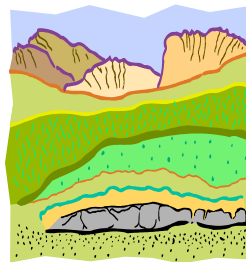


IT CAME FROM PLANTED EARTH

Draft Revision March 2006



Science Experiences and Resources for Informal Educational Settings (SERIES)

California State 4-H Youth Development Program

University of California

**Division of Agriculture and Natural Resources
Human Resources Program
Science, Technology & Environmental Literacy Workgroup**

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- in response to the need for increased science literacy of California's youth and
- families, especially in the areas of agriculture and natural resources.

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WELCOME TO 4-H SERIES

Dear Teen Leader & Adult Coaches,

When I watch news broadcasts or read the newspaper, I continue to be impressed by the enormous importance and ubiquitous nature of science in our daily lives. Scientific discoveries inspire and enrich us, teaching us about the nature of the physical world and our connections to the environment. As we face the challenges of the twenty-first century we find ourselves confronting critical environmental and human issues that require increased scientific literacy. Science literacy has also become the gateway to an increasing number of high-quality jobs.

The 4-H Science Experiences and Resources for Informal Educational Settings (SERIES) is committed to improving the opportunities for teenage and younger youth to explore and learn about their world through the problem-solving and thinking skills of science – what we call sciencing. The 4-H SERIES program and materials are committed to the principle that learning science can be interesting and fun. In 4-H SERIES, you will do more, think more, and learn more about science. Specially trained SERIES teen leaders engage younger youth (ages 9-12) in hands on, inquiry based science activities. Then, as part of the science learning and fun, youngsters design and carry out their own community service project based on the science they have learned.

All the SERIES curriculum units are designed to be presented by teens in an informal setting and in a learn by doing manner. The goal is to have the younger youth observe and experience aspects of the world as they interact with the materials and each other, ask questions, develop ways to find and solve problems using scientific thinking skills, and construct understanding and knowledge in the process. Thus, the youngsters construct knowledge in a way scientists do – by sciencing.

Science is an enterprise made active by our human capacity to think and learn. We invite you to participate in sciencing as a teen leader, an adult coach, or a younger participant. We invite you to learn about the natural world and to explore the idea that knowledge is invented – through scientific investigation you can invent and construct knowledge about the world and the relationships among things in the world. We encourage you to share your discoveries and the joy of sciencing with others.

Sincerely,

Richard C. Ponzio
Director, 4-H SERIES Project
4-H Specialist, Science and Technology
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THE LEARNING CYCLE

In 4-H SERIES Curriculum

Since Socrates' time, and probably even before, teachers have known what we learn best through our own guided investigations followed by thoughtful conversations with others. During the past 30 years, science educators have identified a sequence, known as *the learning cycle* that has proven to be an effective means for learning concepts and processes of science. The learning cycle also has been found effective for developing reasoning abilities and for reducing scientific misconceptions. The learning cycle used in the 4-H SERIES Project curriculum materials involves four distinct types of instruction strategies presented in sequence.

EXPLORATION

Exploration is an introductory activity designed to provide hands-on, direct experiences on which more elaborate understanding and concepts can be built. Participants learn through their own actions and reactions with minimal guidance or expectation of accomplishment. This can be done as an individual investigation or small group work. Usually this exploration accounts for approximately 30 percent of the activity or session in this curriculum.

DEVELOPING THE CONCEPT

Developing the Concept requires a teen leader to guide the participants in sharing and discussing observations they have made during the exploration phase. The discussion usually includes developing or discovering the underlying concept or principle based on individual and group observations, comparisons, or data assessment. The concepts then become part of the experience and background the participants can apply to finding and solving problems. Concept development normally accounts for 20 percent of the activity or session in this curriculum.

APPLYING THE CONCEPT

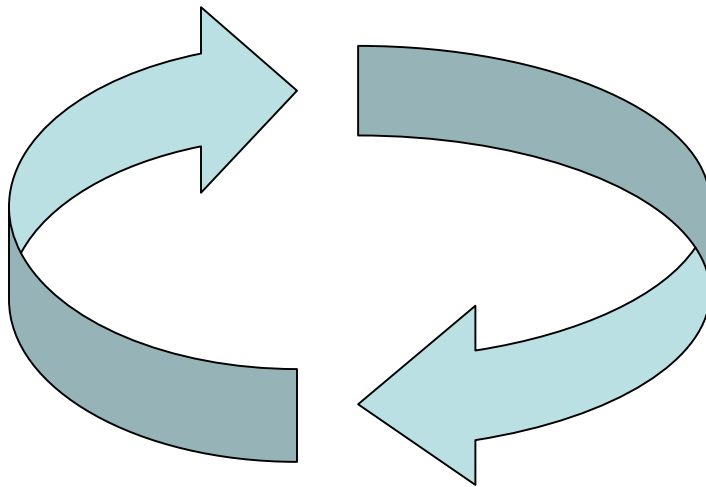
Applying the Concept extends the range of the concept the participants have developed. It provides them with additional time to practice using new concepts and reasoning patterns. The 4-H SERIES projects have shown that learning science involves developing and practicing scientific thinking strategies and decision-making skills rather than just accumulating information about science.

APPLYING THE CONCEPT AT HOME AND IN THE COMMUNITY

Applying the Concept at Home and in the Community is integral to the 4-H SERIES learning cycle because it encourages to improve their homes and communities by applying the science concepts and processes they have learned. In the learning cycle, application activities account for about 50 percent of the educational time.

THE LEARNING CYCLE

1. Exploration



**2. Developing
the Concept**

3. Applying the Concept

Get Ready to Think Like a Scientist!

Good News! Anyone can discover and understand science. Whether you are big or small, female or male, short or tall – all you need is your own exploring mind and the belief that SCIENCE IS FUN!

Underlying all the 4-H SERIES activities are the basic concepts and processes scientists use every day. As a leader, you will be introducing and practicing these with your group.

OBSERVING

Observing is the most basic scientific thinking process. It involves using all of your senses – sight, smell, taste, touch, and hearing – to gather information and construct knowledge about the world and how it works.

Sample: “Using all your senses except taste, describe what you observed as you *looked* at the soils, *heard* when rubbed the soil near your ear, *smelled* when you put your nose to the soil, and *felt* when you touched the soil.”

COMMUNICATING

Communicating is the process by which we create and use language and symbols to share ideas and information with others. We can communicate by using written and oral language to describe observations, events, and data. Video and audio tapes, role-playing and acting, and reports, charts, and graphs are all forms of communication that allow us to share information and ideas with others. Communication lets us learn from the past and share with others in the future.

Sample: “What happened when the soils were allowed to sit after mixing with water?”

COMPARING

Comparing is the process by which we discover, through observation, similarities and differences between ideas or things. To find out more about an unfamiliar object, scientists often compare it to something they know well. Some comparisons may be sensory, such as observing how different things look, smell, taste, feel and sound. Other comparisons may be based on measurements using standard units, such as centimeters, inches, pounds, and liters. When you with things or measure their length or volume to learn more about them, you are making comparisons.

Sample: “Which two soils were most similar? How?”

ORGANIZING

Organizing is the scientific thinking process that deals with patterns of ordering, grouping, and classifying. In this process, we systematically compile, classify and order information that has been observed and compared. For instance, sequencing objects from smallest to largest, lightest to darkest, or first to last involves organization. Grouping and classifying things accordingly to rationale-based properties, characteristics, and relationships is also an organizing task.

Sample: “What categories did the groups use to sort the seed samples? How many other ways can they sort the samples?”

RELATING

Relating is the scientific thinking process that deals with principles concerning interactions. It is the process by which we see relationships between things. These relationships involve interactions, dependencies, and cause-and-effect events.

Sample: “Which soil might a farmer want to have to grow corn? Wheat? Rice? Trees? Why?”

INFERRING

Inferring deals with ideas that are remote in time and space. Inferences are not directly observable or experienced. Based upon your earlier findings, you can begin to recognize and predict general patterns and relationships, thus forming a more comprehensive theory.

Sample: “Does the ratio of sand, silt, clay and organic matter determine the quality of soil?”

APPLYING

Applying is the process by which we use knowledge to solve problems. Inventing, creating, problem solving, and determining probabilities are ways of using current information to gain further knowledge.

Sample: “Which type of soil might be the best for germinating seed?”

The various activities in each 4-H SERIES unit engage participants in the thinking processes and actions typical of those used by scientists. The participants have the opportunity to organize and classify data, predict outcomes, verify predictions, collaborate with others in looking for solutions, and create new and different approaches to doing common things.

IT CAME FROM PLANTED EARTH

Overview of Purpose and Objectives for each Session and Activities

PURPOSE	ACTIVITY	OBJECTIVES
<p><u>FROM THE FIELD TO THE TABLE</u></p> <p><i>To explore the connection between agriculture & food</i></p> <p><i>To understand the process of food production from the farm to the table</i></p>	A: From Wheat to Flour	<i>Participants will use their five senses to learn about wheat and how it is made into flour and related food products</i>
	B: From Flour to Food	<i>Participants will make muffins or another wheat product. They will follow the directions, measure the ingredients, determine the doneness, and enjoy!</i>
	C: From Cream to Butter	<i>Participants will learn the ingredients of butter and how it is made</i>
	D: Growing Wheat	<i>Participants will learn how to grow wheat from seed.</i>
<p><u>SEEDS, SEEDS, AND MORE SEEDS</u></p> <p><i>To use critical thinking skills in observing, identifying, sorting, and classifying different types of seeds and plant parts.</i></p> <p><i>To understand the importance of seeds to agriculture and food production</i></p> <p><i>To encourage participants to eat five or more fruits and vegetables a day</i></p>	A: Sorting Seeds and “Sorta” Seeds	<i>Participants will learn about the importance of sorting and classifying plants to aid in identification</i>
	B: Finding Seeds	<i>Participants will use their five senses to learn about seeds and parts of plants that we eat.</i>
	C: Dispersal of Seeds	<i>Participants will explore how seeds are dispersed in our environment.</i>

<i>PURPOSE</i>	<i>ACTIVITY</i>	<i>OBJECTIVES</i>
<u>GERMINATING SEEDS</u> <i>To understand how seeds germinate</i> <i>To develop and use the experimenting techniques of observing, communicating, comparing, relating, and inferring then applying the new knowledge to understand the variables of germinating seeds</i> <i>To understand the effects of temperature, moisture, light, and depth of the seed on germination and plant growth</i>	A: Looking at Lima Beans	<i>Participants will explore the parts of a seed . . . embryo, seed coat and food storage.</i>
	B: It's Simple as 1,2,3	<i>Participants will grow a crop of "sprouts" to observe and understand the growing needs of plants. We will NOT be eating these sprouts because of food safety issues.</i>
	C: Does Cold, Cool or Warm Air Make a Difference?	<i>Participants will explore at what temperature seeds germinate best.</i>
	D: Can Seeds Be Planted Too Deep to Grow?	<i>Participants will experiment how deep seeds can be planted and still germinate.</i>
<u>SOILS AT OUR FEET</u> <i>To understand the importance of soil to agriculture</i> <i>To understand the composition of soils</i> <i>To explore the relationship of soil type to food production</i>	A: Soil Mysteries	<i>Participants will use their senses of touch, hearing, smelling and seeing to explore the different types of soil.</i>
	B: Soil Soup	<i>Participants will separate soil into the major components (sand, silt, clay and organic matter) by utilizing a simple process.</i>
	C: Downhill Race	<i>Participants will predict and compare how water infiltrates (or enters) and percolates (passes through) different soil types.</i>
	D: I am Soil	<i>Participants will gain a better understanding of the different types of soil.</i>
	E: How Well Does Your Plant Grow?	<i>Participants will experiment with different soil types by germinating seeds and growing plants.</i>

<i>PURPOSE</i>	<i>ACTIVITY</i>	<i>OBJECTIVES</i>
<u>WATER, WATER EVERYWHERE</u> <i>To understand the importance of water to agriculture and plant life</i> <i>To understand how water moves into, through and out of plants</i> <i>To understand the source of water for agriculture</i> <i>To explore the relationship of irrigation practices to food production</i>	A: How Does Water Move in Plants?	<i>Participants will predict and observe how plants react to water and how water travels in plants</i>
	B: Is There Water Underground?	<i>Participants will explore ground water and learn that not all water is visible on the surface. Terminology is water table, ground water, aquifer, artesian well, and spring.</i>
	C: How Does Water Flow?	<i>Participants will observe and compare different methods of irrigation</i>
	D: How Do Radishes Grow?	<i>Participants will become “farmers” and grow radishes and determine how much water is needed.</i>
<u>GROWING FURTHER</u> <i>To gain an understanding of the importance of insects in agriculture.</i> <i>To gain an understanding of what is DNA (deoxyribonucleic acid), the basis of genetic engineering or biotechnology</i> <i>To further explore the interface of agriculture, the environment, and urban and rural settings.</i> <i>To further discuss how science and society can affect issues such as land use, biotechnology, water quality and quantity, and sustainable agriculture.</i>	A: Bees & Much More	<i>Participants will gain an understanding of the important role insects play in pollination of plants.</i>
	B: Friend or Foe?	<i>Participants will learn the difference between beneficial and pest insects, and explore a technique of integrated pest management.</i>
	C: Today & Beyond	<i>Participants will learn how to extract DNA for a living thing as the first steps in becoming a genetic engineer.</i>
	D: Agriculture and Society	<i>Participants will explore how agricultural and society interface in the production of safe, wholesome food and clothing and shelter. Issues identified are biotechnology, land use, sustainable agriculture, and water quantity and quality.</i>

IT CAME FROM PLANTED EARTH

The School Contents Standards for Science for each Session and Activity

California's State Board of Education has adopted a standards-based education approach. They have issued content standards that state explicitly the content the students need to acquire at each grade level. Standards cover the content areas: English and Language Arts, Mathematics, History and Social Sciences, Science, and Visual and Performing Arts. It Came From Planted Earth has been reviewed for alignment with the content standards for science for grades fourth through sixth. For more information, go to <http://www.cde.ca.gov/>.

