety hazards.

Stakes: Wire and bamboo stakes frequently used in gardens can be a hazard. As a precautionary measure, paint the top of the stakes white or orange, or cover them with a small piece of white adhesive tape to make them more visible. This could prevent an eye or other type of injury. Place stakes where they won't cause someone to trip and fall.

Hand tools: Accidents with hand garden tools like rakes, hoes, spades, and shovels usually happen when people trip over tools left on the ground or floor. Keep all such tools in a standing, hanging, or leaning position when in use and in storage. If this isn't possible, lay tools with their points or sharp edges downward. To prevent foot injury, gardeners should wear closed-toe shoes.

Power tools: Rototillers and other power tools are dangerous if used carelessly. Learn about a power tool fully before operating it. Never remove or override built-in safety features. A gardener should never work alone when using power tools; if an accident occurs, someone else is there to apply first aid and/or go for help.

Garden hoses: Most gardeners use hoses, but they can become dangerous if left lying around the lawn and garden area. Keep coiled hoses nearby for fire protection.

Pesticides: Treat herbicides, insecticides, fungicides, bactericides, rodenticides, nematicides, miticides, and baits all as dangerous materials. Try other control measures in the garden first. Use pesticides only as a last resort.

- Store all pesticides in their original containers with a complete, intact label.
- To avoid dangerous confusion, never put a pesticide in a container that was used for food.
- Lock up pesticides.
- Mix pesticides only in a well-ventilated place.
- Before buying a pesticide, read the entire label. By law, the label has important information on how to properly handle, mix, and apply the pesticide.

Read the first-aid instructions before use. The telephone number for poison control is 1-800-222-1222. Visit www.poison.org to learn more.

Pesticides can enter the body through the skin, eyes, nose, or mouth. When using pesticides, wear proper clothing to reduce exposure—at least a long-sleeved shirt, long pants, shoes that completely cover feet, gloves, and goggles or safety glasses.

- A hat makes sense when spraying overhead.
- A gardener who has breathing problems should wear a mask over the mouth.
- Wash protective clothing separately from the rest of the laundry to avoid spreading pesticide residue to other clothing.
- If a pesticide splashes on the skin or into the eyes, wash immediately with clear water.

Other garden chemicals: Chemicals like paint, gasoline, and fertilizer are commonly used around the home and garden. They should be stored in proper containers and locked up.

Preparing for frost/freeze warnings

The threat of an early fall frost or a late spring frost causes gardeners to become concerned about their vegetable crops. Vegetable plants vary in their susceptibility to cold temperatures.

- Tender crops such as tomatoes, peppers, melons, and okra cannot withstand frost unless protected by some insulation.
- Cool-season crops like cabbage, broccoli, Brussels sprouts, and kohlrabi tolerate frost or even a light freeze.
- Other crops such as beets, carrots, lettuce, and potatoes will stand a light frost.

Suggestions for protecting the garden

- Mulching is a good way to protect small gardens. Use several layers of newspaper, straw, or chopped cornstalks. It might be more practical in a large garden to protect only a few plants of each crop. Place blankets, tarps, or floating row covers over rows of vegetables to supply insulation.
- Covering plants is one way to protect them. Cloches, hot caps, or even newspaper folded into a cone and placed over a plant all protect from frost. Light frost might damage only the upper and outer foliage, and the plants continue production.
- If covering plants isn't feasible, pick as much produce as possible if frost is predicted. Some crops can be further ripened indoors if they are not fully mature. For example, most green tomatoes can be ripened to full red indoors. Light isn't necessary to ripen tomatoes; in fact, direct sun might promote decay of the fruit due to excessive heating. Ripening is mostly affected by temperature. The warmer the temperature, the faster the ripening. To store tomatoes for later use, wrap the fruit individually in newspaper and store at 55°F. The fruits will gradually ripen in several weeks.

Cold-temperature tolerance of vegetables

Tender (damaged by light frost)	*Semi-hardy (tolerate light frost)*	*Hardy (tolerate hard frost)*
Beans	Beets	Broccoli
Cucumber	Carrots	Brussels sprouts
Eggplant	Cauliflower	Cabbage
Muskmelons (cantaloupes)	Celery	Collards
New Zealand spinach	Chard	Kale
Okra	Chinese cabbage	Kohlrabi
Pepper	Endive	Mustard greens
Pumpkin	Lettuce	Onion
Squash	Parsnip	Parsley
Sweet corn	Potato	Peas
Sweet potato	Salsify	Radish
Tomato		Spinach
Watermelon		Turnip

Integrated pest management in the garden

Managing weeds

In simplest terms, a weed is a plant growing where it is not wanted. Weed control in the garden is a must. If weeds are allowed to grow, they rob other plants of water, nutrients, and sunlight. They also harbor insects and disease. The best time to get rid of weeds is when they are small.

The two recommended methods of weed control in the home garden are:

- Cultivation/mechanical removal (hoeing, pulling, etc.)
- Mulching (covering soil to prevent weeds from sprouting)

The following suggestions can help prevent certain weed problems and to reduce the time and effort a gardener must spend in the garden.

Cultivating

- Remove all weeds in the garden space by plowing, tilling, or hoeing before planting.
- Hoe the garden several times during the summer to control other weeds that come up after the first hoeing.
- Weed with a sharp hoe, using a shaving stroke, not a chop, and don't go deeper than 1 inch into the ground. Deep hoeing might bring last year's weed seeds to the surface, where they can sprout, and can also hurt garden plants' roots.
- Keep hoes sharp and in good condition to help reduce injury to garden plants.
- Hoe carefully around your plants, and hand-pull weeds close to them.
- For large garden plots, use a wheel hoe with knives (push-plow), or power equipment like a tiller or garden tractor. Avoid deep cultivation. Shallow cultivation controls weeds without harming plant roots.
- Use a combination of several thicknesses of newspaper covered by organic materials as a summer mulch.
- Mulch in late May or early June, after weeds are cleaned up. Place the mulch material around the plants and between the rows—up to 4 inches deep if using a coarse material like straw, but no more than 2 inches deep if using a fine material like grass clippings.

Materials	Pros	Cons
Straw/Hay	Cheap; generally available; adds organic matter	Might contain weed seed, insects, and/or disease
Leaves	Easy to get and apply; good source of nitrogen	Can burn plants; may contain weed seeds
Pine needles	Attractive, easy to supply	Can be difficult to collect in large quantities; might be too acidic
Wood shavings	Weed- and disease-free; easy to apply; available	Can be acidic; tends to tie up nitrogen in soil; must be from untreated lumber
Manure	Excellent source of fertility and organic matter	Must be well-rotted to avoid burning plants; expensive; usually contains weeds
Newspaper	Easy to obtain and apply; earthworms thrive in it	Decomposes quickly; must be weighed down
Plastic	Provides total weed control if dark plastic is used; warms soil for an early start; recyclable; can be used more than one season	Expensive; might be unattractive; does not improve soil texture; must be weighed down and cleaned up and removed in the fall

Mulching

- Mulching helps prevent weeds, holds moisture in the soil, and can make the soil cooler or warmer depending on the type of mulch.
- Mulching is especially useful for vegetables that have a long growing season, like tomatoes.
- Weathered straw, shredded bark, peat moss, crushed corncobs, sawdust, shredded paper, and compost are all good mulching materials. They tend to cool the soil. They can be worked in at the end of the growing season to improve soil.
- Black plastic makes an excellent mulch that also warms the soil by several degrees. It is best used on warm-season plants such as tomatoes, peppers, melons, pumpkins, and cucumbers. Lay the plastic on top of the soil and secure the edges by covering them with soil. Then cut holes in the plastic for the plants. The plastic must be removed at the end of the growing season. Reuse or recycle, if possible.

Composting

Use the following troubleshooting guide to help solve common composting problems.

Symptom	What happened?	Try this
Bad odor	Not enough air	Turn the pile.
Center of pile is dry	Not enough water	Moisten the pile when turning it.
Pile is damp and warm only in middle	Pile is too small	Build a larger pile; mix new materials with the old.
Pile is damp and sweet-smelling but remains cool	Lack of nitrogen	Add a nitrogen source such as fresh grass clippings, manure, or blood meal.

Chemical control

Chemical weed control is generally not recommended for 4-H gardeners. Only a few herbicides are labeled for use in the home vegetable garden. None of them can be used on all vegetable crops, nor do they control all of the many different weeds. A gardener who chooses to use a herbicide must read and follow all of the label recommendations before applying it.

Managing plant diseases

Anyone who has grown a vegetable garden has faced some loss from insects, diseases, or weeds. Seeds planted in the garden might never break through the soil surface or die soon after emerging. Tomato vines might produce fruit with a rotten end caused by blossom end rot. Knowing how to recognize and control some of the common problems can greatly increase a garden's yield as well as the gardener's satisfaction.

Three things must be present for an infectious disease to develop. Removing any one of them greatly reduces the possibility of disease.

- Susceptible host—a garden plant that can get sick
- Pathogen—the living organism that causes the disease
- Proper environment

Symptoms like a fever, sneezing, coughing, and sweating tell a sick person what kind of disease he or she might have. Likewise, a plant is diseased any time it does not function normally. The abnormal, visual condition produced in the plant is called a disease symptom. A sick plant might show symptoms such as leaf spots, root rots, stem cankers, fruit spots, and wilts.

- Sometimes the damage is caused by noninfectious agents, which cannot be passed from plant to plant. These include wind, too much fertilizer, too little water, or mechanical injury from animals, garden tools, or blowing sand.
- In other cases, the damage is from an infectious disease-causing agent and can be passed from plant to plant. Examples are a bacterium or fungus.

Infectious agents

Infectious agents are transmitted from a diseased plant to a healthy plant, and under favorable (usually wet) conditions, cause disease in the healthy plant. A living organism that causes a plant disease does not cause a human disease, nor do the organisms that cause diseases in people (germs) cause diseases in plants. The infectious agents—fungi, bacteria, viruses, and nematodes—are all microorganisms. "Micro" means small, and "organism" means plant or animal.

Just because a microorganism is associated with a plant doesn't mean the plant is diseased, however. The world has billions of microorganisms, and only a very few cause disease. Microorganisms are important to the balance of nature.

- On one side of the scale are all the plants—growing and dying—building up a big pile of dead trees, leaves, and weeds.
- On the other side of the scale are the microorganisms breaking down the pile to its simple chemical parts and returning them to the soil. Microorganisms that feed on the dead organic matter are called saprophytes. Occasionally, one of them become numerous or too aggressive and causes a plant disease. Microorganisms that feed on live plants are called parasites.

If conditions are right, infectious microorganisms enter a living plant and cause it to become sick (diseased). These parasites are called casual agents of infectious disease. The plant that provides a place for one of these casual agents to live is the host. A sick plant is a susceptible host. If it stays healthy, it is resistant.

Some microorganisms that cause plant diseases are:

- Fungi (singular, fungus) are thread-like plants that do not have green chlorophyll. Other plants have green leaves and use energy from the sun, carbon dioxide from the air, and nutrients from the soil to make their own food. Fungi cannot make their own food. They feed on other plants and organic matter. Fungi are sometimes called molds. Many people have probably seen mold growing on bread or maybe a mushroom growing on a decaying log. A mushroom is also a fungus. *Fungi can cause leaf spots, root rots, seedling disease, leaf curl, wilts, fruit rots, and stem cankers.*
- Bacteria (singular, bacterium) are the simplest living organisms known to man. They are much smaller than fungi. Some are so small that 10,000 of them laid end to end would measure less than 1 inch. They are one-celled but multiply rapidly—in some cases, a single bacterium produces over a billion offspring in 12 hours. *Bacteria cause leaf spots, blights, wilts, galls, stem cankers, and soft rots of vegetables and fruits.*
- Viruses can only be seen with a powerful electron microscope. They are regarded as neither plants nor animals. They are made up of genetic material (DNA or RNA) and are spread by insects and some fungi. Viruses can live only inside a living cell of a plant or animal. *Viruses cause disease symptoms like chlorosis (yellowing), leaf mosaic (green and yellow pattern), stunting leaf spots, and wilting.*
- Nematodes are round, slender, non-segmented, thread-like worms about 1/70 of an inch long. The unaided human eye can barely see them. They insert a spear mechanism into a plant to withdraw its juices. Some nematodes feed on the outside of roots, others on the inside, and still others on buds, leaves, and stems. Plants attacked by nematodes do not grow well, are yellow and stunted, and wilt quickly after dry periods. *Some nematodes cause galls on roots. Others cause a small and rotted root system.*

Control of infectious diseases

The most important part of control is correctly diagnosing the problem so choosing a control is possible. The two main types of control measures for infectious diseases are:

- Cultural control
- Chemical control

Cultural control

	How it works
Resistant plants	Plants do not become sick when exposed to certain infectious disease agents. Resistance to specific diseases is listed in seed catalogs, on seed packets, and sometimes on stakes in purchased vegetable transplants.
Sanitation	Cleaning up dead plants removes disease organisms and makes for a healthier garden. Diseases and insect pests get a head start in a garden if plants are left there all winter. Many fungi, bacteria, and insects cannot live outside a plant, which is their house for the winter. Removing old plants and weeds removes insects and diseases, too. Good gardeners clean up their gardens in the fall.
Weed control	Because insects live and reproduce in weeds, removing them reduces the number of insects like aphids that spread diseases.
Crop rotation	Moving plants to different areas of the garden each year helps to avoid a buildup of disease organisms.
Time of planting	Planting at the proper date avoids wet, cool soils and possible seed and root rot, as well as soil compaction.
Proper watering and fertility	Maintaining vigorous plants makes them less susceptible to disease.
Clean seed	Plant disease-free seed for a healthy start.

Chemical control

Chemical control measures in the home garden include the use of fungicides in two forms:

- Seed treatments to protect the seed from rotting as it sits in cool, wet soils awaiting good germination conditions
- Preventive coatings on healthy leaves to control the spread of disease

To protect healthy plant tissue, fungicides must be used before or shortly after the disease appears. They do not kill the infectious disease-causing agents (unlike insecticides, which kill insects.) Fungicides keep healthy leaves from becoming infected. Sprinklers and rain easily wash fungicides off leaves, so they usually must be applied every 7-14 days during the growing season to protect the leaf tissue. This is time-consuming and expensive, so use cultural control measures first.

Noninfectious agents

Noninfectious agents cannot be passed or transmitted from one plant to another. They include:

- Mechanical – rototillers, cultivation equipment (hoes, rakes), sand, insects
- Chemical – fertilizers, herbicides, other pesticides
- Environmental – water, wind, temperature, hail, sunlight

Many noninfectious agents such as water, temperature, and fertilizer are necessary for normal plant growth. They produce a noninfectious disease when there is too much or too little of them. For example:

- Too much water drowns roots.
- Too little water dries out the plants.
- Too much sun burns the plants.
- Temperatures too low cause poor growth or plant injury.
- Too much fertilizer or improper placement burns the roots.
- Too much pesticide may cause abnormal growth.
- Soil compaction restricts root growth.