SESSION	ACTIVITY	Grade Four Standard #	Grade Five Standard #	Grade Six Standard #
<u>FROM THE FIELD TO THE TABLE</u>	A: From Wheat to Flour	2, 3, and 6	6	6 and 7
	B: From Flour to Food	6	1 and 6	6 and 7
	C: From Cream to Butter	6	1 and 6	6 and 7
	D: Growing Wheat	2, 3, and 6	2 and 6	6 and 7
<u>SEEDS, SEEDS, AND MORE SEEDS</u>	A: Sorting Seeds and "Sorta" Seeds	6	6	6 and 7
	B: Finding Seeds	2	6	6 and 7
	C: Dispersal of Seeds	2, 3, and 6	6	7

<u>GERMINATING SEEDS</u>	A: Looking at Lima Beans	2, 3, and 6	6	5 and 7
	B: It's Simple as 1,2,3	2, 3 and 6	6	5 and 7
	C: Does Cold, Cool or Warm Air Make a Difference?	2, 3 and 6	6	5 and 7
	D: Can Seeds Be Planted Too Deep to Grow?	2, 3 and 6	6	5 and 7
<u>SOILS AT OUR FEET</u>	A: Soil Mysteries	4, 5, and 6	6	2 and 7
	B: Soil Soup	4, 5 and 6	6	2 and 7
	C: Downhill Race	4, 5, and 6	6	2 and 7
	D: I am Soil	5	6	2
	E: How Well Does Your Plant Grow?	3, 5 and 6	6	5 and 7

<u>WATER, WATER EVERYWHERE</u>	A: How Does Water Move in Plants?	6	2, 6	5 and 7
	<i>B: Is There Water Underground?</i>	5 and 6	3, 6	5 and 7
	C: How Does Water Flow?	5 and 6	3, 6	5 and 7
	D: How Do Radishes Grow?	3 and 6	6	5, 6 and 7
<u>GROWING FURTHER</u>	A: Bees & Much More	3 and 6	6	5 and 7
	B: Friend or Foe?	3 and 6	6	5 and 7
	C: Today & Beyond	2, 3 and 6	6	5 and 7
	<i>D: Agriculture and Society</i>	6	6	5 and 7

IT CAME FROM PLANTED EARTH

An Introduction

WHAT IS AGRICULTURE?

Agriculture is the science, art and occupation of cultivating the soil, producing crops and raising livestock. Agriculture is the very basis of civilization. It is the food we eat, the clothing we wear, the material of our homes, the gardens around us, and many of our traditions and values.

The term also includes the financing, processing, marketing, and distribution of agricultural products; farm production supply and service industries; health, nutrition and food consumption; the use and conservation of land and water resources; development and maintenance of recreational resources; and related economic, sociological, political, environmental and cultural characteristics of the food and fiber system.



In addition to food and fiber, some of the products we use everyday come from plant and animal by-products produced by farmers and ranchers for example:

Health Care:	Pharmaceuticals, ointments, surgical sutures, latex gloves, x-ray film.
Manufacturing:	Adhesives, lubricants, solvents, detergents, polymers
Education:	Crayons, textbooks, chalk, desks, pencils, paper
Personal Care:	Shampoo, lotions, cosmetics, toothpaste, fingernail polish
Construction:	Lumber, paints, tar paper, brushes, dry wall, particle board, tool handles

The partnership continues as farmers depend on industries such as manufacturing for tools and equipment, health care for their families and livestock, construction for their homes and buildings, and computers for tracking market and weather information.

Everyone benefits from agricultural research and operations. Agricultural land provides food and habitat for 75% of the nation's wildlife. Biotechnology or genetic engineering has lead the way in developing new techniques to increase crop yields and farm productivity. In addition, scientists have gained more knowledge about chromosomes and DNA markers through plant research. Research is less expensive and more rapid using plants rather than animals or people.

Transgenic plants have been developed to ensure crop protection against weeds, diseases, and insects using fewer chemicals. Similar research has resulted in new antibodies for immunizations against disease to increase our food supply from animals. Biotechnology promises environmental benefits including protection of water quality, conservation of topsoil, and improvement of waste management techniques and reduction of chemical pesticide usage.

Other research has developed surgical techniques and pharmaceuticals from agriculture that help save lives. Ethanol and new bio-diesels fuels made from corn and other grains are beneficial to the environment and promote energy security. Research on biodegradable plant products that break down easily in landfills benefits the environment. Integrated pest management explores new ways to reduce plant diseases, insect injury and application of chemicals.

The nation's demand for food grew with its population and agriculture became a key player in developing water storage and delivery to provide a steady flow of water for irrigation, flood control, recreation, human consumption and manufacturing.

Cooperation is the key. Neither the farm nor the city can exist in isolation. Instead, the interdependence of the two creates jobs, products, markets and relationships that make our economy and nation strong.

WHY IS IT IMPORTANT FOR CHILDREN TO LEARN ABOUT AGRICULTURE?

Now consider what life would be like if all of the farms vanished one day. What would happen to the food supply? How would you eat your next meal? Many simply go to the stores, buy food products and never think twice about how our food was produced and who produces it. As generations of Americans become more distant from their agrarian origins, fewer and fewer people understand agriculture's importance to society. They do not understand the impact it has on the economy, the balance of trade or jobs close to home or how food and a myriad of other products are produced and processed.



The term “agricultural literacy” means understanding the interdependence between all consumers and agriculture. An agricultural literate person understands the food and fiber system including history and current economic, social, and environmental significance and particularly, its link to human health and environmental quality to all Americans.

In a study of agricultural knowledge of 2,000 elementary, junior, and senior high students in Kansas, which is a major agricultural state, fewer than 30 percent of the students gave correct answers to relatively basic questions (Horn and Vining, 1986). Only 27.3 percent of the elementary students knew that veal is the meat of young cattle; 25 percent of middle and junior high students knew that the sprouting of seeds is called germination; and 10 percent of the senior high school students knew that beef cattle production was the primary industry in Kansas in terms of gross sales. In many cases, the majority of students chose to answer, “I don’t know”.

Given the decreasing farm population and widespread lack of understanding among consumers about the sources of their food and fiber, agricultural education is vitally important to the future of farming and ranching. Increasingly, people with limited agricultural knowledge and background are determining agricultural policy. What the future holds for agriculture will determine the quality of life for all farmers and ranchers, suppliers, food processors, wholesalers, retailers and consumers. All youth, as future voters, will make decisions about agriculture's future.

In addition, all students need an understanding of basic science concepts. There are many opportunities to teach science through agriculture. A common way to capture student interest in science is often by "hands on" activities. Recent efforts in California to reach the goal of "a garden in every school" is designed to give elementary school children an awareness and understanding of science and nutrition through the process of growing and tending a garden.



In summary, although less than two percent of nation's population is directly involved in agriculture production, a healthy agricultural system is vital to everyone's daily life. Agriculture provides the basic necessities of food, clothing, and shelter, yet many of us take for granted the ease with which we obtain these items. Additionally, the important economic impact of agriculture in the California, the United States and the world is often not realized.

"It Came From Planted Earth" provides activities using the scientific process and discussions to gain a better understanding of agriculture. It has been extensively pilot-tested as a useful tool in helping elementary students to begin to gain knowledge about agriculture and its application in the real world.

Each session provides hands on activities for youth to explore agriculture from the beginning seeds to the foods we eat to the importance of water and soil to production. Further exploration is given about current issues in agriculture from biotechnology to organic farming to integrated pest management to urban-rural interface.

The session outline provides an overall purpose and background material. Then, each activity states an objective, materials that will be needed, getting ready, suggested grouping, action steps and sciencing questions. Youth are encouraged to further explore their world with hands-on experiments and community action.

SESSION ONE

FROM THE FIELD TO THE TABLE

PURPOSE

- To explore the connection between agriculture and food
- To understand the process of food production from the farm to the table

BACKGROUND INFORMATION

Now consider what your life would be like if all of the farms vanished one day. What would happen to your food supply? How would you eat your next meal? Many of us simply go to the store, buy food and never think twice about how our food was produced and who produces it. Agriculture is the foundation for the world's food system and the main reason there is civilization. Our ability to grow plants and raise animals in controlled conditions makes possible six billion of us people able to be alive at the same time and for most of us to have some certainty of enough to eat throughout our lives. It also yields fiber for our clothes, and is even a source of automobile fuel and home building materials.

The world of agriculture is huge, complex and fascinating. Because it is so important to our lives, it is important that we know something about it. In the sessions that follow, we will be learning about agriculture from the ground up, exploring some agricultural basics: seeds, soil, and water. In this first session, we will see how plant and animal products become our food.

Wheat, like all grains, is a grass, a relative to lawn grass. Grain crops are the most important sources of human food and domestic animal feed in the world. From wheat, we grind flour to make cereals, bread, cakes, noodles, and many other wheat products. After the wheat is grown, it is harvested (cut), shucked (removal of outer casing), and processed into flour and eventually made into a food product.



The wheat kernel is made up of three basic parts. These are wheat flour, the wheat germ and the bran. If the germ and bran are removed during processing, all that is left is the wheat flour. Wheat flour is often bleached to make it white. When vitamins and minerals are added to the flour, it is known as enriched flour. If the germ and bran are not removed in the processing, the flour is called whole-wheat flour.

Cows worldwide produce milk. There are around 1.3 million cows in the world. A cow produces between 60 and 200 pounds of milk a day. The average cow produces 100 pounds of manure a day. She drinks 15-30 gallons of water a day and eats about 50 pounds of hay, grain and grass a day. Cows weigh from 800 to 2000 pounds. A cow can make milk when she's two years old and after having a calf. A cow must be freshened or have a calf annually to continue making quality milk. Butter is a by-product of cream, which is made from milk. It takes 21 pounds of whole milk to make one pound of butter. Go to <http://webexhibits.org/butter/index.html> to learn more about the history and making of butter.

Butter is actually the fat in milk. Therefore, butter should not be eaten in large quantities. Go to the website <http://mypyramid.gov> for more information about nutrition and activity for better health.



ACTIVITY A: From Wheat to Flour

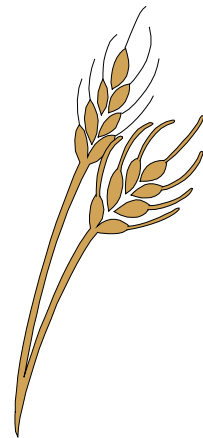
OBJECTIVE: Participants will use their five senses to learn about wheat and how it is made into flour and related food products.

MATERIALS YOU WILL NEED:

Wheat stalks- 3 dozen
Wheat berries also known as wheat seed
Grain mill, coffee grinder or flour sifter, to grind the wheat berries
Bowls - 2 medium
Bowls - 2 small
Plastic tablecloth - 1
Airtight Container - 1 to store the grain
Sturdy table to attach food grinder, if used
Electrical outlet & extension cord, if needed
Activity A: From Wheat to Flour Worksheet, 2 pages
Optional – Other grains, e.g., rye, pearled barley, oats, corn, millet, etc.

GETTING READY:

- Obtain all necessary materials.
- Copy worksheet, one per group or set for all to use
- This activity can be messy so be prepared to sweep up. A tablecloth makes it easier to gather up the fine particles from the wheat milling process.
- If using a manual grain mill, be sure you have access to a sturdy table on which to mount it. Electric grinders may be more convenient, but hand grinding is fun and provides additional learning opportunities.
- Wheat stalks can be purchased at farmers markets or contact a local farmer. Craft stores are expensive but will provide you with a sample if wheat stalk quantities are not available. Wheat berries are often found in the bulk food bins at supermarkets and health food stores. Take care to store grain stalk samples and grains in pest-proof conditions.



Small groups of 3-4 participants. Groups can rotate between the Activities A, B, C and D in this lesson. One group can be learning about wheat, another removing the grain from the wheat stalks, another group grinding of the wheat berries and the last groups cooking the muffins, making butter, or planting wheat seeds. All can rotate so they receive the same experiences.

ACTION (communicating, inferring)

1. Using the Activity A: *From Wheat to Flour Worksheet* let students decide how the farmer grows wheat. What steps are taken? Put the steps in order. Answer the questions on each card. If participants have a different sequence, ask them why they put the steps in that order.

2. Show participants the stalks of wheat. Let children look at a stalk closely.

If you have enough wheat stalks, give each participant a stalk and let youth find the grain. Challenge them to find a way to remove the grain easily.

TIP:

The grain can easily be removed by rubbing a stalk between the palms of your hands.

3. Make flour using the purchased wheat berries. If you have a hand grinder, give each child a chance to crank the handle. Adjust according to the strength of the child.
4. Have the children repeat grinding the grain to suitable fineness of flour by continuing to use a flour sifter and/or grain mill.
5. Try to make enough ground flour for Activity B.

SCIENCING

Communicating and comparing:

- Describe what a wheat stalk looks like?
- Are all wheat stalks the same size? The same color?
- What color is the wheat berry or seed?
- Are all of the berries the same size and color?
- What are the steps to process wheat from the time it is planted until it is flour on the shelf of a store?
- How many times did you grind the wheat berries? Did the flour become finer? Softer? Change color?



Communicating, Relating and Inferring:

- How much of the wheat plant do we use?
- How much bran and germ are in the flours that we buy?
- What happens to the unused components?
- What about the stem, leaves and roots?
- If they rot in the fields, are they wasted and lost?

Relating:

- How much time and energy did it take to grind the wheat?
- What are other ways to grind the wheat?
- How much time do you spend on preparing your food to eat?
- What if we still had to grow and grind our own wheat?
- How would your life be different? Why?

Further SCIENCING (comparing and organizing):

- If available, grind some other grains and compare the raw flours using the five senses.
- Take a sample of the freshly ground flour and compare it to samples of commercial cake flour, bread flour, whole wheat flour, wheat germ and wheat bran.
- Which products are softest?
- Sift the fresh sample. Compare it again with the other products.
- Can you identify the bran and germ?

Answers to Activity A: From Wheat to Flour Worksheet

1. Acquire the proper farm implements and tractor.
2. Prepare the soil.
3. Determine how much seed per acre.
4. Plant the seed.
5. Irrigate the land.
6. Let the seed sprout and grow.
7. Time to harvest the wheat.
8. The harvested wheat is cleaned and dried.
9. The wheat is milled.
10. The wheat flour, bran and germ are taken to a food processor.
11. The wheat products are delivered to the grocery store.
12. The farmer is paid for his wheat.

ACTIVITY A: From Wheat to Flour Worksheet, page 1 of 2

Cut apart and determine the steps of growing wheat. What happens first? What is the correct order? Further discuss each step the farmer must do to grow wheat.

Irrigate the land. How much and how often should you irrigate? What do you do if it rains? Can you grow wheat without irrigation?



Prepare the soil. What would you need? How do you know if the soil is the right type or has the correct nutrients for growing wheat?



Plant the seed. How would you plant 500 acres? By hand? What type of farm implement is needed to plant wheat seeds?



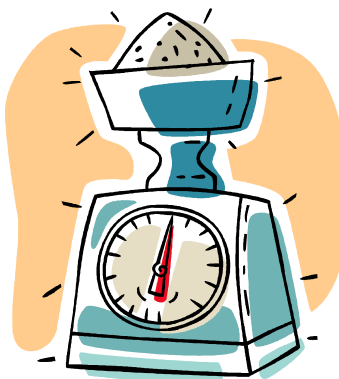
Acquire the proper farm implements and tractor to prepare the soil and plant the seed. Do you buy, lease or borrow? Do you know how to use the equipment properly?



Let the seed sprout and grow. How long does it take for the seed to sprout? What is the germination rate? What factors may affect the growth of the plant?



Determine how much seed per acre. How do you determine? Who do you ask? How do you measure an acre?



ACTIVITY A: From Wheat to Flour Worksheet, page 2 of 2

Cut apart and determine the steps of growing wheat. What happens first? What is the correct order? Why? Further discuss each step the farmer must do to grow wheat.

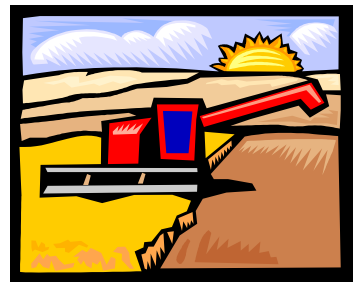
The harvested wheat is cleaned and dried. Why is this important? Are there drying bins in your community?



The wheat is milled. What does the milling process do to the wheat? Name the three raw products.



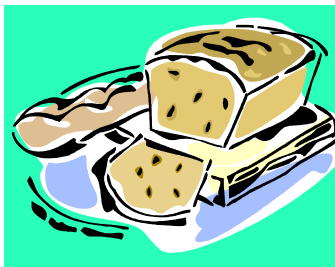
Time to harvest the wheat. How do you know when the wheat is ready to harvest? How do you harvest the wheat?



The farmer is paid for his wheat. What is the price of raw wheat? What are some of the farmer's costs to grow wheat?



The wheat products are delivered to the grocery store. How many items in the store do you think uses wheat as an ingredient?



The wheat flour, bran and germ are taken to a food processor. What happens there?



ACTIVITY B – From Flour to Food

OBJECTIVE: Participants will make muffins or another wheat product. They will follow the directions, measure the ingredients, determine the doneness, and enjoy!

MATERIALS YOU WILL NEED:

Bowl – 1 medium
Bowl - 1 small
Wooden spoon - 1
Toothpicks - 6
Muffin tins or loaf pan
Paper muffin cups- 1 box
Dry measuring cups – 1 set
Measuring spoons – 1 set
Paper towels - 1 roll
Dishwashing detergent - $\frac{1}{4}$ cup
for clean-up
Oven or Toaster Oven

*Refer to Recipes for amount of ingredients
depending on the number of participants.*

Ground Flour from Activity A
Salt
Baking Powder
Oil
Water
Egg
Sugar

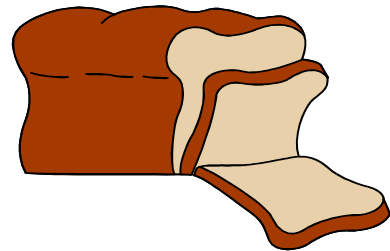
GETTING READY

- Gather all supplies.
- Be familiar with the recipe and try it first. This will help you formulate some questions to generate a discussion with participants.
- Be sure to plan to make enough so that everyone will have a chance to help cook and eat.
- Preheat oven according to recipe.

SUGGESTED GROUPING

Small groups of 3-4 participants. Groups can rotate between Activities A, B, C & D.

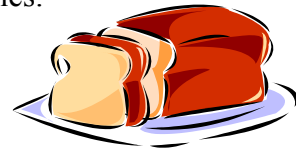
Be sure to prepare the butter, Activity C, the same day for tasting with the baked product.



ACTION (Observing and Communicating):

Make a quick-bread recipe with variations. You may, if you prefer, use your own favorite recipe for a wheat flour product i.e. fruit breads, scones, cakes, cookies.

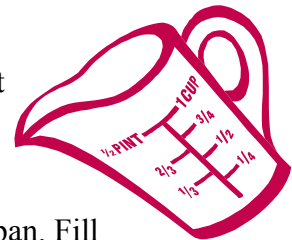
Muffin or Loaf Recipe:



Number of People	Flour	Salt	Baking Powder	Oil	Liquid (water, milk or juice)	Egg	Sugar
8	2 cups	½ tsp	4 tsp.	¼ cup	1 cup	2	¼ cup
16	4 cups	1 tsp	2 Tbsp + 2 tsp	½ cup	2 cups	4	½ cup
4	1 cup	¼ tsp	2 tsp	2 Tbsp	½ cup	1	2 Tbsp
32	8 cups	2 tsp.	5 Tbsp. + 1 tsp	1 cup	4 cups	8	1 cup

Step 1: Preheat oven to 400 degrees.

Step2: Measure and mix all dry ingredients in the large bowl; mix the wet ingredients in another bowl. Pour the wet ingredients into the dry and stir until just moist. Don't over mix or beat batter!

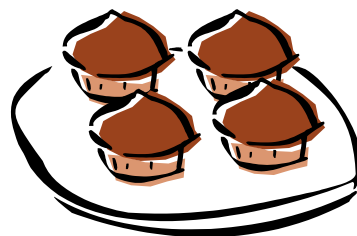


Step 2: Pour batter into paper-lined, greased or Teflon muffin tins or loaf pan. Fill approximately 2/3 full. Place in pre-heated oven (400 degrees F). Baking time will vary depending upon oven, size of tins or loaf pan and size of recipe. Twenty (20) minutes is a good average, but be sure to check often with a toothpick when getting browned.

Step 3: Remove from oven and cool five minutes. Remove muffins or loaf from pans. Serve with butter (Activity C) or spread of your choice. Eat and Enjoy!

Variations:

- ✓ Add raisins, chopped nuts, chocolate chips, grated apple, blueberries, jam in centers, etc.
- ✓ Substitute $\frac{1}{2}$ of the flour to whole wheat flour.
- ✓ Substitute honey for the sugar; use $\frac{3}{4}$ cup honey instead of 1 cup of sugar and slightly reduce the liquid.
- ✓ For biscuits: Cut liquid in half and omit eggs.
- ✓ For pancakes and waffles: Increase liquid by half.



SCIENCING

Observing and Communicating:

- Use your five senses to describe what you observed as you mixed, cooked and ate the food product in this activity.
- Did any of you use different ingredients or amounts of ingredients listed in the recipe?
- Did your final product differ from others? Why do you think that is?

Comparing, Organizing and Relating:

- What functions do the different ingredients serve? Baking powder? Sugar? Flour? Liquid?
- Try substituting non-wheat flours (e.g., corn, rye, oats) using the same recipe given above. Then look up and try a recipe created for that grain. How did the results differ?
- How are the recipes different? Why do you think they are?

Inferring and Relating:

- How do you think recipes are created? How do you determine variations for the recipe?
- How is the baking temperature determined?
- What happens if you use the above recipe and baked it at 200 F for a longer time? Or at 450 F?



ACTIVITY C – From Cream to Butter

OBJECTIVE: Participants will learn the ingredients of butter and how it is made.

MATERIALS YOU WILL NEED

Heavy whipping cream - $\frac{1}{4}$ cup for each group
8 oz glass jar with secure lid - 2 per each group
6 oz paper cups - 1 per participant
Liquid measuring cup - 1
Plastic knives - 5
Crackers, or bread made from Activity B
Refrigerator or Ice Chest with ice
Optional: Seasonings, fruit, jam or jelly
Optional: Marbles - 5
Optional: Lively dance CD or audio tape
Optional: CD Player or tape player



TIP:

Use an ice chest with an ice pack or refrigerator to keep the cream cold until you are ready to use it.

GETTING READY

Obtain all necessary materials. Have at least one group do the activity with the marbles to compare their results with others.

SUGGESTED GROUPING

3-4 participants per group. Groups can rotate between Activities A, B, and C. Be sure to prepare the muffins, Activity B, the same day for tasting with the baked product.