Air pollution is a noninfectious disease that can kill plants. Smog is air polluted with mixtures of moisture, smoke, and gases. Exhaust from cars reacts with moisture and sunlight in the atmosphere to form plant poisons such as oxides of nitrogen and ozone. These noninfectious disease agents harm plants. Air pollution causes many plants and trees to age early. It might also cause leaf burning and discoloration.

Diseases commonly found on home garden vegetables and recommended control measures

Vegetable	Principal disease	Control measures
Asparagus	Rust Fusarium wilt and crown rot Virus diseases	1,5,8 1,6,9 1,10
Beans	Bacterial blights White mold Anthracnose	1,3,4,5,7,9 3,4,5,6,7 1,2,3,4,7,9
Beet	Cercospora leaf spot Alternaria leaf spot	1,2,3,4,7 1,2,4,7
Cabbage, cauliflower, broccoli, Brussels sprouts, and other cole crops	Club root Black rot Fusarium yellows	5,6,8,9 1,3,6,9 1,6,9
Cucumber	Scab Virus diseases (mosaic) Powdery mildew Bacterial wilt Anthracnose Angular leaf spot	1,3,4,7,8,9 1,9,10 1,3,4,7,8 1,2,5,7,10 1,2,3,4,7,8 1,2,3,4,7,9
Eggplant	Verticillium wilt Fungal leaf spots	6,9 2,3,4,7,8
Muskmelon	Bacterial wilt Fusarium wilt Powdery mildew	1,2,5,7,10 1,6,9 1,3,4,7,8
Onion	Other fungal leaf spots Blast, purple blotch, and leaf blights Neck rots Fusarium basal rot Bulb rot Bacterial soft rot	1,2,3,4,7,8 2,3,4,7,8 3,4,5,7 3,4,5,7 1,3,4,5,7 3,4,5,7 2,3,4,5,7
Pea	Fusarium wilt Root rot Virus diseases	1,6,9 6,11 1,10
Pepper	Virus diseases (mosaic) Sunscald Anthracnose Bacterial leaf spot	1,9,10 3,14 2,3,4,7,8 1,2,3,4,7,9
Potato	Scab Virus diseases Early and late blight Black leg	1,6,9,11 1,9,10 2,3,4,6,7,8,9 2,5,6,7,9
Pumpkin	Powdery mildew	3,4,7,8

Diseases commonly found on home garden vegetables and recommended control measures

Vegetable	Principal disease	Control measures
Squash	Fusarium wilt	1,6,9
	Powdery mildew	1,3,4,7,8
	Scab	3,4,7,8,9
	Virus diseases	1,4,9,10
Sweet Corn	Stewart's bacterial wilt	1
	Rust	1,3,4,8
	Smut	1,2
	Virus diseases	1
	Other fungal leaf spots	1,2,3,4,7,8
Tomato	Blossom end rot	13
	Cracking	13
	Catface	0
	Sunscald	14
	Fusarium wilt, verticillium wilt	1,6,9
	Fungal leaf spots	1,2,3,4,6,7,8
	Bacterial leaf spots	2,3,4,6,7,9
	Root knot nematode	1,6
	Virus diseases	1,9,10
	Walnut wilt	12

Key to control measures

0. Might occur when cool, cloudy weather at blooming time causes the blossom to stick to the young developing fruit, resulting in malformation of the fruit. 2,4-D can also cause this type of distortion.
1. Plant disease resistant or tolerant varieties.
2. Plant sanitation: Cleaning up dead plants and diseased plant parts removes disease-causing organisms and makes for a healthier garden.
3. Water early: Avoid wetting foliage, if possible. Water early in the day so aboveground plant parts dry as quickly as possible.
4. Improve air circulation: Avoid crowding plants. Space them apart to allow air circulation. Eliminate weeds around the plants and garden area to improve air circulation.
5. Rogue plants: Remove and discard or destroy entire infected plant immediately as well as surrounding soil or soil clinging to roots.
6. Crop rotation: Sow seed or set transplants in a different location in the garden than the previous year. Remove infested soil in a container garden and replace it with fresh soil.
7. Autumn cleanup: In the fall, rake and dispose of all fallen or diseased leaves and fruit.
8. Apply a fungicide as recommended on the label.
9. Use disease-free plants or seed.
10. Control insects that spread the disease.
11. Improve soil drainage and maintain balanced fertility; mulch where appropriate.
12. Avoid planting tomatoes or other solanaceous crops within 50 to 100 feet of black walnut trees to avoid juglone toxicity from the tree roots.
13. Avoid soil moisture extremes during hot, dry spells by mulching and irrigating.
14. Caging offers the best protection as foliage increasingly covers the fruit.

Supporting tomato plants

Advantages	Disadvantages
No support (letting plants run)	
• Very little time spent caring for crop; little or no pruning; no staking and training; no support to build or buy. • Total yield might exceed staked or caged plants.	• Requires more room; sprawling plants bush out quite a bit. • In wet weather, tomatoes on the ground get rot, slugs, or bug problems. • Sometimes hard to find tomatoes close to the ground or hidden by thick growth.
Staking	
• Saves space; can grow more tomato plants in a row, if staked as close as 28 inches. • Keeps vines and tomatoes off the ground; no slugs, less rotting; harvest is cleaner. • Earlier harvest. Pruning staked tomatoes forces more of the plant's energy into ripening the fruit. Tomatoes tend to be larger; more energy goes into fewer tomatoes. • Easier to pick tomatoes and to work around staked plants.	• Takes time and effort to set stakes, train plants up them, and prune the plants. • Plants usually need plenty of mulching. • Staked plants need more water than unstaked ones. • More prone to cracking, blossom end rot, and other problems when standing up because more exposed. • Decreases yield (number of fruit).
Cages	
• If cages are set up as seedlings are transplanted to the garden, no additional work is necessary. • No pruning; leaves shade the tomatoes, protect them from sun scald, and allow them to ripen evenly. • Easier to pick tomatoes and to work around caged plants. • Keeps vines and tomatoes off the ground; no slugs, less rotting; harvest is cleaner.	• Store-bought cages can be expensive: make your own from galvanized wire mesh. • Work is required to set up the cages and secure them to small stakes. • Takes time at the end of the season to disassemble cages and store parts.
Trellising	
• Holds tomatoes off the ground for cleaner, easier-to-pick harvest. • Usually does not require as much pruning as staked tomatoes; two or three main stems can grow with trellising.	• Trellising can be hard work, especially for a large planting. • Requires weekly maintenance to keep plants running up the trellis; tied to trellis wire. • Takes time at the end of the season to disassemble the trellis and store parts.

More on staking tomatoes

Put a stake, approximately 8 feet tall and 1-2 inches wide, about 4 inches from each tomato plant. Use large sticks or branches if stakes are not available. Drive the stake 1 to 2 feet into the ground. Tie 1-inch strips of soft cloth around it. Tie the strips again in a loose loop around the stem of the tomato plant under the first group of blossoms. To train the tomato plant, twist the main stem around the stake once a week.

Prune staked tomatoes regularly to remove non-fruiting suckers, which grow between the main stem and the leaf. Remove suckers when they are small by snapping to one side and pulling off in the opposite direction; do this weekly. Be careful not to confuse suckers and fruiting stems, or to injure flowers on the main stem. Remove all suckers even if they have flowers. If left unpruned, each sucker grows into a whole new vine.

Managing insect pests

Information in this section is from "Managing Insects in the Home Vegetable Garden," Purdue Extension publication E-21-W by Extension entomologists Rick E. Foster and John Obermeyer. It is available at The Education Store (www.edustore.purdue.edu).

Insects feeding on vegetables in the home garden is a fact of life for most gardeners. The gardener's two choices are to tolerate the damage or attempt to prevent it. Tolerating the damage is often a reasonable approach. For example, when tomatoes begin to ripen, most gardeners have more tomatoes than they can possibly use. Caterpillars chewing on a few of the fruits are therefore of no real concern. Corn earworms usually confine their damage to the tips of sweet corn ears, which can be cut off before cooking the corn. Some crops are much less likely to be attacked by insects than others (see chart, right). Planting crops that are less likely to suffer injury from insect feeding reduces the problems a gardener can expect from insect pests.

Preventive practices

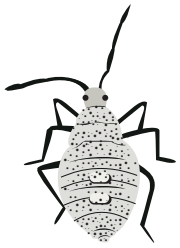
The home gardener can use a number of practices to reduce insect problems.

- Dispose of plant residues from the previous year's garden.
- Plant varieties recommended for use in the gardener's area and at the proper time for best growth. (Planting too early, when the soil is cool, might make the plants more susceptible to some soil insects.)
- Use proper plant spacing, fertilizers, water, and cultural practices to ensure vigorous plant growth. Vigorously growing plants tolerate more insect damage than poorly growing plants.
- Inspect transplants before purchasing them to make sure they are not infested with insects.
- Keep the garden as weed-free as possible. This helps plants continue to grow vigorously. Weeds also often harbor insects that attack crops.
- Inspect plants regularly for insects or insect damage. Early detection can lead to more effective control and less damage. Particularly in small gardens, caterpillars, loopers, hornworms, and large beetles that the gardener finds early can be handpicked from plants and destroyed before they cause problems.

Frequency of insect attacks on vegetables

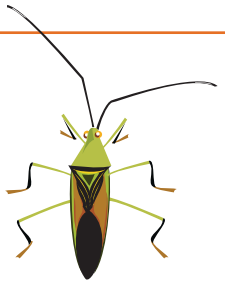
Never or rarely	*Sometimes*	*Usually or always*
Carrot	Asparagus	Broccoli
Green onion	Bean	Cabbage
Lettuce	Pepper	Cantaloupe
Pea	Spinach	Cauliflower
Radish	Tomato	Cucumber
		Eggplant
		Potato
		Squash
		Sweet corn

Common garden pests

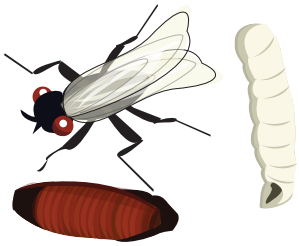


APHID

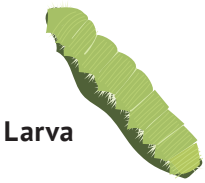
LEAFHOPPER ADULT



SQUASH BUG



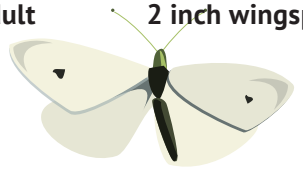
CABBAGE MAGGOT



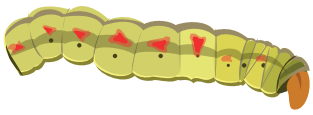
Larva

Adult

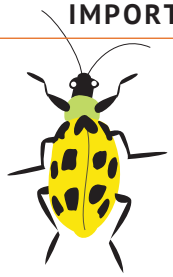
2 inch wingspan



IMPORTED CABBAGEWORM



CORN EARWORM



SPOTTED CUCUMBER BEETLE

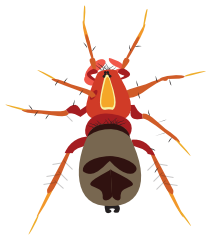
Larva

Adult

COLORADO POTATO BEETLE

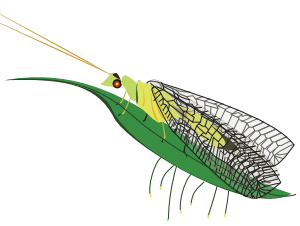
STRIPED CUCUMBER BEETLE

Common beneficial arthropods

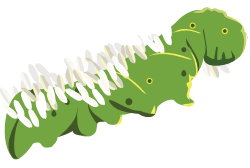


GROUND SPIDER

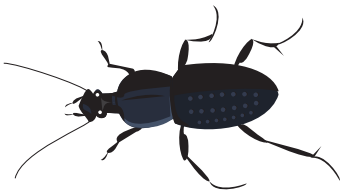
LADY BEETLE



GOLDENEYE LACEWING AND EGGS



PARASITIZED CATERPILLAR



GROUND BEETLE

HONEY BEE

Beneficial arthropods

Arthropods are animals with jointed legs. The phylum includes insects, spiders, and mites.

- Only a small percentage of the arthropods in Indiana are pests, and only a few of those damage vegetables.
- Most are so innocuous that they are never noticed.
- Many are important in providing food for larger animals or helping to break down decaying plants and animals.
- Other arthropods provide direct benefits to gardens.
- Some insects and other arthropods are predators; that is, they eat other insects, including pest insects. These include spiders, adult and immature lady beetles, adult and immature lacewings, preying mantids, and ground beetles.
- Others act as parasites on pest insects. These include a number of species of wasps and flies, which lay eggs in or on the host insect.

Preserving as many of these predators and parasites as possible is important. They often control the pest species well enough that additional control isn't necessary. Protect beneficial insects by spraying insecticides only when necessary and choosing insecticides that are least toxic to the beneficial insects.

One of the most notable beneficial insects is the honey bee. Besides providing honey, they are pollinators for many vegetable and fruit crops. Without them, many crops would never produce fruit. Never apply insecticides that are toxic to bees when plants are in bloom. Here are a few of the hundreds of plants dependent on honey bees.

Vegetables and fruits pollinated by bees

Beets	Cucumber
Black-eyed peas	Eggplant
Bok choy	Green beans
Broccoli	Lima beans
Brussels sprouts	Okra
Cabbage	Onions
Cantaloupe	Strawberries
Cauliflower	Tomatoes
Carrots	Turnips

Insecticides

An insecticide is any product you apply that kills insects. Several different types are available for use by the home gardener.

Botanical insecticides

Botanical insecticides are extracted from plants.

- Neem: Derived from leaves or seeds of neem trees. Works against a variety of pests and primarily acts as a repellent instead of a toxin. Should therefore be applied before a serious infestation occurs.
- Rotenone: Derived from the roots of tropical plants. Needs to be eaten by the insect to act as a stomach poison. Normally used against chewing insects.
- Pyrethrum: Derived from the flowers of certain chrysanthemum plants. Causes rapid paralysis and apparent death, but insects might subsequently recover. Most effective against soft-bodied insects such as scales and aphids. Mixtures with piperonyl butoxide provide improved control.

Microbial insecticides

Microbial insecticides available to the home gardener contain spores of the bacterium *Bacillus thuringiensis* (Bt). Bt contains a toxin that causes gut paralysis after the insect eats it. Most commercial Bt strains are effective against most caterpillars and are sold under various trade names. Several new strains of Bt are effective against beetles, specifically the Colorado potato beetle. A major advantage of microbial insecticides is that they do not affect bees, beneficial insects, humans, or other vertebrates.

Manufactured insecticides

Several different manufactured insecticides are available for use by the home gardener. They vary in the insects they control, how long the insecticide is active, and the recommended length of time between application and harvest.