ACTION (Observing, Communicating and Inferring)

Participants will:

1. Pour $\frac{1}{4}$ cup of cream into the jar. Put the lid on the jar tight.
2. Take turns shaking the jar vigorously. They can count how many shakes are taken. After several minutes of shaking, the cream will begin to thicken. *The action of shaking the jar is also known as churning the butter.*
3. Continue shaking the jar until a ball of butter has formed.
4. Open the jar and pour off the liquid into a clean glass. Observe and taste both products.

5. Repeat using one or more of these variations:

Variations: Buy regular cream and churn.
Place a marble in the jars of cream before churning.
Play some music with a lively beat and do a bottle dance while churning.
Add fruit, jelly, jam, or seasonings.



SCIENCING

Observing and Communicating:

- Describe what happened as you shook the cream.

Comparing and Communicating:

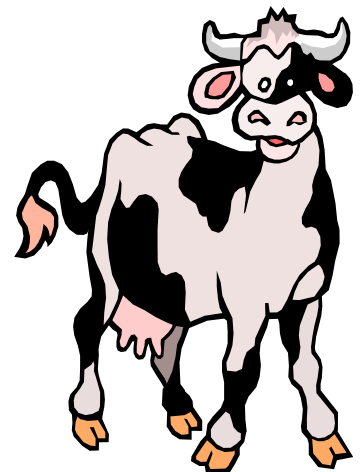
- Was there a difference in the butter from the regular cream and heavy whipping cream?
Was there a difference in time of churning the butter with and without marbles?
- Was there a visual difference in the butter?
- How does your churned butter compare to “store-bought” butter? .

Communicating, Comparing and Relating:

- What is the liquid left with the ball of butter? (Buttermilk)
- How does this buttermilk compare to the “store-bought” product?
- What could make the difference?

Inferring:

- Explain how it might be said that butter is made of grass?
(Cows eat grass, give milk with cream, and the cream is churned into butter.)
- How do you think it was discovered how to make butter?
- How many cups of cream does it take to make one pound of butter?



ACTIVITY D – Growing Wheat

OBJECTIVE: Participants will learn how to grow wheat from seed.

MATERIALS YOU WILL NEED

Wheat seeds – 5 or 6 seeds per participant
8 oz paper cups or other planting containers
- 1 per participant
Potting soil
Water
Plastic pitcher - 2
Masking tape - 5 rolls
Permanent Marking Pen – 5
Optional: Computer with Internet connection



GETTING READY

- Obtain all necessary materials.

SUGGESTED GROUPINGS Individuals or pairs

ACTION (Communicating, Inferring and Applying)

1. Have participants label their planting container with their name and the date.
2. Punch small holes in the bottom of the container for drainage, if needed
3. Moisten soil with water. Fill container $\frac{3}{4}$ full of soil
4. Set 5-6 seeds on top of the soil. Cover with $\frac{1}{2}$ inch of soil.
5. Add more water.
6. Care for the planting at home. Place in a warm sunny location and water, as needed.

7. Record when the seed sprouts, and then record the growth of wheat weekly.
8. Transplant some of your seedlings and/or plant some wheat seeds directly in your garden. Let them grow to maturity.
9. At harvest time, pull one plant and carefully harvest and count the wheat berries. How many seeds did that one plant (i.e., one seed) produce?
10. Carefully harvest and save the remaining plants in order to have them to teach this session to others.
11. Check out the web site: <http://www.wheatmania.com/>. Another site you may find interesting is "Adopt Wheat Field" www.oznet.ksu.edu/pr_aawf/

SCIENCING:

Communicating and Applying:

- If you had to care for an entire field of wheat, what would you have to do?

Communicating, Observing, and Inferring:

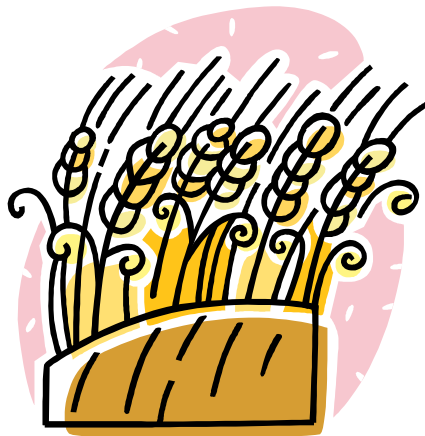
- What could happen that would prevent the wheat seed from sprouting? Growing?
- Do all wheat stalks have the same number of seeds? What makes them different?

Relating and Inferring:

- What are some uses of wheat?
- Are the wheat seed and green plant both edible?
- What type of foods or dishes can you make from wheat?
- How many of you are wearing plants today? What plants?
- How are the plants used in your clothing?

Communicating, Relating and Inferring:

- What crops are grown in our area?
- Why do you think we grow these crops locally?
- What determines why these crops are grown here?
- What other crops does our state grow?
- Are there food processing plants in your community?



SESSION TWO

SEEDS, SEEDS AND MORE SEEDS

PURPOSE

- To use critical thinking skills in observing, identifying, sorting, and classifying different types of seeds and plant parts.
- To understand the importance of seeds to agriculture and food production
- To encourage participants to eat five or more fruits and vegetables a day

BACKGROUND INFORMATION

A first glance a seed may seem small and insignificant. But, seeds are very powerful. In less than 100 days a single kernel of corn can multiply itself over 500 times. Tiny wheat seeds produce field after field of amber waves of grain. The single bean seed develops into a luscious green plant. A huge oak tree starts life as an acorn half an inch long. An apple tree grows from a little pip or seed.

The seed represents our nation's history, livelihood and future. With a handful of seeds, early Americans provided food for their families. Modern researchers today are developing ways to improve our health and environment with a handful of seeds. The most controversial and possibly the most influential, changes in agriculture at the beginning of the 21st century are associated with genetic engineering of agricultural species. This 25-year-old approach to genetic improvement has introduced valuable agronomic traits into some crops and promises many other improvements in our ability to more efficiently raise animals and crops and to generate new and improved agricultural products. Nonetheless, the road to commercializing genetically engineered or "transgenic" product has been and likely will continue to be slow.



The power of the seed is unlimited. From seeds come plants that give food for people and animals, thread for clothing, wood for homes and fuel, and habitat for animals, birds and insects. A world without seeds would be a stark landscape with no life or chance of survival.

Seeds need air, water and warmth to germinate and they need these things in the right order. Not all seeds grow into new plants. Many seeds land in a place where they cannot germinate or are eaten by animals, and eventually they die. Even after germinating, the plant is not safe. For example, lawns that are regularly mowed never get a chance to grow fully and produce seeds.

Seeds are alive. The tiny embryo inside the seed can grow into a full size plant. The seed coat protects the tiny embryo until everything is right to germinate. The length of time a seed is alive depends on how it is stored and the type of seed it is. Some seeds can be stored for only two weeks. Others can be stored for years. Many seeds have been stored for more than 70 years and still germinated! It is best to store seeds in a dry and cool place.

For continued survival, it is very important that the plant scatters its seeds over a wide area. This is called dispersal of seeds. Some seeds are light enough to be spread by the wind. Certain seeds have little hooked hairs that stick onto animal fur or clothing. Many seeds are hidden within attractive fruits so that birds will eat them. The plant naturally disperses others.



People need at least five fruits and vegetables of day for optimum health. Teaching children about where food comes from and helping them explore new foods will encourage them to eat more vegetables and fruits. There are six basic plant parts: roots, stems, leaves, flowers, fruits and seeds. We eat all of these plant parts. Here is a list of plant parts and sample foods.

ROOTS:	onions, carrots, turnip, rutabagas, beets, radish, parsnip, jicama, potatoes, yams
STEMS:	celery, asparagus, rhubarb, nopales (cactus), kohlrabi
LEAVES:	lettuce, spinach, chard, bok choy, cabbage, greens, cilantro, parsley, basil, oregano
FLOWERS:	broccoli, cauliflower, squash flowers, nasturtium, saffron
FRUITS:	squash, cucumber, tomato, pea pods, green beans, grapes, apples, pears, oranges, peppers, eggplant, olives, peach
SEEDS:	nuts, beans, rice, wheat, oats, corn, peas, pomegranate, peanuts

Usually, a fruit is any seed-bearing food on a plant. Therefore, tomatoes, cucumbers, peppers and squash, for example, are actually fruits even though we usually refer to them as vegetables. We also typically identify fruits as high acid foods when vegetables are usually low acid.



ACTIVITY A: Sorting Seeds and “Sorta Seeds”

OBJECTIVE: Participants will learn about the importance of sorting and classifying plants to aid in identification.

MATERIALS YOU WILL NEED

Gallon size plastic bag with zippered closure – 1 for group
Sandwich size plastic bags with zippered closure - 1 per participant or pair
Non-seed items, collection of 10-12 items such as metal nuts, pebbles, jelly beans, shells, noodles, buttons, paper clips, etc.
Assorted seeds, 10 or more varieties - 1 seed variety per person or pair
Examples include varieties of beans, corn, peas, peppercorns, sesame seeds, peanuts, pistachios, walnuts, rice, etc (A soup mix provides a good variety)



GETTING READY

Obtain all necessary materials. For Part A, make a collection of 6-12 non-seed items and 10 seeds in a plastic bag. For Part B, make a seed collection for each person or pair by placing a handful of seeds in each bag. **Hint:** Buy a soup mix with a variety of beans for the basis of the seed collection.

SUGGESTED GROUPING

For Part A, large group or divide into small groups of 3-4 with a seed & non-seed collection for each group. For Part B, groups assigned individually or pairs of participants to encourage participation by all.

ACTION (observing, communicating, organizing and inferring)

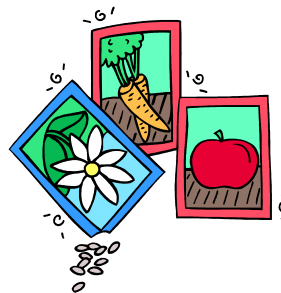
Part A: Group Classifying

1. Place the mixture of seed and non-seed items in the middle of the table.
2. Ask one participant to look at the items and sort them into groups such as big/little, seed/non-seed, food/non-food, etc.
3. Then ask other participants to re-sort them in different ways.



Part B: Sorting Seeds

1. Give each individual or pair one bag of seeds.
2. Spread out the seeds on a flat surface.
3. Observe the seeds carefully. Notice how they are alike and different.
4. Sort them in a different way. Sort them another way. And another.
5. Share findings with others.



SCIENCING

Communicating, Comparing and Applying:

- Explain how you sorted the collections. How did you determine how to sort?
- What knowledge did you need to know?

Inferring and Applying:

- Why is it important to sort and classify plants?
- Does classifying help to determine how plants are related?
- Does classifying help to determine the plants' needs and how they grow?
- What are some other things that are classified in science?

Communicating and Applying:

- What are some non-food seeds that are important to agriculture? (e.g. cottonseeds, ornamental plants, flower seeds, tree seeds, grass seeds for erosion control, etc.)

ACTIVITY B: Finding Seeds

OBJECTIVE: Participants will use their five senses to learn about seeds and parts of plants that we eat.

MATERIALS YOU WILL NEED

A variety of fruits and vegetables with and without seeds, and parts of plants we eat such as tomatoes, apples, zucchini, cucumber, potatoes, seedless and seeded grapes, melons, cherries, lemons, broccoli, corn, peas, carrots, etc.

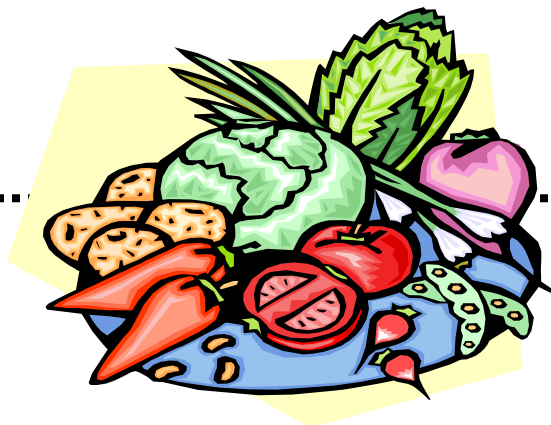
Paper plates- 1 or 2 per group

Clear plastic wrap - 1 roll

Toothpicks - 1 box

Paring Knife - 1 per pair or group

Magnifying glass - 2 per pair or group



GETTING READY

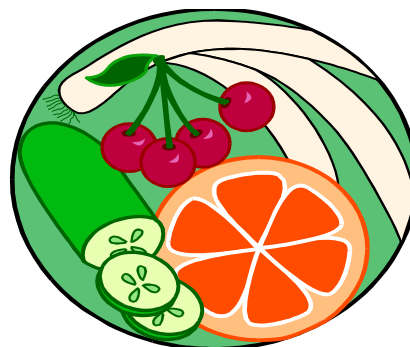
- Obtain all necessary materials.
- Cut the fruit and vegetables into sections so “seeds” can be easily seen, if any. Place an assortment of cut fruits and vegetables on each plate for each group. Cover with plastic wrap.
- If the students are older and able to safely handle cutting utensils, you can have each group cut open their own fruits and vegetables to explore.

SUGGESTED GROUPING:

Pairs or small groups of 3-4 participants.

ACTION (observing, communicating, comparing, and organizing)

1. Have participants look at the samples of fruit and vegetables. Can they find the seeds? Are all of the seeds the same size, color or shape?
2. Ask the participants to sort the samples into categories.
3. Have them explain how they sorted the samples.
4. Are there other ways to sort the samples? Explain.



SCIENCING

Communicating, comparing and organizing:

- What categories did the groups use to sort the samples?
- Why did they choose those categories?
- How many other ways can they sort the samples?

Communicating, organizing, and inferring:

- What parts of the plants do the samples represent?
- What parts of plants are not represented?
- Do we eat all of the plant?
- What parts of the plants do we usually eat?

Communicating, organizing, and inferring:

- How many samples have seeds?
- What samples did not have seeds?
- How do the samples without seeds reproduce?

Inferring:

- Can you identify the sample as a fruit or vegetable by comparing and organizing the samples into the different characteristics?
- What characteristics make the sample a fruit? A vegetable?

ACTIVITY C: Dispersal of Seeds

OBJECTIVE: Participants will explore how seeds are dispersed in our environment.

MATERIALS YOU WILL NEED

Seeds such as bean, corn or pea - 12 seeds per group
Construction paper - 10 pieces per group
Tape – 1 or 2 rolls per group
Glue stick – 1 or 2 per group
Scissors – 1 or 2 pair per group
Pencils - 1 per participant
Collection of materials, 4-5 of each item per group
i.e. rubber bands, toothpicks, balloons, plastic bags,
corks, cotton, feathers, tacks, metal springs, wire.

Extension activity:

Peppers - 1 or more
Knife to cut peppers - 1 or more

GETTING READY

Obtain all necessary materials.

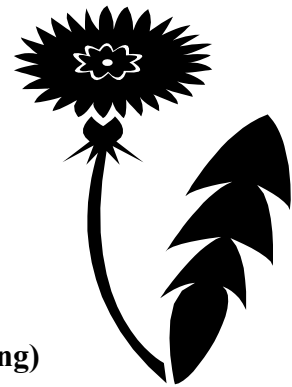
SUGGESTED GROUPING

Small groups of 2-4 participants.

ACTION (observing, communicating, relating, inferring, and applying)

1. Ask participants to share ways that seeds are dispersed in our environment or take a walk to explore ways seeds are dispersed and then share.

We know plants grow from seeds. But, how does a seed get to a certain place? Where did the weed seeds in the garden come? Have you ever seen seeds flying in the air? Floating on water? Being carried by a dog? If you examine seeds, you will see features that help them travel in a special way. This activity will encourage participants to explore and design seeds to travel in different ways?



2. Divide the group into small groups of 2-4 participants.
3. Give each group seeds to be adapted.
4. Ask the different groups to adapt their seed to . . .
 - float on water at least five minutes or
 - attract a bird or animal or
 - hitchhike on an animal or person for 20 feet or
 - fly at least three feet.
5. When dispersal inventions are complete, have groups demonstrate how they work.

SCIENCING

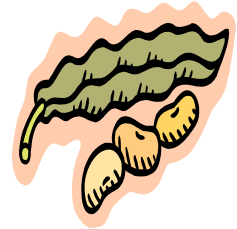
Observing, communicating and inferring:

- What are some ways seeds are dispersed?
- Why do seeds have dispersal mechanisms?
- Predict what would happen if a plant dispersed all of its seeds directly beneath itself?
Could the seeds grow into healthy plants?
- Why do not all seeds become new plants?



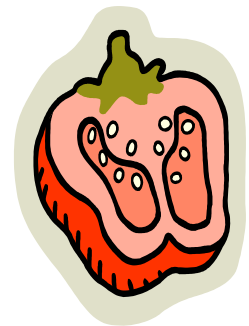
Communicating, organizing, and inferring: (OPTIONAL)

- Take a pepper and cut it open. Count the number of seeds.
- How many pepper plants could grow from the seeds in that one pepper?
- If one pepper produces 30 peppers, how many plants could be grown from all the seeds of those 30 peppers?
- Why don't peppers grow everywhere and cover the earth?



Inferring and applying:

- How does seed dispersal affect farming?
- What practices does a farmer do to decrease the amount of weeds or unwanted plants in his fields? (*mechanical, chemical or integrated*)
- Why is it important to control the weeds in a field growing crops?
(*Weeds create competition for water and nutrients.*)
- Are weeds always not wanted? When are weeds good for our environment? (*Habitat for insects, decrease soil erosion*)



SESSION THREE

GERMINATING SEEDS

PURPOSE

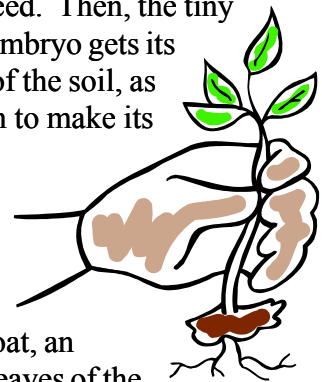
- To understand how seeds germinate
- To develop and use the experimenting techniques of observing, communicating, comparing, relating, and inferring then applying the new knowledge to understand the variables of germinating seeds
- To understand the effects of temperature, moisture, light, and depth of the seed on germination and plant growth.

BACKGROUND INFORMATION

Every seed contains a tiny plant, stored food and is covered by a seed coat. All three of these parts are important. Without them, a plant could not grow out of the seed. The tiny plant inside the seed is called an embryo. The embryo has roots, a stem and leaves. The stored food in the seed gives the embryo energy to grow. The seed coat is a protective layer that protects it until it is time for the embryo to grow.

Seeds need warmth, moisture and air to grow. When these three things are present in the right amounts, the seed will swell and the embryo will begin to grow. This is called germination. Moisture and warmth soften the seed coat. This makes it easier for the growing embryo to break out of the seed. First, the beginning of the root system will push out of the seed. Then, the tiny stem with buds for the first leaves will appear. During germination, the embryo gets its energy from the stored food. After the stem breaks through the surface of the soil, as the leaves open up to the sun and roots take in water, the plant can begin to make its own food.

There are two basic types of plants and seeds, dicots and monocots. “Mono” means one; these plants start life with one leaf, like a grass. “Di” means two; these plants like beans or radishes, start life with two leaves. Monocot and dicot seeds have three things in common; a seed coat, an embryo or baby plant and a food supply. Cotyledons are the initial seed leaves of the plant. Monocots have one seed leaf and dicots have two. When mature, the leaves of monocots are long and thin (lilies, and grasses like corn, wheat and rice); dicots’ leaves are broad (almost all other plants).



Each plant has its own requirements for germination, which includes availability of water and specific temperatures. For some, it is warm rains or a spring thaw, while others require the intense heat of a

forest fire or a flash flood in a riverbed. To continue growth, all plants have the same requirements. They need air, water, nutrients, light, and an optimal temperature. Different plants like differing amounts of water, different types of soil and grow in different temperature ranges. For example, broccoli grows well in cool temperatures but melons need heat. Strawberries like acidic soil, potatoes don't thrive in it. Too much heat and sunlight will make lettuce taste bitter and go to seed; tomato plants won't make tomatoes if they don't get enough light and warmth.

Seeds do best when planted just deep enough, but not too deep. The tiniest seeds often need just a sprinkling of soil over them. Others need to be an inch underground so the roots are anchored solidly. All seedlings need to stay moist at first. Often seeds are planted close together and then later when plants are up and growing they are thinned to an appropriate density. Plants that are left too close together will compete for moisture and nutrients and stunt



each other's

growth. Some plants do not produce seeds. So, how do we grow these plants without seeds? Taking cuttings from a “mother” plant reproduces some agricultural crops. This is also called plant propagation. Some of the methods include rooting plant cuttings (perennial plants); by runners and rootstocks (i.e. strawberries, Kentucky bluegrass, lily of the Nile, buffalo grass); by stem tubers (i.e. Irish potatoes); by fleshy roots (i.e. sweet potato); by bulbs (i.e. onion sets); and starting plants from leaves (i.e. African Violets, hydrangea). Some trees are also grafted; joining a bud of one species to the rootstock of another species. Grafting is a simple method of insuring plants with desired flowering or fruiting qualities. It is usually done during the dormant season. Budding is another form of grafting but is done during the growing season after new growth has stopped.



ACTIVITY A: Looking at Lima Beans

OBJECTIVE: Participants will explore the parts of a seed . . . embryo, seed coat and food storage.

MATERIALS YOU WILL NEED

Lima beans- 15 beans per participant or pair
Plastic bowl- 1 per participant or pair
Paper towels- 1 roll
Water – 1 to 2 gallons
Pitcher- 2
Magnifying Lens – 1 for each pair
Paring Knives (*optional*) – 1 for each pair
Looking at Lima Beans Worksheet, one per pair



GETTING READY

Obtain all necessary materials.

Sample A: Pre-soak lima beans (one per participant) 3-4 days before the activity covered in water. Be sure to rinse and change the water daily.

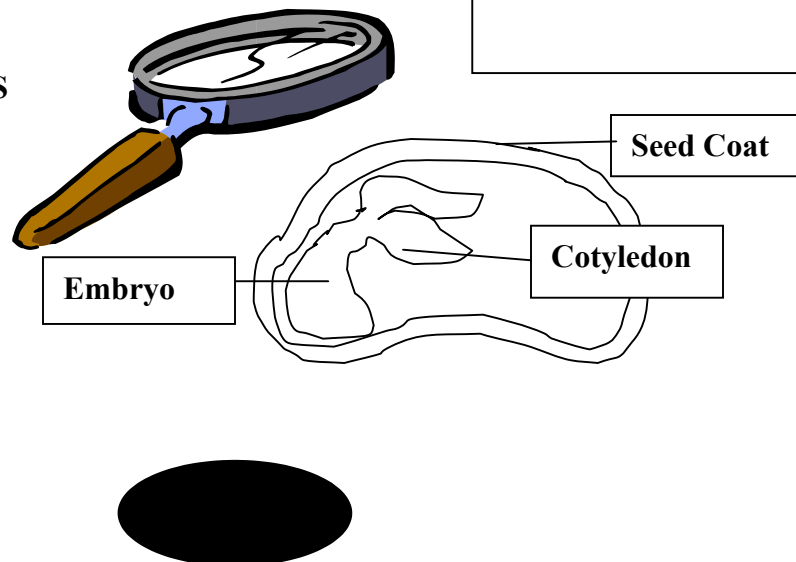
Sample B: Pre-soak more lima beans (one per participant) overnight

Hint:

Purchase 1 pound bags of lima beans in the grocery store; they are less expensive than seed packets and they work well for this activity.

SUGGESTED GROUPINGS

Individuals or pairs



ACTION (Observing, communicating, comparing and inferring)

Part 1:

1. Distribute the following for each participant or pair:
 - 1 un-soaked lima bean seed
 - 1 “Sample A” lima bean seed, soaked 3-4 days
 - 1 “Sample B” lima bean seed, soaked overnight
2. Observe and compare the presoaked lima beans and the un-soaked lima bean.
3. Remove the seed coat from all of the three beans. Notice the differences.
4. Carefully split open the three seeds. Notice the differences.
5. Observe the split soaked seeds. Look for the embryo (young) plant inside. Can you find the leaves, roots, and stem?

Part 2:

1. Give each participant or pair a plastic bowl, paper towels and twelve lima beans, un-soaked.
2. Instruct the participants to fold the paper towel and place it in the bowl. Place the seeds on top of the towel. Add water to moisten the paper towel.
3. Instruct participants to take the bowl of seeds home and care for them. Place the bowl of seeds in a warm sunny location. Keep the towel moist.
4. Tell participants to open one seed each day to observe the new growth and record their observations in pictures or words on the *Looking at Lima Beans Worksheet*.
5. Participants will share their findings at the next meeting.