Inorganic insecticides (oils and soaps)

- Highly refined oils can be used at low concentrations to control insects. Oils work only on contact and have no residual effects. They can damage growing plants, so test an oil spray on a few plants before using it more widely. Wait a couple of days to see if the oil damages those plants before spraying the rest.
- Commercially available insecticidal soaps made from naturally occurring fatty acids help control aphids, mites, leafhoppers, scales, and whiteflies. Like oils, soaps control only those insects the spray lands on. Gardeners can use a pure unscented household soap after testing it on a small scale first to make sure the soap doesn't burn the leaves.

Insects commonly found on vegetables and recommended insecticides for control

Insects	Vegetables attacked	Recommended insecticides
Aphids	Many vegetables	4,7,8,9,10
Asparagus beetle	Asparagus	2,4,5,6
Bean leaf beetle	Bean	2,3,4,5
Blister beetles	Many vegetables	2,5,8
Cabbage looper	Cabbage, cauliflower, broccoli	1,6
Colorado potato beetle	Potato, tomato, eggplant, pepper	2,3,5
Corn earworm/fruitworm	Corn, tomato, bean	2,3
Cucumber beetle	Cucumber, bean, melon, squash, pumpkin	2,3,5,6
Cutworm	Many vegetables	2 bait
European corn borer	Corn, pepper, bean	2,3,6
Flea beetle	Many vegetables	2,3,4,5
Grasshoppers	Many vegetables	2,3,8
Imported cabbageworm	Cabbage, cauliflower, broccoli	1,2,3,6
Japanese beetle	Many vegetables	8
Leafhoppers	Bean, potato	2,3,5,7,8
Mexican bean beetle	Bean	2,3,5,6
Spider mites	Many vegetables	3,4,7
Squash bug	Cucumber, melon, squash, pumpkin	2
Squash vine borer	Cucumber, melon, squash, pumpkin	2,4,5
Tomato hornworm	Tomato, potato, eggplant, pepper	2,6
Whitefly	Many vegetables	3,4,7,8,9
Wireworms	Corn, potato, sweet potato	3 as soil treatment

Recommendation current as of October, 2015. Read labels carefully for up-to-date information.

Key to recommended insecticides:

1. *Bacillus thuringiensis*
2. Carbaryl
3. Diazinon
4. Malathion
5. Methoxychlor
6. Rotenone
7. Soaps or oils
8. Neem
9. Pyrethrins
10. Soap (insecticidal)

Garden Care group activity 1: It's Tool Time

Supplies: Things around the home that can be used in the garden (old forks, spoons, kitchen scoops, turkey baster, eye dropper, shoebox, empty coffee can, etc.); scissors; hole punch; wooden craft sticks; three or four empty plastic gallon milk or juice containers; markers and stickers (optional)

Time required: 30-40 minutes

Preparation

- Think about which tool(s) are possible for your group to make.
- Prepare some sample garden tools that you've made out of recycled materials.

This activity is about making do with what's available. Youth who are unable to buy garden tools can perhaps borrow what they need to work up the soil. Here are some ideas for using household items in the garden:

- Use old flatware (forks, spoons, and kitchen scoops) to plant seedlings.
- Use a turkey baster to water germinating seeds and seedlings or even to water hanging baskets.
- Scissors are useful for taking cuttings or clipping away seedlings when thinning a row.
- An empty coffee can makes a watering can.
- Use an eyedropper to water seeds germinating indoors.
- A shoebox can safely store tools.

Experience

1. Tell youth that this activity is about making tools from recycled materials—empty plastic one-gallon milk or juice containers—including a tool tote, watering can, scoop, plant labels, plant "hat" called a cloche, and more.
2. Demonstrate how ordinary items around the home can be used as tools in the garden.
3. Lead youth through the directions to make one more of the garden tools. (Note: Take special care with younger youth using scissors to cut plastic containers.)

Tool tote (or compost bucket)

- Use scissors to cut away the top front section of a plastic gallon jug.
- Decorate it using permanent markers, decals cut from adhesive backed paper, or stickers.
- Fill it with gloves, a trowel, old forks and spoons, scissors, string for plants that need support, a magnifying glass, etc. The handle makes it easy for a gardener to carry tools to the garden.

Watering can

- Use scissors to cut away the top part of a plastic gallon jug.
- Punch holes in the front using a hole punch or large nail.
- Fill with water and pour some out to test it. If necessary, add more holes.

Irrigation jug

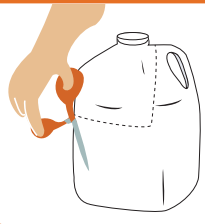
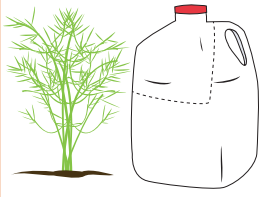
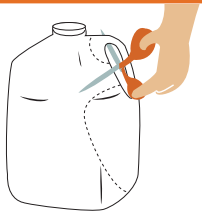
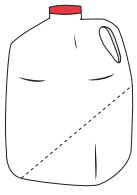
- Use a nail to punch holes in the bottom of a plastic jug.
- Set the jug on the ground near plants to be watered. Water slowly seeps into the ground.

Scoop Variation #1

Cut around the handle of a plastic gallon jug (or plastic 1-liter bottle), adjusting for the size of scoop you need. Several sizes fit many uses—a large scoop at the compost pile, another where you grow container gardens, and a smaller one for digging little trenches when planting seeds.

Scoop Variation #2

Cut off the bottom of a plastic gallon jug at an angle to make another kind of scoop.

Tool tote	Watering can	Irrigation jug	Scoop #1	Scoop #2
				

Garden Care group activity 1: It's Tool Time (continued)

Plant labels
- Cut a strip from the sides of a plastic gallon jug, or use craft sticks.
- Print the plant name with a permanent marker.

Plant hat (cloche)
- Cut away the bottom of a plastic gallon jug. Cut slits up the sides to make a simple cover for tiny seedlings that have just begun growing in the garden outdoors.
- Spread the slits apart, and push the ends into the soil around the plant.
- Once the seedlings grow larger and stronger, put the hats away for next year's seedlings.

Mini-greenhouse (or frost protector)
- Cut the bottom off a plastic gallon jug to make a mini-greenhouse.
- Remove the cap during the day.
- Use the mini-greenhouse to cover plants when frost is possible overnight.

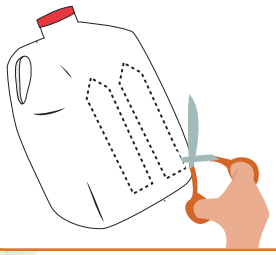
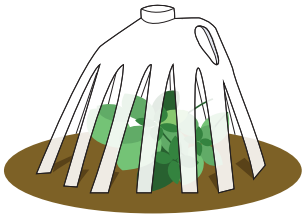
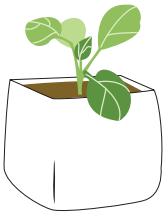
Plant collar
- Cut a plastic gallon jug as shown to make a collar for seedlings to keep cutworms away.
- Place the collar around the seedling and push it in the ground a little so it doesn't move around.

Share
How did you save money or manage your resources in this activity?
How did you decide which garden tool(s) to make?

Process
How did making your own garden tool(s) help you learn about managing resources?
Why is it important to learn how to manage resources?

Generalize
Besides learning about managing resources, what else did this activity demonstrate?
The activity also emphasized conserving the environment.
In what other ways do you manage your resources? (Hint: Think about spending your allowance and time.)

Apply
In what other areas of your life will you manage your resources as you grow older?
How can you use things you find around your home (other recycled materials, for example) to make other useful items?

Plant labels	Plant hat	Mini-greenhouse	Plant collar
			

Garden Care group activity 2:
Planting Ideas

Materials: pad of paper and pencil for the reporter, video camera (a tablet computer or cell phone also works), props for fun

Time required: 30-45 minutes

Preparation

This activity helps youth understand both sides of a garden-related issue with environmental impact. Youth may:

- Role-play a news conference or interview.
- Produce a public service announcement for TV or radio.
- Write a news article for the local newspaper about what your group is doing about the issue.

Think about garden-related issues in your local area. Examples might include a pesticide spill, the no-till planting method, or what to do with grass clippings if the local landfill no longer accepts them.

Read through the activity, and consider the size of your group. Making a public service announcement or writing a newspaper article involve fewer people and are less complicated than staging a news conference.

Youth who choose the news conference can take the following roles, depending on the issue the group chooses to explore.

- News reporter
- Camera/video person
- Parent
- Youth
- Person with strong environmental views and beliefs
- Volunteer who works with youth groups interested in gardening
- Industry spokesperson representing a company involved with the issue

Experience

1. Tell youth this activity is about expressing their feelings in an interview or news report by creating a video. Gardening-related issues like organic produce are popular news topics. Youth can think about these topics by role-playing a news conference or interview on an environmental concern in the local area; making a public service announcement about a garden-related practice; or writing a news article or editorial about the group's activities and submitting it to the local newspaper.
2. Brainstorm on what the group wants to do. Local issues may influence the choice. For example, where to locate a new community garden might result in a heated discussion but also provide an opportunity to make a public service announcement about the benefits of a community garden.
3. Ask youth to pretend they are not familiar with a garden-related issue the group wants to explore. As individuals or groups of two or three, think of questions about how the issue affects the community. Think of possible answers as well.
4. Assign roles if the group is role-playing a news conference or interview, including:
   - One 4-H garden project member
   - A parent or guardian of the member
   - A farmer who sells produce in the local area
   - A vocal opponent of the garden-related issue
   - A local news reporter
   - Camera/video person
   - Others

Share

What happened in this activity?
How did you feel about the role you played?

Process

How did this activity help you understand the other side of the garden-related issue?
Why is it important to listen to both sides of an issue?

Generalize

Give an example of an experience like this which you have had. Think about school-related issues and other 4-H experiences, such as those with animal and animal welfare/animal rights issues.
What other environmental conservation impact issues have you heard or read about?

Apply

What would you do differently the next time you must deal with an environmental conservation issue?
How can you use the skills you learned in this activity to tell your point of view the next time you are questioned by a person with ideas very different from your own?

Harvest and Storage

Background

Harvesting, storing, and cooking vegetables and herbs

Here are some helpful hints for the harvest and use of garden vegetables. Before harvesting vegetables, be sure to review the days-to-harvest restrictions on the labels of any pesticides that are used.

- Eat vegetables raw or cooked.
- Eat vegetables right away, or freeze or can them for later use.
- Give vegetables away or sell to neighbors and friends.
- Store certain vegetables in root cellars or other special structures. Ask your county Extension office for its publication on storing fruits and vegetables at home.

Any vegetable should be cleaned carefully in preparation for eating it. Vegetables taste best if they are eaten at the right stage of their development.

Basil
Pinch stem tips to keep growing plant bushy. Harvest leaves just as the first few flowers appear. Use fresh, or dry for later use in Italian dishes.

Beans, snap or green
For the best taste harvest green beans as pods fill but before the seeds bulge. Green beans can also be picked later and shelled out. To cook: boil green beans whole, sliced (Frenched), or snapped/chopped until tender. Whole beans take 10-15 minutes to cook, while smaller beans take 5-10 minutes. A little onion and/or bacon adds to their taste.

Beets
Begin harvesting when beets are 1 inch in diameter. Beet tops make excellent tender greens at this time. Beets are considered full size at 2-3 inches in diameter.

Broccoli
Harvest the terminal head while florets are still tight and bluish-green. Smaller heads develop from side shoots after the main head is removed. Eat broccoli raw in salads, stir-fried, or steamed until tender but firm.

Cabbage
Cut, twist, or pull the cabbage when it's mature. Maturation time depends on the cultivar. Some are fully developed in 80 days; others need up to 105 days. Eat cabbage raw, shredded, or in a combination salad. To cook: boil, pan fry, pickle, or make sweet-and-sour cabbage.

Carrots
Pull carrots from the time they are the size of your thumb. If the green tops break off, dig them out. Wash and peel carrots before eating. To cook: shred, slice, shave, shoestring, or leave whole. Boil or steam. To eat raw, cut into strips, make curls or leave whole.

Cauliflower
To keep head white, tie outer leaves above the head when curds are 1-2 inches in diameter. Heads are ready for harvest about two weeks after tying. Eat cauliflower raw in salads or steamed until tender.

Corn, sweet
Harvest sweet corn when kernels are plump and tender. Silks will be dry and the kernels filled. Check a few ears for maturity. Open top of ear and press a few kernels with your thumbnail. Milky juice means it's ready for harvest. If the kernel is doughy, the flavor will be starchy. Watery juice means the corn isn't ready to pick yet.

Cucumbers
Although size depends on the cultivar, most slicing cucumbers are ready to harvest when 1-1/2 to 2-1/2 inches in diameter and 5-8 inches long. Pickling cucumbers are more blocky and 2-3 inches long.

Eggplant
Harvest when fruits are firm and color is solid and bright. Eggplants do not store well; keep in the warmest part of the refrigerator up to 1 week.

Kohlrabi
Harvest when the swollen stems are 2-3 inches in diameter. Stems become woody if allowed to grow larger.

Leaf lettuce
Harvest leaf lettuce from about 3 inches long until it sends up a seed stalk. Cut off the leaves. Do not disturb the root; new leaves will grow. Wash the lettuce leaves to remove soil and other residue. Use lettuce raw as a salad vegetable. To cook: shred, wilt, or braise until lettuce is tender. Bacon, onion, and seasonings add to the taste of wilted lettuce.

Mint
Harvest leaves any time during growing season. Use fresh in iced tea and salads, or dry for later use.

Muskmelon (cantaloupe)
Harvest when the stem slips easily from the fruit. The color beneath the outer netting of the melon should be slightly orange with little green.

Okra
Harvest pods when 2-3 inches long. Larger pods are tough and seedy. Harvest pods daily to keep plants in production. Use pods in stew or soup.

Onions
Pick onions green or let the bulbs mature until the tops fall over. After pulling mature onions, let them dry outside for several days in the shade. Eat raw in salads or on sandwiches or use to flavor stews and other foods. To cook: boil whole for 15-40 minutes, bake, fry, French fry or braise.

Oregano
Pinch stem tips as plants grow to keep plant bushy. Harvest leaves just as the first few flowers appear. Use fresh or dry for later use in Italian dishes.

Parsley
Harvest leaves any time during growing season. Use fresh in salads, or dry for later use.

Parsnips
Harvest in late fall after several moderate freezes. Cold weather enhances the sweet flavor. Steam or boil like carrots.

Peas
Harvest shelling peas when the pods are rounded and firm. Do not let the pods turn yellow or the peas will be tough. To cook: steam or boil 10-20 minutes. Cook peas with mushrooms, young potatoes, melted butter, or in a cream sauce. Harvest oriental or snow peas before the seeds begin to bulge. Snap peas are harvested as seeds fill the pod. The pod is edible on both oriental and snap peas; stir-fry or steam.