TIP:

Seeds will stop growing if they are kept too wet or allowed to dry out.

SCIENCING

Observing and communicating:

- What differences did you observe in the presoaked and un-soaked seeds?
- Were there any differences in the smell? Feel?
- How did seeds soaked overnight compare to the seeds soaked 3-4 days?
- What did you notice about the seed coats on the seeds?
- When you split the seed open, what did you see inside?
- Could you recognize the plant parts?

Inferring:

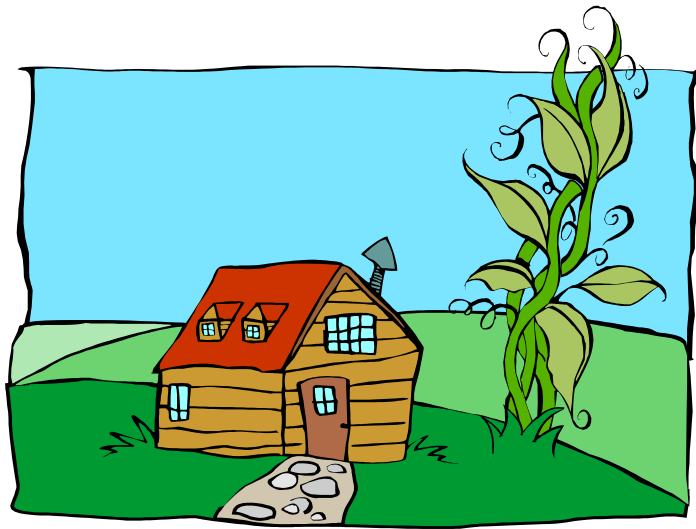
- What do you think the seed coat is for?
- What do you think you will notice each day when you split open a new seed from your bowl?

Observing and communicating:

- At the next meeting, discuss the results of this activity.
- Explain what happened to the seeds and young embryo plant each day.

Communicating and applying:

- What foods do we eat that are germinated seeds?



ACTIVITY A: Looking at Lima Beans Worksheet Part 2

Draw or describe the lima beans each day. Label the parts.

DAY 1:	DAY 2:	DAY 3:
DAY 4:	DAY 5:	DAY 6:
DAY 7:	DAY 8:	DAY 9:
DAY 10:	DAY 11:	DAY 12:

ACTIVITY B: It's Simple as 1,2,3 (Soak, Drain and Grow)

OBJECTIVE: Participants will grow a crop of “sprouts” to observe and understand the growing needs of plants. We will NOT be eating these sprouts because of food safety issues.

MATERIALS YOU WILL NEED

Seeds (Untreated), 1/4 cup per person of alfalfa, mung beans, lentils, cabbage, broccoli, radish, or kale
Clean wide mouth quart canning jar with screw-top ring only - 1 per participant
Cheesecloth, cut 6” x 6” squares -1 per participant
Water - 1 cup per participant
Room thermometer- 1 for large group to share

GETTING READY

Gather all necessary supplies.

When purchasing seeds for sprouting, be sure to get seeds that have not been treated with a fungicide, insecticide or any other materials. This type of seed is available at health food stores and many supermarkets.

SUGGESTED GROUPING

Individually

IMPORTANT!

Do **NOT** eat the homegrown sprouts in this activity!

Since 1995, raw sprouts have emerged as a significant source of food borne illness in the US. These illnesses have involved the pathogenic bacteria Salmonella and E. coli O157:H7. The best conditions for sprouting are also ideal for multiplication of these pathogenic bacteria. Therefore, the US Food and Drug Administration and the California Department of Health Services have issued warning to consumers that children, elderly, and persons with weakened immune systems should not eat raw sprouts.

ACTION (Observing, communicating, and applying)

1. Cover the bottom of the jar with the desired amount of seed, generally NOT more than 1/4 cup.
2. Cover the mouth of the jar with cheesecloth and secure with screw-top ring.
3. Soak the seeds for 8-12 hours in a volume of water at least double that of the seeds.
4. After soaking, drain off the water and rinse the seeds.
5. After the rinse water has been drained off, invert the jar and prop it at an angle so the seeds are evenly distributed along the side of the jar.
6. Keep the jar in a dark place, at 68 F degrees to 70 F degrees.
7. Each day observe the seeds. Continue to rinse the seeds two to four times a day until they have sprouted and grown to the desired length. Always be sure that the excess water is drained off the sprouts. Most sprouts will take two to five days to grow to their optimum size.

SCIENCING

Communicating and inferring:

- Why do the seeds need to be soaked 8-12 hours?
(This will soften the seed coat for sprouting.)

Communicating, observing and inferring:

- Why is it important to drain the sprouts thoroughly?
(If the sprouts remain in the water they could ferment and spoil.)
- Why should we place the jar at an angle?
(By placing the jar at an angle, the sprouts will have good drainage and air circulation.)

Communicating, relating and inferring:

- What would happen if you placed the jar in the light?
(Sprouts grown a lighted or sunny location will turn green)
- Why should we NOT eat our sprouts?
(This is an ideal environment for bacteria to grow; moist and warm with a food source.)

Guide to Growing Sprouts – a list of suggested seed and yield.

Seed	Desired sprout length	Average sprouting time	Amount of seeds used	Amount of sprouts produced	Proper sprouting method
Alfalfa	1- 1½ inches	1-2 days	1 cup	2 ½ cups	Soak & Rinse
Bean	½ - 1½ inches	3-5 days	¼ cup	1 ¼	Soak & Rinse
Cabbage, broccoli, kale, brussels sprouts, cauliflower	½ to 1 inch	3-5 days	¼ cup	1 ¼ cups	Soak & Rinse
Lentil	¼ to ½ inch	3-5 days	1 cup	2 cups	Soak & Rinse
Mung Bean	½ to 3 inches	3-8 days	1 cup	4 cups	Soak & Rinse
Radishes	½ to 1 inch	2-4 days	1 Tbsp.	¾ cup	Soak & Rinse
Soybean	¾ to 1 inch	4-6 days	1 cup	3 ½ cups	Soak & Rinse 4-6 times a day
Wheat	Seed length	4-5 days	1 cup	4 cups	Soak & Rinse

ACTIVITY C: Does Cold, Cool or Warm Make a Difference?

OBJECTIVE: Participants will explore at what temperature seeds germinate best.

MATERIALS THAT YOU WILL NEED

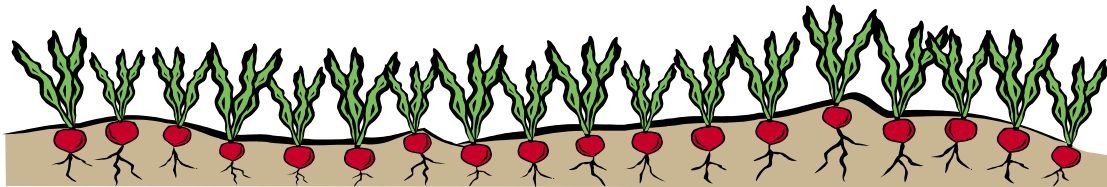
Sponges, 4" x 6", less than 1 inch thick, 3 different colors – 1/3 of a sponge of each color for each participant or group

Water – 1 or 2 gallons

Small waterproof pans or plates, 6" x 6" - 3 for each participant or group

Different types of small seeds, 3 different seeds for each participant
(i.e. radish, lettuce, broccoli, Brussels sprouts, sesame)

"Does Cold, Cool or Warm Make a Difference?" Data Sheet, one per group



GETTING READY

Cut the sponges in thirds to (4" x 2"). Give each participant three different colors of sponges, 4" x 2" each. Now, cut the sponges again in thirds so there are a total of nine (9) small sponges (2" x 1.25") for each participant or group.

SUGGESTED GROUPINGS

Individually, if participants will be taking the experiment home to care for. Or one set if the participants will be able to observe what is happening every 1-2 days.

ACTION (Communicating, and Organizing)

1. Wet all sponges, squeeze excess water.
2. Have each participant sprinkle about 10 radish seeds on three sponges of the same color. Do the same with each type of seed. Be sure to keep the same color of sponge for each type of seed. Try to make the seeds go into the holes of the sponges.
3. Place three sponges, one of each color, on a plate and add water to each container to the middle of the depth of the sponge. Do the same for all three colors of sponges.
4. Place one set of sponges in a warm place like a sunny window sill; another in the refrigerator, and the third on a counter where it is not too warm.
5. The sponges can dry out very quickly, particularly if they are in the sun. Poke the sponge every day to see if it is still wet. If it starts to dry out, add water right away.
6. Use the *How Does Cold, Cool or Warm Make a Difference? Data Sheet* to record what happens to the three different types of seeds in the three different locations.

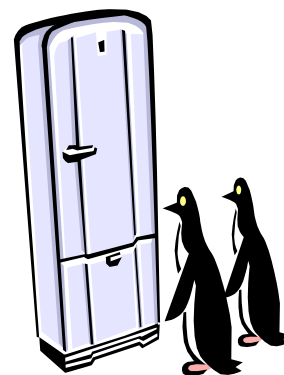
SCIENCING

Communicating, organizing and inferring:

- What do you expect will happen?
- Which seeds do you think will sprout first? Where?
- What did you notice about the environmental conditions in which the seeds were placed? How were they different or similar?
- What did you notice about the rate of germination with your three dishes?

Observing and inferring:

- If the sponge dries out, even for a short time, will this experiment work properly? Why not? (*Being dry even a short time may kill the seed or seedling.*)
- What do you think caused the difference in the rate of germination between the three groups of seeds?
- Is the temperature or light or both that influenced the germination of seeds?



Communicating, comparing, relating, and inferring:

- At the next meeting, share what did happen.
- Did they sprout sooner in a warm growing spot or a cool growing spot?
- Did they sprout in the cold refrigerator?
- Do you think seeds will sprout outside if the weather is cold or there is snow on the ground?
- Do some seeds like different temperatures to sprout?
- Is there a difference between air and soil temperatures?
- How does light affect the seeds germinating?

Communicating and applying:

- What affects does temperature have on a germinating seed?
- How could the change in amount of daylight hours affect the germination rate of plants with respect to temperature?
- How does the weather or climate play a role?
- How does the farmer know when to plant his crop seeds?

Applying:

- What crops are grown in your state or region?
- Why are these crops grown here?
- Is the season and/or weather important to the farmer?
- Does the air temperature affect when the crop will be ready to harvest?



ACTIVITY C: Does Cold, Cool or Warm Make a Difference? DATA SHEET

Record the results of your experiment in the chart below: Make additional pages, if needed.

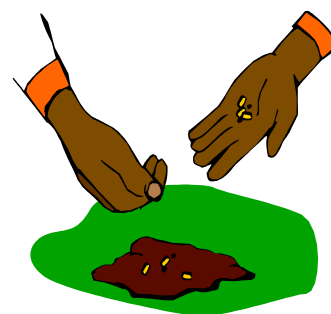
Date of Observation	TYPE OF SEED & Color of Sponge	COLD	COOL	WARM
Date of Observation	TYPE OF SEED & Color of Sponge	COLD	COOL	WARM
Date of Observation	TYPE OF SEED & Color of Sponge	COLD	COOL	WARM

ACTIVITY D: Can Seeds Be Planted Too Deep To Grow?

OBJECTIVE: Participants will experiment how deep seeds can be planted and still germinate.

MATERIALS YOU WILL NEED

Radish Seeds – 30 to 40 per person
Bean Seeds - 10 to 12 per person
Nails – 5 to 6
8 oz Paper or other planting containers - 8 per participant
Water – 1 to 2 gallons
Potting soil – 2 dry quarts
Permanent marking pens - 4
Masking tape - 4 rolls
Pitcher, 2
“Can Seeds Be Planted Too Deep to Grow?” Data Sheet, one per group



GETTING READY

Gather all the necessary materials. If using bean seeds, soak overnight. Wet the potting soil so it is evenly moist. Poke several small holes at the bottom of each cup with a pencil.

SUGGESTED GROUPING

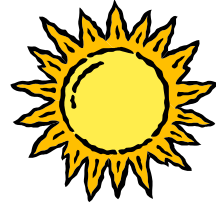
If participants will be taking the experiment home to care for it, do the activity individually. Or one set, if the participants will be able to observe what is happening every 2-3 days for several weeks.



ACTION (communicating, relating and inferring)

1. Fill two containers with 1 inch of potting soil. Place two bean seeds in one container and sprinkle some radish seeds in the other container. Cover with 3 inches of soil. Label as bean or radish and 3 inches.

2. Fill two more containers with 2 inches of potting soil. Place two bean seeds in one container and sprinkle some radish seeds in the other container. Cover with 2 inches of soil. Label as bean or radish and 2 inches.



3. Fill two more containers with 3 inches of potting soil. Place two bean seeds in one container and sprinkle some radish seeds in the other container. Cover with 1 inch of soil. Label as bean or radish and 1 inch.
4. Fill the last two containers with 4 inches of potting soil. Place two bean seeds $\frac{1}{4}$ inch deep in one container and sprinkle some radish seeds in the other container and lightly cover with soil. Label as bean or radish and 0 inches.
5. Add $\frac{1}{4}$ cup of water to each container.
4. Place all containers in a sunny, warm place. Do not let the containers dry out.
7. Keep a record of how the seeds grow.

SCIENCING

Communicating, observing and comparing:

- What do you think will happen? Which seeds will grow first?

Communicating, observing and comparing:

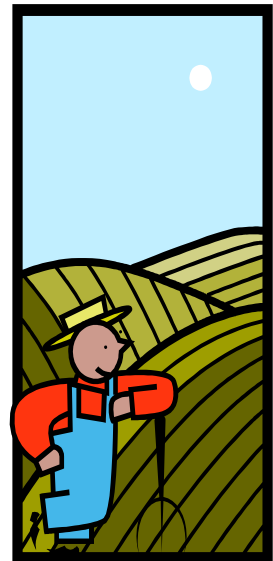
- At the next meeting, share your results.
- Which seed and at what depth started growing first? Second?
- Were there any seeds that do not grow at all?

Inferring and Relating:

- Why did some seeds not grow?
- Did they sprout and then die? Why?

Applying:

- Think about other seeds.
- Does the size of the seed make a difference on how deep you plant it?
- What will happen if the seed is planted too shallow? Too deep?
- How does a farmer know how deep to plant his seeds?



ACTIVITY D: Can Seeds Be Planted Too Deep To Grow? Data Sheet

Record the results of your experiment in the chart below: Make additional pages, if needed.

Date of Observation	Type of Seed	0" or ¼" Depth	1" Depth	2" Depth	3" Depth
	Beans				
	Radish				
	Beans				
	Radish				
	Beans				
	Radish				
	Beans				
	Radish				
	Beans				
	Radish				

SESSION FOUR

SOILS AT OUR FEET

PURPOSE

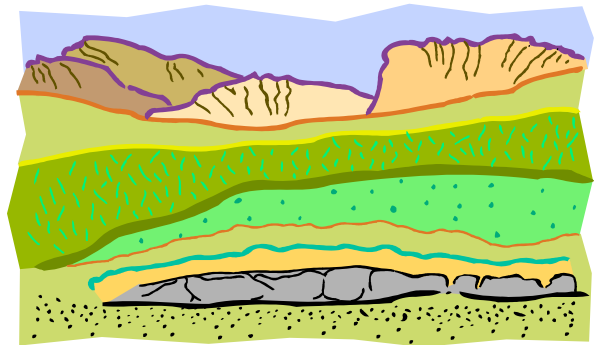
- To understand the importance of soil to agriculture
- To understand the composition of soils
- To explore the relationship of soil type to food production

BACKGROUND INFORMATION

What is soil? Soil is a living, dynamic resource that supports plant life. It is made of different size mineral particles (sand, silt, and clay), organic matter and numerous species of living organisms. Soil has biological, chemical and physical properties that are always changing.

The process of making soils is very slow. Rocks must be weathered and worn down into tiny particles making minerals available, while at the same time organic matter is being decayed and mixed with the minerals to form new soil.

There are only three main types -- clay, sandy and loam soils -- and one very simple way to figure out which is which. Take a handful of soil and squeeze it. If it keeps its shape, you've got clay. If it falls apart and won't hold its shape, it's sandy. And if it holds its shape, but is still crumbly, you have loam.



Clay soils have the smallest particles. They have numerous pore spaces between them and are highly effective holders of both water and nutrients. But small pore sizes also don't allow air and water to move through the soil, so clay soils don't drain very well. As a result, a plant's roots can essentially smother because it can't get any air.

Sandy soils have just the opposite problem because the pore spaces between particles are too large. They drain too well and water and nutrients are leached away before they can do your plant much good.



A good loam is a combination of clay, sand and silt (a medium-sized particle) that holds nutrients well and provides good drainage. A loam soil is ideal for growing most crops; it is about 40 percent silt, 40 percent sand and 20 percent clay. Loam soils retain enough water, yet also allow the soil to drain, for an optimum combination of water and air at a plant's roots.

What does soil do for us? Soil provides a physical matrix, chemical environment, and biological setting for water, nutrient, air and heat exchange for living organisms. Soil controls the distribution of rainfall or irrigation water to runoff, infiltration, storage or deep drainage. Its regulation of water flow affects the movement of soluble materials, such as nitrate nitrogen or pesticides. Soil regulates biological activity and molecular exchanges among solid, liquid and gaseous phases. This affects nutrients cycling, plant growth and decomposition of organic materials. Soil acts as a filter to protect the quality of water, air, and other resources. Soil also provides mechanical support for living organism and their structures.

To improve the quality of soil for agricultural crops, farmers often use soil amendments such as gypsum, lime, sulfur or other materials which, when properly used, make the soil more productive. Other times it may not be practical to alter the composition of the soil by adding amendments. The reason may be the cost, inability to adequate drain, or quantity of irrigation water. The farmer needs to make a laboratory analysis of his soil type to determine the best practices concerning soil amendments, planting seeds, tillage, and irrigation. The farmer can also select crops that can tolerant poor quality soils.

The pH of the soil is important to know because it often determines the amount and type of nutrients that are available to your plants. The pH scale of 0-14 measures the soil's acidity and alkalinity; the lower the number, the more acid the soil and the higher the number, the more alkaline or base. A pH of 7.0 is neutral, but most plants will grow in soils that range from 5.5 to 7.5 pH. Some plants actually prefer an acid or alkaline soil, such as azaleas or rhododendrons which need an acid soil, but in general, the neutral pH is the best for the better.



Most nurseries sell small pH testing kits and many communities also have soil testing labs that can test the soil. Both are inexpensive and helpful, though more accurate results are received from a lab.

As a rule of thumb, remember that areas that receive a lot of rain, like the Pacific Northwest, usually have more acidic soils, and those that don't, like the Southwest, tend to have alkaline soils.

ACTIVITY A: Soil Mysteries

OBJECTIVE: Participants will use their senses of touch, hearing, smelling and seeing to explore the different types of soil.

MATERIALS YOU WILL NEED

Containers of different types of soil: clay, sand, silt and compost
Scoop or garden trowel – 1
8 oz paper cups or lunch size paper bags - 4 per group
Permanent Marking Pen- 1 per group
Spray bottle with Water – 1 or 2
Pencil or pen - 1 per participant
Activity A: Soil Mystery Worksheet - 1 per participant or group

Scoop or garden trowel – 1

8 oz paper cups or lunch size paper bags - 4 per group


Permanent Marking Pen- 1 per group

Spray bottle with Water – 1 or 2

Pencil or pen - 1 per participant

Activity A: Soil Mystery Worksheet - 1 per participant or group

GETTING READY

- Be prepared for some dirt in the classroom or set up to do the activity outside.
 - Obtain all necessary materials.
 - Label cups or bags 1, 2, 3 & 4. Put a few scoops of soil in each bag or cup. Make the same soil mixture in the containers, #2, #3, & #4 for all groups.
- 



SUGGESTED GROUPINGS

Groups of 2-4 participants. With younger children, they can observe, communicate and compare as a group and post the information learned on a flip chart or poster of the Soil Mystery Worksheet. Also, by only distributing one type of soil at a time, the children will be more focused on the lesson. Or you can have only four groups and pass the different soil samples but asking the same information of each.

ACTION (Observing, Communicating and Comparing)

1. Place the four soil samples in the middle of each group.
2. Ask the participants to select one of the bags or cups with soil and note the number of the soil sample.
3. Have them record their observations on the Soil Mystery Worksheet, using their senses of sight, smell, touch and hearing.
4. After observing the soil dry, ask them to place a small amount of soil in the palm of their hand and spray it with water. Now, again, have them record their observations on the *Soil Mystery Worksheet* for each “wet” soil sample.
5. Be sure that at the end of the activity the participants have explored all four soils.
6. Have the participants share their observations with the group by discussing each soil type.

SCIENCING

Observing and Communication:

- Using all your senses except taste, describe what you observed as you *looked* at the soils, *heard* when you rubbed the soil near your ear, *smelled* when you put your nose to the soil and *felt* when you touched the soil.
- Ask the same questions for the “wet” soil samples.

Comparing:

- Which two soils were most similar? How?
- Which two soils were most different from each other? How were they different?
- How do the soil types differ when “wet” versus “dry”?

Inferring and Relating:

- Which soil might a farmer want to have to grow corn? Wheat? Rice? Trees? Why?
- Why is it important to understand how soil reacts to water?

ACTIVITY A: Soil Mystery Worksheet

Observe each soil type using your four senses (seeing, hearing, smelling and feeling) and record using descriptive words.

SOIL #		DRY	WET
1	SEE		
	HEAR		
	SMELL		
	FEEL		
2	SEE		
	HEAR		
	SMELL		
	FEEL		
3	SEE		
	HEAR		
	SMELL		
	FEEL		
4	SEE		
	HEAR		
	SMELL		
	FEEL		

ACTIVITY B: Soil Soup

OBJECTIVE: Participants will separate soil into the major components (sand, silt, clay and organic matter) by utilizing a simple process.

MATERIALS YOU WILL NEED

Four different types of soil - sand, clay, silt and compost or organic matter.
Soil samples from two or more locations or make a mixture of different percents of the above soil types.

Clear quart glass jars with lids, 2-3 jars for each group

Masking tape - 2 rolls

Permanent marking pens - 1 per group

Water, 2-3 gallons

Activity B: Soil Soup Worksheet (page 62)- 1 per participant or group

Pencil or pen - 1 per participant

Optional: Calgon® Liquid or Powder Water Softener

Optional: Baking Soda (Sodium Bicarbonate)

GETTING READY

- Obtain all necessary materials.
- Decide where the soil samples will be taken from. If there is little variety available at the meeting site, you may want to ask participants to bring samples from home and other locations. Label all soil types by number.

SUGGESTED GROUPINGS

Groups of 2 - 4 participants. Each group can explore all soil types or select a minimum of two to observe and compare.

ACTION (Observing, Communicating and Comparing)

Explain to the participants that they will make a “soil soup” and watch what happens. *It will separate soil into the major components (sand, clay, silt and organic matter).*

1. Each group gathers materials needed.
2. Selects a soil sample and notes the number.
3. Label a jar with masking tape with the number of soil sample selected. Fill the jar 1/3 full with the soil sample.
4. Observe the soil contents in the jar. What are their predictions of what will happen when water is added?
5. Add water until the jar is almost full. Place the lid on tightly. Shake the jar vigorously for a couple of minutes to stir up all the clumps and moisten the entire soil sample. Put the jars down and let stand for 5-10 minutes to let the soil settle. Observe what happens.
6. Draw the different layers of the soil sample on the *Activity B: Soil Soup Worksheet*. Share your observations with the group for each soil sample.
7. Select another soil sample and repeat procedure.
8. Going Further: Add 1 tablespoon of Calgon® or 1 teaspoon baking soda to a clay sample; mix well; add water and observe.
9. Compare your observations with the other groups.

TIP:

Do not pick up the jar when making observations or this will stir it up again and delay the settling.

Be patient; wait until the soil has settled.

SCIENCING

Observing and communication:

- Did your predictions come true?
- What happened when the soils were allowed to sit after mixing with water?
- Describe what you observed as you looked at the different soil soups.
- How many layers were formed?
- What did the layers look like?



Comparing:

- How were the soils the same as they settled out? How were they different?
- Which soil type settled the fastest? The slowest?
- Were the bottom layers the same in all the jars? How were they different?
- Were the top layers the same or different?