Peppers
Harvest when firm, before softening occurs or brown spots appear. To eat raw, wash and cut out the stem. Remove seeds before cutting into strips or rings, dicing, or leaving whole. To cook: hollow out, stuff with mixtures of shrimp, beef, or chicken, and bake.

Potatoes
Harvest when the tops have yellowed. Cure for about a week in a shaded, well-aerated place before storing. Avoid exposing the potatoes to light to prevent greening. Bake, boil, fry, broil, or stew.

Pumpkin
Harvest when the skin is hard and the colors darken before the first fall frost. Leave 1-2 inches of stem attached. Use for baking or carving.

Radishes
Harvest radishes from the time they reach the size of cherries, depending on the cultivar. Eat raw, or slice for salads. If left in the soil, radishes become fibrous; these are good to eat sliced and steamed or stir-fried because their texture is like water chestnuts.

Sage
Harvest leaves any time during growing season. Use fresh, or dry for later use.

Spinach
Harvest from the time the leaves are 4 inches tall until the plants send up seed stalks. If you cut off spinach about an inch above the ground, the plants grow out again. Eat spinach raw in salads, or steam until wilted.

Squash, summer (zucchini and others)
Harvest when fruit is small (6-8 inches long or 3-4 inches in diameter for scallop-types). Fruits should be tender with skin that is easily scratched. Use raw in salads, steam, or stir-fry.

Squash, winter
Harvest when the skin is hard and the colors darken before the first fall frost. Bake until tender.

Tomatoes
Don't pick tomatoes too early! Wait until they are almost fully red. Eat tomatoes raw, sliced, plain, with lettuce, in a salad, or on sandwiches. To cook: stew, fry, or bake.

Turnips
Harvest turnips from when they are golf ball-sized until they become large, woody, and difficult to cut. Raw turnip sticks are delicious with a dunking sauce. Eat the tops as cooked greens. Eat turnip roots raw, or cook them by stewing, frying, or baking.

Watermelon
Harvest when the underside of the fruit turns from whitish to yellowish. The tendril at the juncture of the fruit stem and vine usually turns brown when the fruit is ready to harvest. Some gardeners use the thump method. Thumping a ripe melon with your thumb makes a dull thud. A melon that isn't ready makes a ringing sound.

Using and preserving garden vegetables

Vegetable	Salads	Cooking	Canning	Freezing	Dehydrating	Storing
Beans	yes	yes	yes	yes	yes	yes
Beets	yes	yes	yes	yes	no	yes
Broccoli	yes	yes	no	yes	no	no
Brussels sprouts	no	yes	no	yes	no	no
Cabbage	yes	yes	pickled	yes	no	yes
Carrots	yes	yes	yes	yes	yes	yes
Cauliflower	yes	yes	yes	yes	no	no
Chard	yes	yes	yes	yes	no	no
Corn	no	yes	yes	yes	no	no
Cucumbers	yes	no	pickled	freezer pickles	no	no
Eggplant	no	yes	no	yes	no	no
Kohlrabi	no	yes	no	no	no	yes
Leeks	no	yes	no	no	yes	yes
Lettuce	yes	no	no	no	no	no
Okra	no	yes	no	yes	no	no
Onions –						
Green	yes	yes	no	yes	yes	no
Regular	yes	yes	no	yes	yes	yes
Muskmelon	yes	no	no	yes	no	no
Parsley	yes	yes	no	yes	yes	no
Parsnips	no	yes	no	no	no	yes
Peas	edible pods	yes	yes	yes	yes	no
Peppers	yes	yes	yes	yes	yes	no
Potatoes	no	yes	yes	no	yes	yes
Pumpkin	no	yes	no	yes	no	yes
Radish	yes	braised	no	no	no	no
Spinach	yes	yes	yes	yes	no	no
Tomatoes	yes	yes	yes	yes	yes	no
Turnips	yes	yes	no	no	no	yes
Zucchini	yes	yes	yes	yes	yes	no
Watermelon	yes	no	pickled	yes	no	yes

**Such as in food cellars, where no other treatment is necessary after drying.*

Summary of activities related to harvesting and marketing in the youth manuals

This guide does not provide more information on selling the garden's harvest beyond what is already in the four youth manuals. Each manual contains activities that introduce youth to topics related to harvesting, storing, and marketing vegetables. Here is a summary of the activities.

Level A, See Them Sprout

Is it Ready? and Use it Up discuss when to harvest vegetables and what to do with too much produce.

Level B, Let's Get Growing

One of a Kind and Too Much to Eat! cover judging vegetables and managing resources by freezing extra produce and storing vegetables. On Your Own discusses growing vegetables for cash and methods to do so.

Level C, Take Your Pick

Garden Cents helps youth learn how to keep records, such as for harvest production. Lead the Way introduces youth to a judging contest and teaches them how to organize an event for younger garden members. Let's Preserve shares more information about canning and pickling vegetables and drying herbs.

Level D, Growing Profits

Youth learn about making a financial record of gardening expenses and comparing it to harvest production in Profit or Loss. More information about preserving the harvest using pressure canning and drying is presented in Save the Best. Growing a Business encourages youth to start making plans (budget plan and business plan) to start a vegetable or plant-related business.

Harvest and Storage group activity 1: Sowing Knowledge

Supplies: plain printer paper (or colored and/or construction paper), pencil, markers, old seed catalogs (optional), letter stencils (optional), computer with publishing software (optional)

Time required: up to 1 hour

Preparation

Many vegetables and herbs can be grown in the garden, and each has different maturity characteristics and dates. In this activity youth create an informational flyer or brochure to educate their club, family, or other community members about proper harvesting for various vegetables and herbs.

Experience

1. Alone or with partners, have the youth choose three to four vegetables or herbs. Review the vegetables and herbs at the beginning of this unit, or provide Internet access to view those available from seed companies. (Alternately, provide seed catalogs). Encourage the youth to choose vegetables that are related (see Level B, page 5, "Grow What You Know"); from the same center of origin (see Level D, page 28, "Grow What You Know"); or that can be used together in a recipe—for example, peppers, onions, and tomatoes can be used to make salsa.
2. Explain that for each of these vegetables or herbs, the youth should create a brochure, flyer, or other creative display that tells the following information:
   - Describe the vegetable or herb.
   - What does the mature form look like?
   - What is the average maturity date?
   - When should it be planted in your area?
   - What are the best ways to store it?
   - What are its culinary uses?
   - Any other special facts or information.
3. Provide the youth with paper (printer paper, construction paper, cardstock, etc.), poster board, pencils, markers, or if available, a computer with publishing software to create their informative piece—a brochure, poster, or even a website. Before they begin, encourage them to first think about their audience.
   - Will their piece be for youth or adults?
   - Will it be displayed in a public place, handed out at a workshop, or shared digitally?

Share

How did you choose which vegetables or herbs to use?
What did you learn about your vegetables or herbs as you worked on your piece?

Process

How did you choose your presentation method for your informative piece?
How did you decide what information to share about your vegetable(s) or herb(s)?

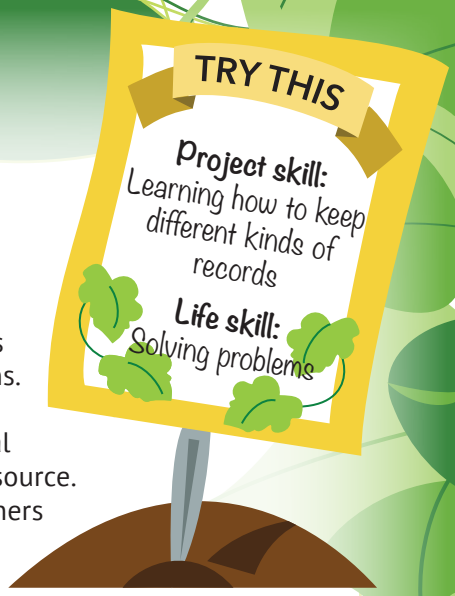
Generalize

What are some other methods you have used to share information?
Why is it important that your piece shares accurate information?

Apply

How can you educate friends or family members about proper harvesting and storage of vegetables and herbs?

Harvest and Storage group activity 2:
A Garden Journal



Supplies: paper, pencils, notebook or flip-chart

Time required: 30 minutes-1 hour

Preparation

Using a notebook or flip-chart, make sample records/activity logs for weather, crop rotation, harvest quantities, rainfall, weeding and hoeing, or any other type of activity related to gardening as examples for the youth. Read this entire activity for more ideas.

Keeping records might or might not be a fun thing for youth to do. Some find it interesting, but others become discouraged because they don't know what to write or how to keep track of garden-related activities. As a leader/helper, how you introduce records can determine the youth's attitude toward keeping records for the rest of their lives. This activity explores how and what youth can learn through good record-keeping. Their records might come in handy the following year when they have to solve a garden-related problem—if they know, for example:

- What seeds produced the best yield?
- How much did it rain?
- How many days were over 90^{0}F?
- How did this year's harvest compare to last year's?

Recordkeeping answers these kinds of questions. Over many years, a personal garden journal becomes a valuable resource. Many successful gardeners keep such a journal.

The end of a growing season is a good time to jot down records and notes for next year. It's always a good idea to keep track of the season's successes and failures so the gardener can determine which cultivars turned out best and which were disappointments. Seed varieties change every year or two. New ones are introduced and older ones discontinued. Some gardeners like to mark the seed catalogs and keep them for future reference, but it might not be practical to store all the catalogs. Another idea is to combine a notebook for garden records with cutout pictures and descriptions from the seed catalogs. Going paperless is also an easy option. Many applications for smartphones and tablets provide garden planning as well as recordkeeping in the same application.

Examples of garden records	
Soil records	When fertilizer was applied and other amendments such as conditioners and mulches were added to the soil as well as what kinds and in what amounts. Important to know to avoid a mineral imbalance.
Rainfall amounts	Water stress sometimes causes symptoms that look like those from insects or diseases, so it's important to know how much rain the garden receives.
Comparison records	How well certain plants resisted heat, pests, and/or diseases as well as how they were received at the dinner table.
Crop rotations	Helps give the gardener a visual reference for planning and planting this year's crop. Ensures the gardener does not plant crops from the same family in the same spot year after year, making the plants more susceptible to diseases.
Daily temperature readings	Data on weather conditions helps a gardener make better judgments about the real cause of symptoms seen in the garden.
Harvest quantities	Records of pounds and number or pieces is helpful to determine if certain cultivars had a better yield.
Frost dates	First and last frost dates are important for garden planning.
Seeds/transplants purchased	Knowing quantity and cost is handy for planning a garden in future years.
Planting time for each cultivar	Helps to schedule planting dates and determine when to start seeds indoors.
Pest problems and treatment	Helps determine which treatments are best for the garden.
Harvest preservation methods	Includes cooking, freezing, and canning records as well as favorite recipes.

Harvest and Storage group activity 2:
A Garden Journal (continued)

Experience

1. Explain to the youth that this activity is about keeping records. They have an opportunity to be creative and design their own kind of record.
2. Ask youth to recall events in their garden in the past two or three years. Remind them that a lot happens in a garden, not just planting seeds and harvesting. Explain that records can be great resources, especially if kept for several years, and many successful gardeners do just that.
3. Review some examples of the type of records youth can keep.
4. Ask youth how they would organize their record-keeping. Discuss if anyone knows a gardener—a grandparents or neighbor, for example— who keeps records and the type of records they keep.
5. Explain that many successful gardeners keep a notebook, ring binder, or file near the place they store garden tools. It may contain the garden plan along with:
   - Planting and harvest dates
   - Notes on the cultivars planted
   - Reminders for next season's garden
   - Rainfall amounts
   - Weather conditions

   Some gardeners cut up the seed catalog and use the plant descriptions as part of their permanent gardening notes.
6. Suggest the following ideas for a personal garden journal.
   - Youth can use any notebook as a journal and decorate it, if they wish. They might glue pictures of vegetables and flowers cut from magazines, seed catalogs, or old greeting cards; draw illustrations; or use stickers of vegetables, flowers, birds, butterflies, etc. to create a garden scene.
   - To keep the decorated notebook from getting wet or dirty, cover it with a piece of clear adhesive shelf paper found at hardware stores. Youth can keep pencils and markers in a zippered pencil pouch right in the notebook. Suggest they add some pocket pages for seed packets and magazine clippings, too.
   - The journal could begin with a garden map or plan showing planting location and dates, if possible. The youth can add photos or drawings.
   - Youth who are using a loose-leaf ring binder can organize it by month, day, or section; for example, assign one page for each vegetable in the garden.
   - Youth may record monthly activities in the garden and/or make daily entries. If they choose to organize by month, they can use plastic index tabs or pages from a calendar to label them. One good idea is to keep an extra page or two for each month to write down personal thoughts and ideas, or to draw pictures of the garden. Every month the gardener writes:
     - What seeds were planted, and when
     - Other things that were planted, when and where
     - Which seeds sprouted, and when
     - Which plants bloomed first, and when
     - How many vegetables were picked, and when
     - Height of the full-grown plants; did they have enough room where they were planted?
     - Which days the garden was watered
     - When the garden was fertilized, and what kind of fertilizer
     - Plants that were pruned
     - The visitors that came—birds, bees, butterflies, and others
     - Problems with garden pests, and what was done
     - Weather—when did it rain or frost? What were the high and low temperatures?
     - Any other information
   - Youth who assign one page to each vegetable in their garden could jot down any interesting or important facts they hear or read about under the entry for that particular vegetable. This sort of personal record book contains the best ideas of authors and experts. Consider including on each page:
     - Cutout picture and description of vegetable seeds purchased
     - Yearly record of how well each variety performed
     - Dates of first and last frosts
     - Planting time for each cultivar
     - Quantities harvested for each cultivar
     - Any other ideas they have

     Youth could also add pages for soil preparation, fertilizer use, mulch piles, various pests, cooking methods they used, and favorite recipes. This vegetable-on-a-page journal becomes a reference of unusual value to the gardener. No book has everything an individual wants in it, but a personal garden journal is tailored to the gardener's own garden.

Share

How did you feel about keeping records before you did this activity? After you brainstormed on this activity?
When are records important?

Process

How can a personal garden journal help solve a problem in the future?
What parts of keeping records seemed most difficult?

Generalize

How does recordkeeping help you plan? Solve problems?

What other kinds of records does your family keep? *Medical and dental records, checkbooks, school report cards, etc.*

Apply

How will you change how you keep records to make it easier to complete a record sheet for your next project?
In what other areas of your life will you use recordkeeping to learn from and solve problems in the future?

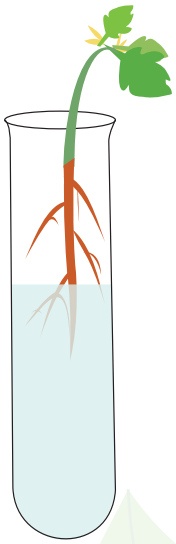
Careers

Background

You can help youth prepare for an exciting, plant-related career. This chart describes undergraduate programs that youth who are interested in gardening might want to pursue at a college or university.

Undergraduate program	Description of career possibilities
Crop protection	Study entomology, plant pathology, weed science, and related areas for employment with chemical manufacturers, distributors, farm management firms, government agencies, and agribusiness.
Entomology	Protect our food supply from pests while working as a pest-control operator, pesticide service representative, extension specialist, taxonomist, or teacher, or in in research entomology or medical entomology.
Environmental soil science	Qualify to be a technically trained specialist to help protect and improve the environment. Demands for environmental scientists will continue to grow with job opportunities in government, environmental consulting firms, public health services, or federal research laboratories. Or prepare for graduate study in environmental sciences, soil microbiology, soil chemistry, and soil physics.
Farm management	Understand the challenges of managing a farm. Work as a professional farm manager for a landowner or on the home farm. Studies production finance, marketing, and management strategies.
Horticultural production and marketing	Learn how to grow horticultural crops and manage greenhouses or nurseries, floral or plant shops, garden centers, orchards, vegetable farms, and farm markets.
Horticultural science	Work in a science-oriented career as a technician in plant breeding, propagation, or research industry; or prepare for graduate studies.
International agronomy	Gain technical and cultural training for international careers in agronomy with commercial companies or with technical assistance or social action agencies such as the Peace Corps.
Landscape architecture	Study the design and construction of land use. Pursue a career in private practice, government, or related land-use areas.
Landscape horticulture	Prepare to operate a landscape construction or maintenance firm, be a grounds manager, or distribute equipment, supplies, or plant materials in the landscape industry.
Landscape horticulture and design	Train for a career in design, construction, installation, and maintenance of landscapes. Work as a grounds manager, small-scale landscape designer, or plant-installation specialist, or be involved in the development, distribution, or sales of equipment, supplies, or plant materials.
Plant genetics and plant breeding	Prepare for research and technical positions in industry, government, or academia. Specialize in plant genetics, which emphasizes biochemistry, plant anatomy, and plant molecular biology; or in plant breeding, which focuses on crop breeding and plant-disease interrelationships.
Plant science	Gain a strong basic education in plant structure, development, physiology, classification, and ecology. Begin a research career or graduate studies in plant physiology, plant pathology, weed science, and plant biotechnology.

Undergraduate program	Description of career possibilities
Public horticulture	Train for a professional position in the public sector in education, therapeutic horticulture, garden writing and editing, or management and curatorial maintenance of plant collections in public gardens and conservatories.
Recreation resources	Work professionally in nature centers, reservoirs, camps, wilderness areas, national parks and forests, state and local parks, wildlife refuges, Bureau of Land Management lands, and private recreation businesses. The three most common entry-level positions are interpretive naturalists, recreation area managers, and planners.
Sales and marketing	Train for a career in professional selling and marketing of agricultural products and services.
Soil and crop management	Use knowledge of soil and crop production to manage land for efficient crop production and advise others on land use and environmental management issues. Work as a soil conservationist, fertilizer or chemical salesperson, soil testing director, seed producer, crop farmer, or Extension educator.
Soil and crop science	Work as a soil scientist, crop physiologist, research agronomist, plant breeder, soil chemist, pollution research scientists, conservationist, or soil physicist who understands plant growth, genetics, soil, crop responses, and classification of land for government agencies, colleges, or private research organizations.
Turf science	Train in chemistry and plant and soil science to work as a park supervisor, turf supply dealer, landscape contractor, teacher, researcher, Extension educator, or manager of golf courses and athletic facilities.



Exploring what careers are really like

Knowing what the work is really like is important to choosing a career. The following activities inform youth about work and careers, and improve chances for youth to reach their goals.

Tell a youth who wants to visit a job site to:

- Plan ahead by arranging a day and time to tour, interview, or job shadow.
- Contact the personnel office if he/she does not know anyone in the company.
- Research the job and the company before going to the job site.
- Prepare questions before going.
- Dress neatly.
- Speak clearly.
- Be on time for the interview, tour, or job shadow.
- Listen carefully and take notes.

Visiting a job site	Description
Informational interview	Meet with someone in a job that you might like; prepare questions about the job and things related to it before going.
Job shadow	Spend time with someone on a job for an inside view; ask many questions and take notes when observing the person; talk with others at the work place about the job.
Workplace tour	View different areas of a workplace; tour with a group, or call and ask to tour with someone from the company.
Volunteer	Gives an idea of what the job is really like; gain experience and learn more information about jobs in that field.

Summary of career activities in the garden project member manuals

The following is a summary of the activities that explore garden-related careers in the member manuals. The "Grow What You Know" and "Dig Deeper" sections of each activity offer more ways to learn about careers.

Level A, See Them Sprout

- Interviewing someone who works at a greenhouse, nursery, or garden center
- Brainstorming careers that deal with vegetables and other plants

Level B, Let's Get Growing

- Learning about growing vegetables for cash at farmers markets, on- and off-farm outlets
- Completing an interest chart on horticulture careers

Level C Take Your Pick

- Brainstorming on horticulture- related careers
- Teaching a topic related to the garden project to younger youth
- Arranging for a speaker to talk about vegetable-related food industry careers

Level D Growing Profits

- Completing a self-analysis
- Understanding the role of a plant scientist by conducting a cultivar resistance trial
- Investigating a garden-related career that is personally interesting

Careers group activity 1: Hear the Speaker

Supplies: paper, pencils

Time required: 20-30 minutes

Preparation

- Arrange for a garden expert to be a guest speaker. This individual could be an Extension professional, garden center staff member, 4-H leader, or local avid gardener. If the speaker would like to have a hands-on demonstration as part of the presentation, consider where this could take place. You might need to arrange transportation for youth.
- Ask the guest speaker about any supplies, materials, and/or video equipment he or she might need.
- Arrange transportation, if necessary.

Experience

1. Before the guest speaker arrives, tell youth about the gardening expert who will talk to them and answer their questions.
2. Ask youth if anyone knows an expert gardener or has had contact with someone who works in a greenhouse or garden center.
3. Brainstorm together on questions to ask the guest speaker.
4. Introduce the speaker to the group, and proceed according to your arrangements.
5. After the presentation, have youth ask their questions.
6. At the next meeting, have youth write a thank-you note to the guest speaker, telling him or her how they will use the information they learned.

Share

What did you learn about gardening?
What surprised you about something the speaker said?

Process

Why is it important to know how to garden?
What would happen if you forgot to weed, water, mulch, or fertilize your garden?

Generalize

You can learn in many different ways: reading about something on the Internet, playing a game, watching a video, listening to an expert, or reading a book.
What are the ways you like to learn?
How can you teach someone what you learned in this activity?

Apply

How will you use what you learned in this activity?
In what other areas of your life will you always be learning?

Careers group activity 2: On the Go!

Supplies: paper, pencils

Time required: One hour plus transportation

Preparation

- Arrange to visit a garden-related business where a representative (assistant manager or manager) can provide a tour and/or talk to youth about the types of garden-related job and career opportunities available there. Ask if some workers could explain their job responsibilities. For more ideas, see Where to Find More Help on pages 80-81.
- Arrange transportation, if necessary.

Experience

1. Tell youth this activity will expose them to job and career opportunities at a garden-related business.
2. Before starting the field trip, ask youth to make a list of questions to ask.
3. At the business, introduce the contact person to your group, and proceed according to your arrangements.
4. After the tour, have youth ask their questions.
5. On the way back, discuss the opportunities that are available, and perhaps list some pros and cons of the jobs and careers the youth learned about.
6. At the next meeting, have youth write a thank-you note to the business representative.

Share

What did you learn from this activity that you didn't know before?
What did you think of this activity?

Process

What reasons or criteria did you use to determine which job you were interested in?
Which job/career sounded like something you would like to do?

Generalize

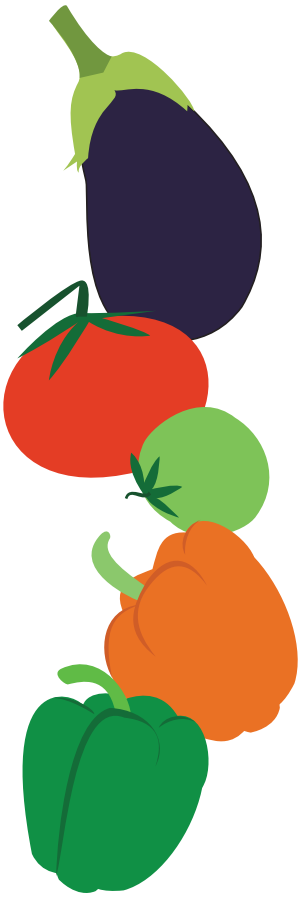
Why is it important to have plenty of information before making a decision?
In what ways do people help each other learn, especially about jobs and careers?

Apply

If you wanted to find out more about a job, how could you do it?
Some possibilities include the following:

- *E-mail a person or company.*
- *Interview a worker at a company where you might be interested in working.*
- *Use online sources to find information related to your interest.*

What did you learn about making career decisions that will help you in the future?



Solutions

This section provides the leader/helper with solutions to problems and answers to questions posed in the manuals. Some questions or problems that have multiple solutions or involve personal feelings are not included here.

Level A

Activity: Seeds Up Close

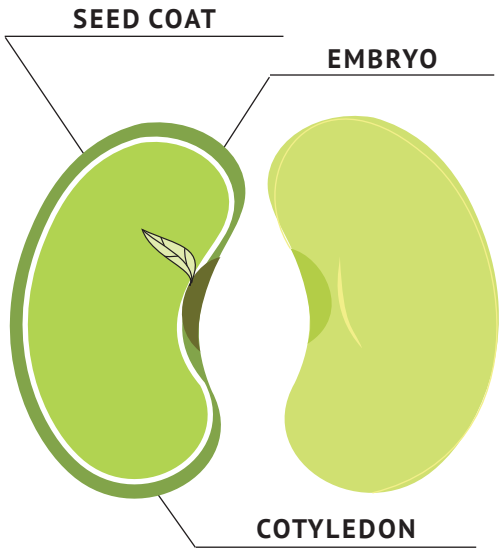
Page 11

Learn what new words mean by matching the words in the list below with their definitions

Seed coat	A tiny plant complete with leaf, stem, and root parts
Cotyledon	To begin to grow; sprout
Embryo	Contains temporary food until the plant can grow up to make food with its leaves
Germinate	Contains the stem and leaves
Shoot	Protects the embryo

What's It All About?

1. Share with your project helper what you predicted would be inside the seed and what really was inside the seed.



2. How did different parts of the seeds change during your week of observation?

When a seed is exposed to water and warmth, water is taken in through the seed coat, and the seed germinates. The youth should observe the seed coat break open. The root emerges first and grows downward. Then the shoot emerges and grows upward.

Dig Deeper

Go on a scavenger hunt in your kitchen to find other examples of seeds. How many different seeds did you find? Sort them by color, shape, size, texture (how it feels), and/or weight. Is the seed size an indicator of the plant size? Why or why not? Give an example.

In the kitchen, it's easy to find seeds inside of vegetables and fruits. Examples are sweet pepper, tomato, cucumber, peach, melon, lemon, orange, grapefruit, pear, and grapes. Seeds that we eat include sunflower, pumpkin, sesame and poppy seeds; green beans, peas, corn, and legumes; and herbs such as dill seed, fennel seed, and mustard seed.

Seed size is not an indicator of plant size. For example, the seed in a peach is large while apple seeds are much smaller. Or compare cucumber seeds and peas. The seeds of the tallest tree in the world, the redwood, are about the size of the head of a pin. The biggest seed is the coconut seed; it grows into a palm tree that is less than half the size of the redwood.

What seeds do we eat? Make a list. The next time you eat a peanut, take a close look at it. It's a seed, too. Find all the parts of a seed. Try to sprout a roasted peanut. What happened?

We eat some seeds because they are already inside the vegetable, like tomatoes, cucumbers, zucchini, and green beans. We also eat sunflower and pumpkin seeds, peas, corn, rice, legumes such as peanuts, lima beans, kidney beans, and lentils.

A roasted peanut cannot sprout a new plant because the cooking process destroys the seed's ability to grow. However, an uncooked peanut could sprout a new plant.

Activity: Plant It

Page 15

What's It All About?

2. Why is it important to know how soil must be prepared before planting a garden?

To have a successful garden. Vegetables do not grow well in hard ground. Certain nutrients might be absent in the garden soil so fertilizers need to be used to supplement it.

Activity: Is It Ready?

Page 20

Grow What You Know

See for yourself the best way to harvest lettuce, spinach, Swiss chard, and other greens. Harvest part of your greens when they're about 3 or 4 inches tall by cutting off the entire plant about an inch above the soil. Harvest another part by picking the outside leaves of the plant. Which method sends up new tender growth? Which leaves taste the best? Which are tougher?

Harvest most greens by cutting off the entire plant about an inch above the soil to encourage tender new growth, which also tastes the best. It's possible to have two or three harvests from a row of lettuce. The outside leaves are tougher because they are older. At harvest, mix older leaves with young, tender ones. Harvest greens like New Zealand Spinach, kale, and collards by picking outside leaves only. These taste best cooked.

Activity: Change It Up

Page 26

Dig Deeper

When Native Americans planted "the three sisters" in mounds, they placed a dead fish under each mound. Investigate why. Where did they get the seeds?

The fish, covered by plenty of soil, rotted and fertilized (fed) the soil. Fish is an excellent source of nitrogen, one of the three nutrients necessary for plant growth. (Phosphorus and potassium are the others.) Today's gardeners can purchase fish emulsion, a mixture to fertilize plants. Some people prefer not to use it because its fishy smell stays around for a couple of days.

Scientists think the ancient corn plant was a tall stalk with one ear at the top and a tassel growing out of the ear. Each kernel was probably wrapped in its own husk or pod, but they grew loosely so they could fall off the cob and plant themselves. Scientists believe the pollen of another grass called teosinte might have fertilized the corn. Hundreds of years later, the plants grew taller and formed larger ears. In time, people in all the Americas were growing different kinds of corn, and Indian tribes planted corn in different ways. Some tribes planted five seeds in a hill; others planted two. Still others planted bean seeds with corn kernels, and some learned to bury fish in each hill to make the soil fertile.

Find out why spacing is so important in these two experiments:

1. Vary the spacing between onion sets in your garden… Record the number of onions in each row, the weight of onions after harvesting, and the biggest individual onion. Which row did the largest onion come from?
2. Count out 60 bean seeds, all the same kind… Watch how the seeds grow. Which shade the ground? How much was harvested from each row?

Bush-type snap beans generally grow best when spaced 2 feet apart in a row. Beans planted closer together will shade the ground more quickly. This can also be an effective weed control method because it blocks sunlight, reducing the ability of weed seeds to sprout.

Activity: Beyond the Stem

Page 29

Grow What You Know

We eat different parts of plants: the fruit, leaves, stem, root, and seed. Match each vegetable to the part of it we eat. Then add the vegetables you grew in your garden to the chart; what part of each of them do you eat?

Vegetable	Parts we eat	Other vegetables (in my garden)
Tomato	Fruit	Cucumbers, eggplant, zucchini, peppers, and various melons
Lettuce	Leaves	Cabbage, other greens, such as spinach, chard, kale
Celery	Stem	Asparagus, rhubarb, kohlrabi, onion
Carrots	Root	Radishes, beets, turnips
Peas	Seed	Peanuts, corn, green beans, kidney and lima beans

What's it All About?

1. Share the results of your mini-experiments with your project helper or friend.

Part 1: Root top garden

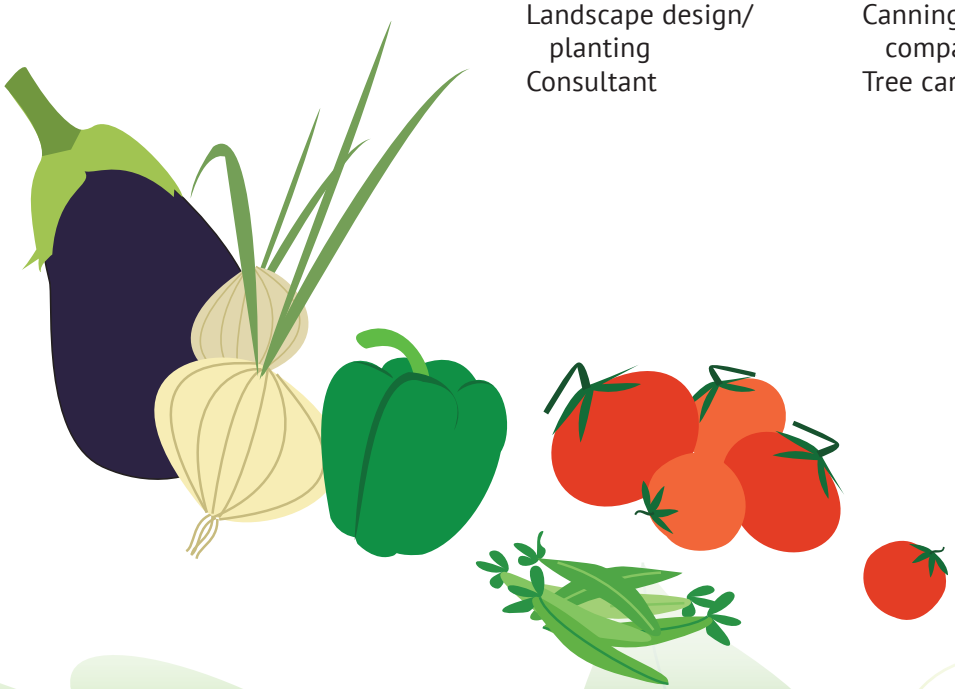
The carrot tops generally produce tiny green stems and leaves. The carrot top is the base of the stem and has a portion of the root on it. It is essentially a complete plant. The root portion contains food for the plant and also supplies the plant with water.

Part 2: Stems alive!
The leaves on the celery stalk standing in the sweet water taste sweet, while those of the celery standing in plain water do not. Water is carried up the stems of plants through tubes called xylem. This is how nutrients in the soil that dissolve in groundwater travel throughout the plant to help it grow.

Youth can see the xylem in the next part of the experiment. The colored water travels up the celery stalk, causing the celery leaves to change color.

Part 3: Look at leaves
The leaf that is covered by black construction paper is paler than the uncovered leaves. Without sunlight to make food, all the food the plant stored in its leaf was used up. Plant leaves are green due to a pigment (chlorophyll) that needs sunlight to make nutrients a plant needs.

Dig Deeper
Page 30
Instead of the celery in part 2, use a carrot and blue food coloring… What part of the carrot is colored? Then cut along the length of the rest of the carrot. Can you see which part of the root carries water and food up the plant?
The xylem tubes are different in carrots than in celery.



Activity: Check out the Veggies

Page 32
What's It All About?
1. What other products made from vegetables did you find in the grocery store?

Answers may vary. In the case of corn, answers could include corn syrup in bread, chocolate, cornmeal, cornstarch, corn chips and other snack foods, popcorn, breakfast cereal (cornflakes), hominy, corn oil, margarine made from corn oil, processed corn (canned and frozen forms), high fructose corn syrup in soda, frozen desserts, medicine, soap, glue, baby powder, and many others.

Activity: Planting Your Career

Page 37
Grow What You Know
Many careers involve vegetables and other plants. Here are a few, but you can probably think of three more.

Researcher
Soil scientist
Horticulturist
Farmer
Teacher
Greenhouse grower
Food processor
Landscape design/ planting
Consultant
Plant breeder
Company sales person
Farm manager
Forester
Florist
Buyer
Pest control service
Canning/freezing companies
Tree care service

Level B

Activity: Plant a Transplant

Page 5

Grow What You Know

Family Name	Common crops	Characteristic
Cruciferae	Broccoli, Brussels sprouts, cabbage, kale, cauliflower, radishes, turnips, kohlrabi	Cool-season vegetables
Cucurbitaceae	Cucumbers, melons, pumpkins, gourds, summer and winter squash, watermelons	Warm-season vegetables
Leguminosae	Beans, peas, dry beans, peanuts	Seeds form in pods
Liliaceae	Onions, garlic, asparagus, leek, shallots	Bulbs or crowns
Solanaceae	Eggplant, peppers, potatoes, tomatoes	Leaves have a similar shape
Umbelliferae	Carrots, parsley, dill, fennel, coriander, celeriac	Tall, feather-like leaves

Activity: On the Move

Page 12

Dig Deeper

This activity describes transplanting by setting a plant vertically straight into the hole dug in the ground. Tomatoes can also be transplanted horizontally! Try both ways yourself to find out why someone would want to transplant horizontally... Which plant blossoms first? Which produced the first harvest? At the end of the season, dig up both plants and look at the root growth along the buried stem. What differences do you see?

Results may differ, but the tomato transplanted horizontally might take longer to start growing than the plant transplanted vertically and so would blossom later. However, the horizontally transplanted plant could produce more tomatoes because the root system is more extensive.

Find out more about the shock of transplanting... Which plants respond best to the shock of transplanting? Which grow fastest? Which produce the first heads?

The plants that had all their leaves pinched off (except for one) respond best to the shock of transplanting, grow fastest, and produce the first heads.

Activity: A-Maze-ing Plants

Page 17

Grow What You Know

The word "vegetable" is really a nonbotanical term that refers to any edible part of a non-woody-stemmed plant... Check off which of the following foods, usually considered vegetables, are really fruits in disguise!

Fruits	Not fruits
Tomato	Lettuce
Eggplant	Celery
Cucumber	Carrot
Zucchini	Potato
Squash	Cabbage
Pepper	Radish
Bean	Spinach
Watermelon	
Pumpkin	

Dig Deeper

What happened to seeds that astronauts took up in space, which has no gravity? What did their experiments with seed germination show? If you can't find the answer, search "seeds in space" online.

Visit the NASA website (www.nasa.gov) to find out what astronauts did on the International Space Station in 2015. For the first time, astronauts ate fresh lettuce grown in space.

Auxins are one kind of plant hormone, a chemical messenger that tells plants to grow in response to the environment. Find out about other plant hormones like gibberellins and cytokinins. What parts of a plant respond to these hormones?

- *Gibberellic acid is produced in the young leaves of plants. It controls stem growth, leaf growth, and root elongation. It is also important in germination for cereal grain seeds like corn and barley. Embryos releasing gibberellins causes food to be released from the endosperm.*

- *Cytokinins are produced in the roots. Together with auxins, cytokinins stimulate cell growth and the production of fruits and seeds. It also slows the process of aging in picked leaves.*
- *Abscisic acid might control root growth response to gravity (geotropism). Gravity causes abscisic acid to collect on the underside of the root and shoot, which react differently to the chemical. It causes the underside of the shoot to grow more rapidly, so the shoot rises up. In the root, the chemical has the reverse effect. It causes the top side of the root to grow more rapidly, so the root grows downward.*

Activity: More Than Seeds

Page 21

What's It All About?

2. Show the results of your experiment to a family member. Ask if this person knows whether most farmers and gardeners grow potatoes from pieces or from seeds. How did he or she answer?

The results of the experiment probably showed the following. Within a week of planting, the potato plants grown from pieces will be tall and sturdy while seeds will be just germinating. Since the potato pieces provide substantial nutrients for early growth, there will be a dramatic difference in growth. Answers from your family members will vary, but be sure to share the experiment results with them!

Activity: Wiggly Farm Acres

Page 24

What's It All About?

2. Why is it important to know that worms have different needs than other garden critters?

The methods you use to control a pest might impact the "good guys." A soil insecticide could also kill off beneficial creatures such as the earthworm.

Activity: What's in a Name?

Page 37

Grow What You Know

Horticulture careers in horticulture can be classified into the 10 areas listed below. Match each area to its related job description by writing the letter in the space provided.

A. *Landscape horticulture*	***H*** Marketing by sales representatives for greenhouse and nursery suppliers; sales for chemical companies; includes fertilizer and pesticide salespersons.
B. *Turfgrass management*	***G*** Teaches and conducts research at universities, including consultants, communicators (writers and educational speakers), and Extension educators.
C. *Floriculture*	***E*** Produces and markets fruits and vegetables for commercial purposes as well as for homeowners and gardeners. Commercial fruit and vegetable production involves storing fresh produce, preserving (canning, freezing, pickling, and drying), and distribut ing products nationally and internationally.
D. *Production of plants and seeds*	***B*** Manages sod production and supervises golf courses, athletic and recreation fields, parks, and private and industrial grounds.
E. *Fruits and vegetables*	***I*** Participates in activities designed to prevent the spread of pests among plants through an inspection service by federal, state, and county inspectors at commercial nurseries, garden centers, and sometimes, field plantings, to ensure that plants are free of certain pests.
F. *Horticulture therapy*	***D*** Breeds and propagates plants at large firms that specialize in developing new cultivars and plant propagation.
G. *Education and research*	***A*** Prepares sites for landscaping (purchasing and planting trees, shrubs, vines, sod, etc.), maintains landscapes, and landscape design, at nurseries, botanical gardens, and other sites.
H. *Horticulture business sales*	***F*** Uses horticulture in therapy for the physical and emotional benefits that result from working with plants. Specially trained people work with those who are emotionally and mentally disabled, senior groups, and troubled youth. Projects may include growing and propagating plants, making flower arrangements, gardening, etc.
I. *Plant inspection*	***J*** Offers many opportunities abroad for individuals with horticultural training, especially in developing countries through private corporations, the Peace Corps, and agricultural assistance programs sponsored by the USDA, private foundations, etc.
J. *International assignments*	***C*** Grows and distributes cut flowers, bedding, and potted plants or markets florist supplies for wholesalers and retailers.

Level C

Activity: Stretch it Out

Page 8

Grow What You Know

Match the season extender with its description

Cold frame	A cover for an individual plant, such as a cone-shaped "hat" or a plastic tunnel-shaped covering that is slit (for ventilation and watering) and suspended over the row; usually has closed ends. Another example can be made from a plastic milk jug with the bottom cut out. (Plastic or glass should not touch the plant.)
Cloche	Sheets of transparent plastic or fabric suspended with metal, plastic, wire, or wooden hoops over a row; the ends are open.
Row cover	Usually a rectangular frame made of wood with a transparent glass or plastic slanting top; can also be tent style or flat-topped.

Dig Deeper

Learn about hotbeds. Why is a hotbed used, and how is it different from a cold frame?

A hotbed is merely a cold frame with electric heating cables buried in the floor. It is useful for germinating seeds early and quickly. Seeds can be sowed directly in the soil above the heating cables, so cool-season vegetables crops can be raised when outdoor temperatures would prohibit it.

Activity: What's Under Your Feet?

Page 14

Grow What You Know

Match the following nutrients with their action

Phosphorus	Helps leaves grow
Nitrogen	Needed in small amounts for health, like vitamins
Potassium	Encourages roots and fruit development
Trace elements	Contributes to overall hardiness and to fighting disease

Page 15

Dig Deeper

Experiment with lettuce and fertilizer. Germinate lettuce seeds in two containers. Give one container fertilizer and the other, no fertilizer. After 20 days, what happened?

The fertilized lettuce should have grown best and have the most leafy growth after 20 days. Note that too much fertilizer can burn the plant. Too much fertilizer is not only bad for plants, but in larger applications such as large crop fields, excess fertilizer can run off into water sources, which can harm aquatic life and us!

Activity: Thyme for Planting

Page 21

Dig Deeper

Make a list of annual, biennial, and perennial herbs.

Annual: *Basil, borage, calendula, chervil, coriander, dill, nasturtium, and summer savory.*

Biennial: *Parsley is actually a biennial herb, but is grown as an annual.*

Perennial: *Catnip, chives, garlic chives, lavender, lemon balm, mints, oregano, sage, tarragon, thyme, winter savory, and yarrow.*

Activity: Acid Basics

Page 24

What's It All About?

2. What color does your indicator (the cabbage juice) turn in acid, such as white vinegar?

Red

In a base, such as a baking soda solution?

Green

Dig Deeper

Investigate what a lab analysis report would recommend you add to soil that is too acidic, and to soil that is too alkaline.

Too acidic: *Lime, in the form of ground limestone, to decrease soil acidity*

Too alkaline: *Sulfur, to increase soil acidity*

Activity: Getting Green

Page 25

Step 7. What colors do you see? Can you explain it?
Analysis shows chlorophyll to be a mixture of several pigments:

- *Green pigments (chlorophyll a and chlorophyll b)*
- *Orange pigment (carotene)*
- *Yellow pigment (xanthophyll)*

Chlorophyll masks the other colors because so much more of it is present in most leaves. Only in the fall, when leaves produce less chlorophyll, do the other colors become visible.

Page 26

Grow What You Know

Can you write out the equation for photosynthesis using only words?
Carbon dioxide and water mix. Chlorophyll absorbs the sun's energy to break down water into hydrogen and oxygen. The hydrogen and carbon dioxide create glucose. This reaction also creates oxygen and water.

Page 27

What's It All About?

2. Explain why the color of leaves changes in autumn.
When leaves stop producing chlorophyll in the fall, other pigments become more prominent, so leaves turn orange, yellow, and red. Chlorophyll normally masks these other colors.

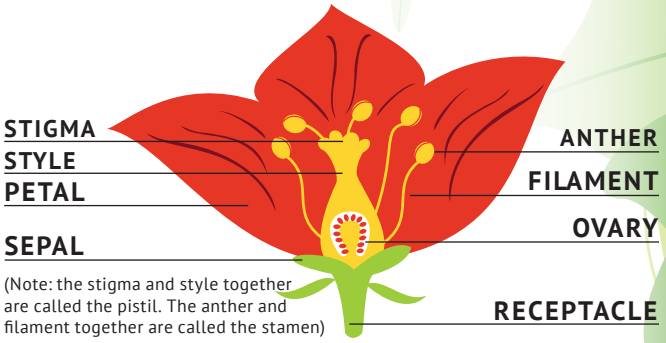
3. Why is it important to understand photosynthesis? What does it mean to life on earth?
Without photosynthesis, there wouldn't be enough oxygen to support life on earth.

Activity: Flower Power

Page 29

Grow What You Know

Label the diagram



(Note: the stigma and style together are called the pistil. The anther and filament together are called the stamen)

Activity: Be a Bug Buster

Page 33

Match each pest to its characteristics by writing its number in the correct space.

6 Larvae tunnel into corn stalks both upward and downward.
9 Brownish with 16 black spots arranged in three rows across the back; larvae are lemon yellow with spines on back; feeds on undersides of bean leaves, eating all but leaf vines.
1 Feeds on leaves, leaving whitish streaks.
7 Oval-shaped beetles that are greenish-yellow with black spots or stripes; likes to eat all parts of cucumber, squash, and melon plants.
8 Green or brown wedge-shaped adults that hop, feeding on undersides of leaves and causing stippling of leaf surface; especially fond of beans; fly off quickly when disturbed.
11 Brownish-black or gray and flat across the back; feeds on vines and fruit of squashes and melons, sucking juices and causing leaves and shoots to blacken and die back.
3 Greenish caterpillar that feeds on cabbages; also called inchworm.
5 Yellowish-orange and black-striped beetles; eats leaves of potato, tomato, and eggplants.
2 Light green to black, striped with a white inverted Y on front of head; feeds in groups on young plants.
4 White larvae of flies that eat roots, leaving plants wilted or stunted.
10 Tiny, spiderlike creatures that spin fine webs, suck juices on undersides of leaves; early damage ap pears as yellow-speckled area on leaf undersides.

Activity: What's With Weeds?

Page 39
Grow What You Know
Think of six ways to water a garden. Two are done for you.
Furrow irrigation – furrows (little trenches) are dug before planting, then filled with water.
Drip irrigation – plastic tubing on the soil surface carries water to individual plants.
Watering can
Soaker hose
Hose-end sprinkler
Hand watering with a hose and sprinkler nozzle

Page 40
Dig Deeper
Learn more about drip irrigation. How would you set up drip irrigation in your garden?
Drip irrigation soaks the soil for individual plants. It's good to use where water is scarce, water pressure is low, and the land is sloping.

Activity: Making Contacts

Page 54
Dig Deeper
Categorize each food industry-related job or career in "Grow What You Know" by its place in the food handler chain—production, processing, marketing, or transportation.
Production: *farmer, inspector, packer at a company*
Processing: *chef/cook, dietitian, restaurant owner, waiter/waitress, food technologist, recipe developer, food processor, home economist, food scientist*
Marketing: *grocery store produce manager, food salesman, food photographer, grocery store owner, food broker, stock person*

Level D

Activity: It's In-Between

Page 9
Dig Deeper
Investigate how companion planting relates to allelopathy. Allelopathy can sometimes be responsible for unexplained poor plant growth.
Allelopathy is the inhibition of seed germination and plant growth by certain plant-produced natural compounds. Plant toxins are usually exuded by roots, but can also be present in varying amounts in stems, leaves, and fruits. Juglone from walnut trees is an example. A garden should be placed more than 50 feet away from a walnut tree.

Activity: All in the Row

Page 12
Dig Deeper
Try this experiment. Tie off two sections in a garden bed with string... What do you notice about the productivity of each plot? Which has more weed growth?
The interplanted cabbage and lettuce plat is more productive and has less weed growth than the cabbage-only plot.

Activity: The Air Up There

Page 23
What's It All About?
1. Share with your project helper how your experiment simulated acid rain. Describe the results.

The most dramatic effects occur with the more acidic solutions; pH 3 (group D) and pH 5 (group C). The evidence is immediate discoloration, curling, and overall stunted growth, followed by the plant dying.

2. What other factors could affect a plant's response in an outside environment?

Weather, including temperature and the duration (how many days) of hot or cold; the amount of rainfall; and humidity.

Activity: Designer Genes

Page 30
Dig Deeper
Find out how seedless watermelons were developed. Hint: It involves a specific type of genetic breeding called polyploidic breeding.
Polyploidic breeding uses chemicals to multiply the number of chromosomes in a plant. Most plants are diploid, meaning they have two sets of chromosomes. When the chromosomes fail to separate as usual during reproduction, fertilization results in offspring with three (triploid) or four (tetraploid) sets of chromosomes. The resulting polypoloids produce very large flowers and fruits.

Activity: Looking Closely

Page 32

Grow What You Know

Match the letter of the plant disease its symptoms.

Plant disease

A. Early blight
B. Anthracnose
C. Bacterial leafspot
D. Clubroot
E. Downy mildew
F. Late blight
G. Mosaic
H. Powdery mildew
I. Rust
J. Bacterial wilt
K. Wilt (fusarium and verticillium)
L. Blossom end rot

D Roots enlarge and swell, often cracking or rotting.
B Dark brown circular, sunken spots on stems leaves, pods or fruit; centers of spots may ooze pink spores.
J Vine plants suddenly collapse from the top down.
L Large brown or black spot on bottom side of all tomatoes: spreads; usually occurs after a hot, dry spell.
K Plant wilts and has darkening veins; leaves may curl upward before they yellow between veins and drop off.
C Brown circular spots with light-colored centers cover leaves, which wither and die.
E Powdery, white to purplish patches appear on undersides of leaf and stems.
I Numerous tiny red or dark brown spots on leaves, stem; leaves turn yellow and die.
F Water-soaked or light spots on lower leaves; then spots turn black, and white growth on leaf under sides is seen; characteristic strong odor.
G Mottled green and yellow leaves or veins; leaves may be wrinkled or curled; fruit is bumpy and misshapen.
H White to grayish powdery growth, usually on the upper surface of leaves.
A Leaves develop brown to black spots with a series of concentric rings like a target; usually appears on older leaves first.

Activity: Save the Best

Page 44

Dig Deeper

What can you do with all the tomatoes that are left on the plants when it frosts?

Cover with a plastic tunnel (cloche) if no other frosts are expected for a while. Or:

- *Pick them for ripening indoors.*
- *Pickle small green tomatoes.*
- *Fry medium-size green tomatoes.*
- *Pull up the entire plant, tomatoes and all, and hang them in a garage or basement that is frost-free.*
- *Store larger ones that are starting to turn color.*

Tomatoes that are stored must be in perfect condition (free from cracks, etc.) or they will rot before ripening. Check them at least once a week, and remove those that have ripened or started to decay. Although setting tomatoes on a sunny windowsill to ripen is popular, it doesn't ripen them properly. They will shrivel and taste bitter, or will be watery and almost flavorless. Instead, store tomatoes in a dry, dark place, like a cardboard box or ice chest, with a few apples. Apples naturally release ethylene gas, which is needed for ripening. Do not store tomatoes where the temperature is below 54°F, which can damage them so they do not ripen normally.

Where to Find More Help (Garden Resources)

The following resources can help answer your vegetable gardening questions.

Books

Visit your local library, favorite bookstore, or website and search for books related to vegetable gardening.

Publications

Purdue University Cooperative Extension Service publications can be found online at hort.purdue.edu/ext/garden_pubs.html. You can also order or download materials from Purdue Extension at The Education Store, www.edustore.purdue.edu.

Planning a Garden

Home Gardener's Guide HO-032, 2007
Organic Vegetable Gardening ID-316, 2002
Collecting Soil Samples for Testing HO-071, 2001
Indiana Vegetable Planting Calendar HO-186, 2009
Container and Raised Bed Gardening HO-200, 2009

Planting a Garden

Tomatoes HO-026, 2001
Growing Cucumbers, Melons, Squash, Pumpkins, and Gourds HO-008, 2001
Leafy Greens for the Home Garden HO-029, 2009
Potatoes HO-062, 2000
Onions and Their Relatives HO-067, 2000
Asparagus HO-096, 2000
Rhubarb HO-097, 2000
Growing Sweet Corn HO-098, 2001
The Sweet Potato HO-136, 2001
Growing Beans in the Home Vegetable Garden HO-175, 2001

Care of a Garden

Managing Insects in the Home Vegetable Garden E-21, 2010
Vegetable Insect Identification E-65, 2010
Common Vegetable Insects of Indiana E-88, 2008
Five Steps to Healthy Garden Tomatoes BP-184, 2012
Blossom End Rot of Tomato Fruit BP-13, 2001
Pumpkin Diseases and Their Control BP-17, 1999
Diseases and Pests of Muskmelons and Watermelons BP-44, 2001
Identifying and Controlling Weeds ($15.00) V-HO-3, 1998

Harvesting and Storage

Storing Vegetables and Fruits at Home HO-125, 2001

Computer Resources

A number of online resources are available to help you plan your garden or learn more about vegetable gardening. If you don't have a personal computer or device at home, visit your local library for Internet access to:

- Check for free online garden planning software or calendars.
- Find local greenhouses and nurseries.
- Locate local garden tours.
- Research new vegetable cultivars.
- Visit gardening blogs.

Magazines and E-newsletters

The following magazines and e-newsletters can be found at newsstands, bookstores, local libraries, or online.

National Gardening Association
www.garden.org

Organic Gardening
www.rodalesorganiclife.com/garden

Fine Gardening
www.finegardening.com

Horticulture
www.hortmag.com

Garden Design Magazine
www.gardendesign.com

Garden Associations

Joining an association or club of people who enjoy gardening is great way to learn more and share your passion for gardening!

American Horticultural Society
www.ahs.org (Search for "Societies, Clubs & Organizations")

Catalogs

One great way to discover new vegetables and discover the latest trends in gardening is to view seed catalogs. There are hundreds of seed catalogs, but here are a few:

J.W. Jung Seed Company
www.jungseed.com

Johnny's Selected Seeds
www.johnnyseeds.com

Burpee Seeds and Plants
www.burpee.com

Gurney's Seed and Nursery
www.gurneys.com

Seed Savers Exchange
www.seedsavers.org

Garden Activity Ideas

The leader/helper's guide includes few supplementary activities that can be conducted at a 4-H club meeting, garden project workshop, or even in a classroom. A list of the activities in all four youth manuals is provided in the Overview section of this manual. The following lists will help you develop your own additional activities. Even more ideas are listed in the Learning Tools to Help Youth section, which follows this one.

Selecting and judging

Identifying varieties and cultivars
Identifying plant parts
Selecting a vegetable cultivar
Constructing the ideal vegetable
Evaluating the garden harvest
Recognizing ripeness and faults
Recognizing disease damage
Recognizing weather damage
Judging a class of vegetables

Management practices

Identifying garden equipment
Setting goals
Making collars around seedlings
Thinning seedlings
Applying mulch
Applying fertilizer
Planning garden management practices
Pulling weeds
Hoeing
Identifying weed seedlings
Watering
Making cloches and row covers
Building a cold frame
Identifying garden friends and enemies
Harvesting techniques

IPM practices

Recognizing a healthy garden
Identifying plant diseases, weeds, and insect pests
Treating diseases
Outlining alternative ways to have a healthy garden
Listing safe ways to deal with pests

Records and recognition

Receiving recognition through 4-H
Understanding garden records
Advancing through your 4-H project
Keeping garden records
Making decision based on records
Selecting cultivars on performance

Mulching and fertilizing

Understanding plant nutrient needs
Formulating a fertilizer
Improving garden production
Evaluating mulches
Identifying and classifying fertilizers
Identifying mulches
Selecting and judging mulches, fertilizers
Fertilizing the garden

Reproduction and genetics

Understanding selection and breeding
Hand-pollination and cross-breeding
Recognizing hybrids
Drawing what happens when a seed germinates
Comparing new products due to biotechnology

Vegetables and byproducts

Judging plates and vegetables
Identifying ways vegetables are sold
Processing vegetables for preservation
Testing cooking or preservation methods
Taste testing unusual vegetables
Finding vegetable byproducts in the home or at the grocery store
Identify vegetable products

Other project activities

Present at a 4-H or other club meeting
Do an action demonstration
Attend a plant/garden show

Learning Tools to Help Youth

As a project leader, you might not have all the knowledge or resources to cover every aspect of gardening, and that's okay! A lot of people in and around your community are probably willing to present or work with your youth to help them learn more about a topic. Youth learn in different ways. Involving additional resources is a way to keep their interest.

Some activities in this manual might not be possible to do at your meeting or group. The following idea starters are designed to let youth use their creativity, imagination, and enthusiasm to create their own activities!

For groups of all sizes

Email-writing campaign about a topic of local interest
Skits, plays, and presentations
Games – original and commercial
Talent shows
Interviews and surveys
Debates and mock trials
Scavenger hunts
Demonstrations
Mentoring younger youth

For individuals and small groups

Create your own:
News article
Blog post
Game
Comic/cartoon
Essay
Poem
Song or rap
Online video
Story
Journal
Photography
Sculpture and art, especially using plant parts
Models and prototypes
Riddles and jokes
Posters

People to involve

Family members
Extension Educators (from all Extension program areas)
Extension Specialists
Other youth organizations (Girl Scouts, Boy Scouts, etc.)
Health care professionals
Pesticide applicators/regulators
Greenhouse owners
School and public library staff members
Teachers
Industry representatives
Park rangers
Government officials
Farmers
Garden supply store owners
Garden bloggers

At places/organizations

County Extension offices
Garden associations
Members' homes
Business offices
Government offices
University and other research facilities
Media stations (television, radio, newspaper)
Garden tours
Local garden clubs
Park and recreation programs
Trade associations
Fairs
Nature centers
Civic clubs
Museums and zoos
State Department of Agriculture
Pesticide companies
Commodity groups (Soybean Board, Corn Board, etc.)
Fertilizer companies

Using things

Internet websites
Blogs
Magazines, books, newspapers
Package labels – seeds, fertilizers
Advertisements
Posters
Maps
Computers, tablets, cell phones
Catalogs

Garden Talk: Glossary

Annual: A plant that completes its whole life cycle in one year or less; its roots do not live to make a new plant the next year.

Anther: One of the male parts of a flower; the top part of the stamen that produces pollen.

Aphid: A tiny brown or green sucking insect usually found in groups on the underside of a leaf or on a stem.

Biennial: A plant that completes its whole life cycle in two years. It grows leaves, stems, and roots the first year, goes dormant over winter, and produces seed the next growing season.

Blanching: Boiling food, such as raw vegetables, for a certain length of time to stop the action of enzymes that otherwise continue to ripen the vegetable; necessary before freezing raw vegetables.

Broadcast planting: Scattering (broadcasting) seeds in a wide row, about 2 to 3 feet across; used for crops that can be eaten when very young.

Bulb: An underground structure made up of a shortened stem that stores food and then makes a new plant during the growing season. Onion and garlic are bulbs.

Burn: Damage caused by applying too much fertilizer to a plant or getting it on its leaves. It injures roots, causes the leaves to brown and wilt, and might kill the plant.

Carbon dioxide: A gas in the atmosphere that plants absorb and use to produce glucose during photosynthesis.

Castings: The waste earthworms leave behind.

Chlorophyll: The green color (pigment) of plant cells that traps and absorbs the energy of sunlight for use in photosynthesis.

Chloroplasts: Structure within a plant cell that contains chlorophyll and in which photosynthesis occurs.

Clay: Very fine soil particles that can be molded when wet, hard when dry, and used to make brick, pottery, and tile.

Companion plants: Certain plants that might be beneficial to other plants if they are planted close to each other; for example, marigolds might help discourage certain insects that bother tomato plants.

Compost: Mixture of rotted plant material from kitchen and garden/yard waste that is rich in nutrients for plants; helps keep soil light and fluffy and can be used as mulch; soil amendment.

Composting: Combining organic materials under controlled conditions so the original raw ingredients change into a rich, dark brown or black complex (humus).

Cool-season vegetable: A vegetable that can be planted either early or late in the planting season when the weather is cool and nights are chilly.

Cotyledon: Part of a seed that contains temporary food for the embryo until leaves form and the plant can make its own food.

Crop rotation: Changing the location of vegetable crops grown in a garden each year to promote soil nutrient balance and prevent disease and insect pest buildup.

Cross-pollination: The transfer of pollen from the anther (male part) of one plant to the stigma (female part) of a flower on another plant.

Crown: The roots and dormant buds of certain one-year-old and other plants, such as asparagus.

Cruciferae: Plant family that includes broccoli and cabbage.

Cucurbitaceae: Plant family that includes cucumbers and pumpkins.

Cultivar: A cultivated variety of a plant.

Cultivate: To dig the soil around plants to let air in and remove weeds.

Cutworm: A caterpillar that cuts off the stem of transplants such as corn and tomatoes at ground level during the night.

Damping off: A fungal disease that results from planting seeds in wet places or too deeply; these seeds might not germinate, or the stem rots at the soil line and the seedling falls over and dies.

Disease-resistant: Refers to plant varieties that have been bred to withstand attack from certain diseases. For example, some tomatoes are labeled VF for resistance to the common tomato diseases verticillium wilt and fusarium wilt.

Drainage: A way for water to move through the soil so a plant does not get too much water.

Ear: The fruiting spike of sweet corn that includes the kernels, cob, and husks.

Embryo: The undeveloped plant in a seed; a tiny plant complete with leaf, stem, and root parts.

Enzyme: A special protein found in small amounts in all plants; promotes ripening in fruits and vegetables.

Eye: The bud of a potato tuber.

Fertilization: In plants, the fusion of male pollen with a female ovule inside the ovary, resulting in seeds surrounded by a fruit.

Fertilizer: Plant food, or nutrients, added to soil to help plants grow better; can be organic (rotted manure, plant materials, etc.) or inorganic (manmade chemicals). The three main nutrients in fertilizers are nitrogen, phosphate, and potassium, known by their chemical symbols N, P, and K, respectively.

Filament: The stalk of the stem of the stamen, the male part of a flower.

Flower: The reproductive structure of a plant that produces seeds.

Fruit: The seed-bearing product of a plant; the part of a plant that develops from the flower's ovary and encloses the seeds. As distinguished from a vegetable, it is usually pulpy, fleshy, and often sweet.

Furrow: A narrow ditch for planting or watering.

Germinate: To begin to grow or sprout from a seed.

Germination: The process by which a seed takes in water and swells, and the embryo (tiny plant inside the seed) begins to grow.

Glucose: A carbohydrate (sugar) produced by plants during photosynthesis. Many glucose molecules join together in long chains to form starch.

Green manure: A crop that is dug into the soil to provide nutrients for soil enrichment; also called a cover crop.

Hand cultivator: A tool used for weeding and breaking up soil in a small area around growing plants.

Hand pollination: Human transfer of pollen from the anther (male part) of a flower to the stigma (female part) of a flower.

Garden Talk (continued)

Hardening off: The process of letting a plant that has been started indoors become gradually accustomed to being outdoors before planting it in the garden.

Hill: A group of seeds planted together in a mounded circle of soil; commonly used with vining plants, such as squashes.

Hoe: A tool used to make planting furrows, cultivate, chop weeds, and break up lumps in the soil.

Horticulture: Deals with developing, growing, distributing, and using fruits, vegetables, nuts, and ornamental plants for gardens, orchards and nurseries; the science and art of finding new ways to grow plants and creating new and better varieties.

Humus: The dark organic materials in soils produced by decaying vegetable or animal matter.

Hybrid: A new plant (an offspring) created by crossing two different strains of a certain plant.

Hypothesis: A guess of what you think will happen.

Imperfect flower: A flower without stamens (female flower) or without a pistil (male flower).

IPM: Integrated pest management, a way of dealing with pests so that chemicals are used only when needed.

Irrigation: Watering with overhead sprinklers, plastic hoses, flooding, etc. to supply crops with moisture.

Kernels: Seeds—actually, one-seeded fruits—of sweet corn that form on a cob.

Leaf: Plant part that makes food for the plant.

Legume: A member of a plant family characterized by a pod-like fruit (legume) and roots bearing nitrogen-fixing bacteria.

Leguminosae: Plant family that includes beans.

Liliaceae: Plant family that includes onions.

Loam: The best kind of garden soil, made up of a balanced mix of sand, clay, and organic matter.

Manure tea: Mixture of manure and water; the resulting brown liquid is a mild, quick-acting fertilizer.

Mulch: A ground cover such as leaves, sawdust, shredded bark, or compost used to keep moisture in the ground and prevent weeds from growing near plants.

Mulching: The process of blanketing the area around growing plants with mulch.

Nightcrawler: Deep-burrowing earthworms that are 4 to 8 inches long and live in permanent burrows 5 to 6 feet deep. They need dead plant material at the surface so are rarely found in plowed fields.

Nitrogen: One of the major nutrients plants need for growth; encourages leafy growth and dark green color; chemical symbol N.

Nitrogen-fixing bacteria: Bacteria found in the soil and in the root nodules of peas, beans, and other legumes that take nitrogen from the air and change it to nitrogen compounds that plants can use.

Nodules: Little lumps on the roots of peas, beans, and other legumes that contain nitrogen-fixing bacteria.

Nutrient: A mineral or chemical element a plant needs for growth, development, or reproduction: nitrogen, phosphorus, and potassium are the major plant nutrients. Plant roots take these nutrients from the soil; compost, manure, and fertilizers replace them.

Organic: Made from things that have been alive or that come from a living plant or animal; can also mean using no chemical additives such as fertilizers or pesticides in the garden up to harvest.

Organic fertilizer: Food for plants originating from other plants, animals, or rocks, rather than chemically manufactured; examples are wood ash, blood meal, and ground lime, respectively.

Ovary: The female part of a flower that contains the ovules that form seeds when fertilized by pollen; the enlarged base of the pistil.

Oxygen: An odorless, colorless, tasteless gas that is necessary for life; produced and released by plants during photosynthesis.

Parent material: Rock from which soil is formed.

Peat moss: Rotted plant material added to soil to loosen it up and/or help it retain moisture.

Perennial: A plant that grows back year after year from the same roots; lives three or more years.

Perfect flower: A flower that contains both stamens (male part) and a pistil (female part).

Perlite: Pieces of a white volcanic rock used in potting soil to help water drain out of it.

Petal: One of the leaves of a plant's flower.

pH: Potential hydrogen, a measure of how acid or alkaline a substance such as soil or water is; tells gardeners if they need to add something to their soil to change the pH. On a scale of 1 to 14, 1 is very acidic, 14 is very alkaline, and 7 is neutral.

Phloem: The part of a plant that moves the food that the leaves make to other parts of the plant, including the roots.

Phosphorus: One of the three major nutrients plants need for growth; encourages development of flowers and fruit as well as root growth; chemical symbol P.

Photosynthesis: Process through which green plants make food using water, carbon dioxide, and energy from the sun.

Phototropism: The bending of a leaf, stem, root, or flower toward or away from a light source.

Pistil: The female part of a flower consisting of the stigma, style, and ovary and growing in the center of the flower; where seeds are produced.

Pollen: The dust-like grains produced by the anthers on the stamens (male part) of flowers to fertilize the stigmas (female part); distributed primarily by wind or insects.

Pollinate: To transfer pollen from the anthers on the stamens (male part) of a flower to the pistil (female part) of a flower in the same flower or another flower.

Pollination: The transfer of pollen from the anthers (male part) to the stigma (female part) of a flower in the same flower (self-pollination) or another flower (cross-pollination); results in fertilization.

Potassium: One of the three major nutrients plants need for growth; encourages root growth; chemical symbol K.

Potting soil: A mixture of materials containing organic matter like peat moss and others that drain water such as perlite or vermiculite.

Garden Talk (continued)

Rake: A tool used to break smaller clods in the soil, smooth prepared soil, and spread soil and organic material.

Red worm: A type of smaller earthworm that is 3 to 5 inches long and usually lives in the top 12 inches of soil, not in permanent burrows.

Respiration: A process constantly going on in every living cell by which food is broken down into carbon dioxide and water with the release of usable energy; the reverse of photosynthesis.

Root: The part of a plant that grows below the ground to anchor the plant and supply water and food to it.

Scoring: Nicking a hard-coated seed (sweet pea, okra, and others) with a knife or nail file to allow the seeds to absorb water more easily so it will germinate; also called scarification.

Seed: The result of fertilization of an ovule with pollen; contained in the fruit.

Seed coat: The outer covering of a seed; provides protection.

Seedling: The first growth stage of a plant; a young plant grown from a seed.

Sepal: A leaf-like part of the outside part of a flower; protects the bud.

Sets: Small onions grown from seed the previous year.

Shoot: The new growth that comes from a seed or the main stem of a plant; contains the stem and leaves.

Shovel: Tool used to dig, turn, scoop, and move soil.

Silks: Portions of the female flowers on an ear of sweet corn that run from the end of the ear to the kernels on the cob; each silk must be pollinated for a kernel to develop.

Soil: The top layer of earth where plants grow, made up of minerals, air, water, and organic matter from plants and animals.

Soil amendment: Organic matter added to soil to improve it; examples include compost, manure, peat moss, and wood products like sawdust and ground-up bark.

Solanaceae: Plant family that includes tomatoes; also called nightshades.

Spade: A shovel with a square end, used to dig soil to an even depth and to move soil.

Spading fork: Tool used to dig and break up lumps in the soil and to spread mulch.

Sprout: To begin to grow or germinate; to send up a shoot.

Stamen: The male part of a flower consisting of an anther and a filament.

Starch: A carbohydrate made up of many molecules of glucose; used to store food energy in plant; also found in stems, such as potato tubers and roots.

Stem: Part of a plant that provides a way for water and minerals to travel from the roots to other plant parts, and for food made by the leaves to travel to other plant parts; also helps a plant stand up straight.

Stigma: The flat-topped knob at the tip of a pistil (female part) of a flower, which receives pollen that causes seeds to develop; the part on which pollen germinates.

Stomata: The tiny pores or openings in plant leaves and stems through which carbon dioxide is absorbed, and water and oxygen is released, during photosynthesis. The singular form is stoma.

Style: The stalk-like middle part of the pistil (female part) of a flower; the tube connecting the stigma to the ovary.

Subsoil: The layer of earth that lies just under the soil on the surface.

Succession planting: Planting seeds in succession or at intervals a few weeks apart to extend the harvest period, rather than planting all at once, so a small quantity of vegetables matures throughout the growing season; good to use with almost any crop.

Tassels: The male flowers of a corn plant; produces pollen (male reproductive cell).

Transpiration: The loss of water through the surface of plant parts, primarily stomata.

Transplant: To plant again in a different place or container.

Transplants: Young plants started from seed and grown indoors; later, planted in the garden.

Treated seed: Seed that has been coated with a chemical to prevent disease from killing it when planted.

Trowel: Tool used to dig small planting holes, dig out weeds, and scoop topsoil.

Tuber: A short, fleshy, and enlarged underground stem or shoot with buds (or eyes); the potato is a tuber.

Tuberous root: A thick, fleshy root like a tuber but having buds present only at the crown (stem end). The sweet potato is an example; the whole sweet potato must be planted to grow a new plant.

Umbelliferae: Plant family that includes carrots.

Variety: A plant that has slightly different characteristics from other plants of its kind. For example, tomato varieties have different color, taste, shape, texture, days to maturity, disease resistance, etc.

Vermiculite: A mineral material used in potting soil to lighten it.

Vining: Describes vegetable varieties that are climbing plants, such as pole beans or peas, usually supported by a trellis, stake, or cage.

Warm-season vegetable: A vegetable that needs hot sun and warm nights and days; plant when a nice, warm spring is already underway.

Watering can: Container used to give plants water.

Wheelbarrow: Type of cart used to move soil, compost, mulch, manure, and other materials.

Wire stakes: Supports that hold up tomato plants and pole beans while they grow.

Xylem: The part of a plant that moves water and mineral nutrients from the roots to the leaves and shoots.

Next Generation Science Standards (NGSS)*

Gardening has many benefits. Youth not only learn to grow their own vegetables and herbs but also gain skills that benefit them in an academic setting.

This section links the 4-H garden project and Next Generation Science Standards (NGSS), making this curriculum a valuable tool for use in the classroom or at home. This chart organizes the standards by grade levels that correspond to each garden manual and its activities. Learn more about the Next Generation Science Standards at www.nextgenscience.org

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Level A, See Them Sprout

NGSS	Youth activity
3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	• Seeds Up Close • Take Time for TLC • Is It Ready?
LS1.B: Growth and Development of Organisms Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	• Plant It!
3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	• The Second-Year Garden
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.	• Beyond the Stem
4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	• Change It Up

Level B, Let's Get Growing

NGSS	Youth activity
5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth, motion and to maintain body warmth) was once energy from the sun.	• Starting from Scratch
5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.	• Let It Rot
5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	• Wiggly Farm Acres
MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	• Let It Rot
MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	• A-maze-ing Plants

Level C, Take Your Pick

NGSS	Youth activity
HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	• Getting Green
HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.	• Be a Bug Buster • When Animals are Pests • What's With Weeds?
MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	• Keep on Planting ("Grow What You Know")
MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	• Getting Green
MS-LS1-4 Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.	• Flower Power
MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	• Acid Basics • What's Under Your Feet?

Level D, Growing Profits

NGSS	Youth activity
HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	• The Air Up There
HS-LS4-4 Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	• Designer Genes
HS-LS4-5 Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	• Designer Genes
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	• The Air Up There

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