Comparing and Organizing:

- Using the Activity B: *Soil Soup Worksheet*, organize the soils. Try to organize the soils in different ways.
- What happened to the jar of soil soup with added Calgon® or baking soda? How does it compare to the clay soil samples without the added chemical? Which one stayed suspended the longest? Which one settled the fastest?

(Calgon and baking soda have sodium. The soil will stay suspended much longer in the sodium solution. This technique does not work as clearly with sandy soils.)

Inferring and Relating:

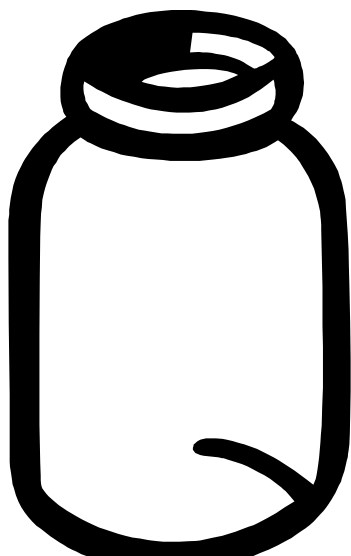
- What do you think would explain the different layers in the jars of settled soil?
- What soil or type of soil might be the best for germinating seeds and growing plants?
- Does the ratio of sand, silt, clay and organic matter determine the quality of soil?
- Why would you want to add chemicals such as sodium to the soil?

ACTIVITY B: Soil Soup Worksheet

Predict what will happen when water is added, mixed, and left to stand. Draw the results.

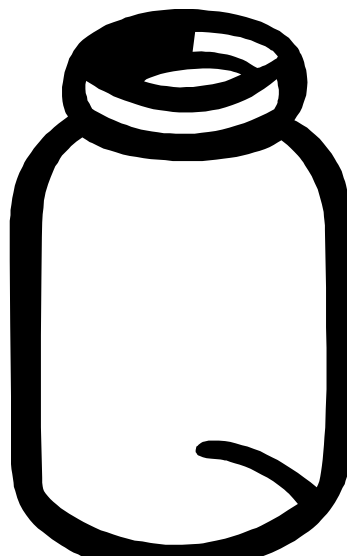
Soil #1

Predication: _____



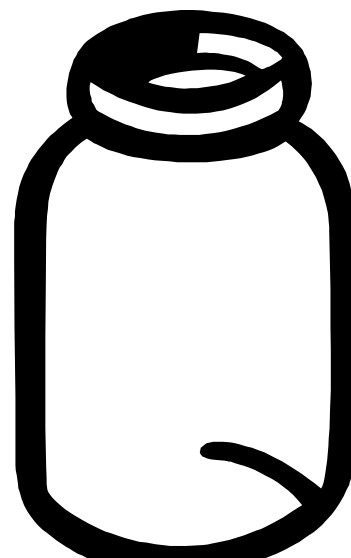
Soil #3

Predication: _____



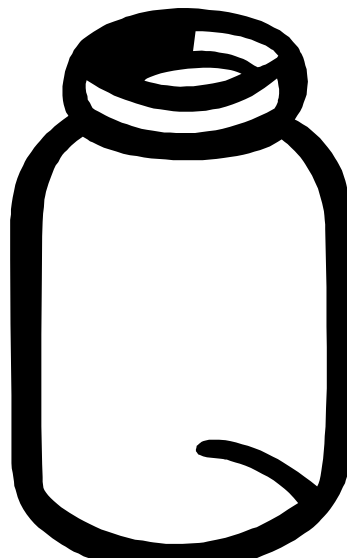
Soil #2

Predication: _____



Soil #4

Predication: _____



ACTIVITY C: Downhill Race

OBJECTIVE: Participants will predict and compare how water infiltrates (or enters) and percolates (passes through) different soil types.

MATERIALS YOU WILL NEED

Six or more different types of soil - sand, clay, silt and compost or organic matter AND soil sample from one or more locations or make a mixture of different percent of the above types. (Enough soil to fill the bottle or funnel 6 inches deep.)
Clear plastic soda liter bottles or large funnels - 6
Coffee filters OR paper towels or loosely woven fabric - 6
Clear glass quart jars, 6 (one per each soil type)
Water, 3-5 gallons
Bucket - 1
16 oz. liquid measuring cup - 6
Watch or clock with a second hand - 1 or more
Masking Tape or Labels – 1 per group
Permanent marking pen – 1 per group
Ruler - 1 per group
Scissors - 1 pair per group
Activity C: Downhill Water Time Charts - 1 per participant or group
Optional: Calgon® Liquid or Powder Water Softener
Optional: Baking Soda (Sodium Bicarbonate)

GETTING READY

- Obtain all necessary materials.
- If large funnels are not available, make funnels out of plastic soda liter bottles by cutting with scissors the bottom of each just above the base. BE CAREFUL. Try to make it as straight as possible. Then make a mark six (6) inches up from the mouth of the bottle.



SUGGESTED GROUPING

Divide the participants into six groups - one per soil type; 2-4 participants per group.

ACTION (Observing, Communicating and Comparing)

Explain to participants that they will be predicting, observing, comparing and testing different soil types to investigate the rates at which water infiltrates (or enters) and percolates (passes through).

Each group will:

1. Take a funnel, coffee filter or paper towel or loosely woven fabric, glass jar, and 16 oz. measuring cup.
2. Line the funnel with the coffee filter, paper towel or fabric.
3. Fill each funnel with equal amounts of dry soil samples or to the 6" measure. Be sure to pat down the soil as you fill the funnel. Place the funnel over the mouth of the jar.
4. Label each jar.
5. Set all funnels with soil next to each other on a table.
6. You will be making two tests on the soil at the same time.

Test #1: See how fast the water disappears from the surface of the soil (infiltration time)

Test #2: See how much water drips through the soil (and out of the funnel) in 120 seconds (amount percolated).

7. Have participants predict how the soils will perform in the two tests. Record on the *Downhill Water Time Chart*.
8. Participants should be appointed a job for each soil type:
Timer - the one who calls out "Start" and reads the watch.
Observer - the one who observes and calls out when the water has disappeared from the surface (infiltration time)
Measurer - the one who records the measurements (time and amount of water) on the *Downhill Water Time Chart*.
Pourer - the one who will pour the water and remove the funnel from the jar when time is called at 120 seconds (amount of percolation)

9. Read and review Step 8 carefully. Make sure that everyone understands their job.
10. Begin the race when the all groups are ready.
11. The *Timer* starts the test by calling out “Start”, which notifies the *Pourer* to begin quickly pouring the water into the funnel.

When the water is gone from the surface of the soil, the *Observer* calls out “Gone” and the *Timer* reads the watch and the *Measurer* records the time.

When 120 seconds have passed, the *Timer* calls out “Stop” and the *Pourer* quickly removes the funnel from the jar.

The *Measurer* then measures the amount of water that has percolated (passed through) the soil and records the amount.

12. All soil types can be tested at the same time with different groups or repeat Steps 4, 5 and 8 for each soil type.
13. You can also repeat the procedures using the same funnel/soil sets to determine what happens with additional applications of water.
14. Another experiment is to pre-soak some clay soil with added baking soda or Calgon® solution and let it dry. Then compare this amended clay soil with a clay that is not treated. It will show how chemistry can affect infiltration and percolation.

SCIENCING

Observing and Communicating:

- Describe what happened to the water that was poured through the funnels.
- How much water is in the jars for each soil type?

Comparing and Inferring:

- Describe any differences between the different soils.
- Which set produced the fastest infiltration times? Why?
- Which soil held the most water? Why?

Communicating, Observing and Relating:

- Review predictions and results on the handouts.
- Remind participants that predictions and results are not right or wrong answers. If the results from the activity were not what you predicted, explain what happened.
- What were the differences?
- Did the soil with the faster infiltration also have the faster percolation?

Inferring and Applying:

- Which soil(s) is the best for growing plants?
- What characteristics are important for plant growth?
- What type of soil would hold the most water?
- Which crops would do best in this soil type?
- Which type of soil filters (cleanses) water best? Why would this be important?
- Which type of soil holds the least amount of water? How do you know this?

Relating :

- Use a soil tester to determine pH, nitrogen, phosphorus, and potassium, if available.
- Why would a farmer need to know the pH, nitrogen, phosphorus, or potassium content of his soil?
- How might soil amendments affect the infiltration and percolation?

ACTIVITY C: Downhill Water Time Chart

	Soil #1	Soil #2	Soil #3
Infiltration Time The time it takes for the water to disappear from the surface.			
Amount Percolated in 120 Seconds The amount of water to pass through the soil.			
Color of Water Describe the water in the jar. Is it clear or cloudy, color, etc.?			
Comments			

ACTIVITY D: I AM SOIL

OBJECTIVE: Participants will gain a better understanding of the different types of soil.

MATERIALS YOU WILL NEED:

Open space

GETTING READY:

Select an open area where the participants can move around easily. Ask the participants NOT to run or push each other. Walking and keeping hands to self will keep everyone safe.

SUGGESTED GROUPING:

Any size group can participate. Ten to fifteen is ideal.

ACTION: (observing and communicating)

1. Divide the participants into two groups. One group needs to be twice as big as the other. Example: Divide ten (10) participants into a group of 6 and a group of 4.
2. The larger group becomes the soil and the smaller group becomes the water.
3. First, have the soil (the larger group) become CLAY. Ask the group how large are the particles of CLAY. (*They are small.*) To represent CLAY, the participants keep hands by their sides and come together in a very tight circle.
4. Ask the WATER to try to move through the particles of CLAY. What happens?
5. Now, have the soil become SILT. Ask the group how large are the particles of SILT. (*They are medium.*) To represent SILT, the participants put their hands on their hips and form a circle with little space in between each other; elbow to elbow.
6. Ask the WATER to try to move through the particles of SILT. What happens?



7. Now, have the soil become SAND. Ask the group how large are the particles of SAND. *(They are large.)* To represent SAND, the participants raise their hands at shoulder height and leave space in between each other.
8. Ask the WATER to try to move through the particles of SAND. What happens?
9. Now, have one third (1/3) of the soil (larger group) become SAND; another 1/3 becomes SILT and the last group becomes CLAY. Ask the group what type of soil are they now? *(They are loam.)*
10. Ask the WATER to try to move through the LOAM SOIL. What happens?

SCIENCING:

Comparing, communicating and inferring

- What soil type could the water pass through the easiest? *(Sand)*
- Which type of soil could hold or stop the most water? *(Clay)*
- What made the differences in the four types of soil? *(The size of the particles)*

Inferring and applying

- What type of plant might like to grow in the clay soil?
(Plants that needs lots of water to grow.)
- What type of plant might like to grow in the sandy soil?
(Plants that store water or need little water to grow.)
- Which type of soil is best for most plants?
(Loam or a mixture of clay, silt and sand)
- Why is the loam best?
(Loam soils retain enough water, yet also allow the soil to drain, for an optimum combination of water and air at a plant's roots.)



ACTIVITY E: How Well Does Your Plant Grow?

OBJECTIVE: Participants will experiment with different soil types by germinating seeds and growing plants.

MATERIALS YOU WILL NEED

Four different types of soil - sand, clay, silt and garden compost

Water, 2-3 gallons

6-8 oz Paper cups or small containers- 4 per group

Seeds (i.e. radish, lima bean, lettuce) - 12 seeds per group

Masking tape

Permanent marking pen

Pencil or pen - 1 per participant or group

Spray Bottle- 1 per group

Optional: Baking soda or Calgon®

Activity D: How Well Does Your Plant Grow Worksheet - 1 per participant or group

GETTING READY

Obtain all necessary supplies. Moisten all soil types with water. The soils should be wet but not soggy or dripping water.

SUGGESTED GROUPINGS

Groups of 2-4 participants

ACTION (Observing, Communicating and Comparing)

1. Select one variety of seeds i.e. radish, lima bean, or lettuce.
2. Fill four small containers or cups 2/3 full of each the moistened four types of soil type. Label each with soil type, seed, and participants' names.
3. Plant 2-3 seeds ½ inch deep in each container. Cover slightly. The

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TIP:

One clay soil could be sodium enriched by adding baking soda or Calgon®.



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moisture of each soil type should be similar; wet but not soggy or dripping with water.

4. Place all four in the same location i.e. temperature and light.
(The only variable should be the type of soil.)
5. Each day observe and record information on the *How Well Does Your Plant Grow Worksheet*. If needed, water to keep the soil moist. Record, if water is added.
6. Compare your results with the other groups.

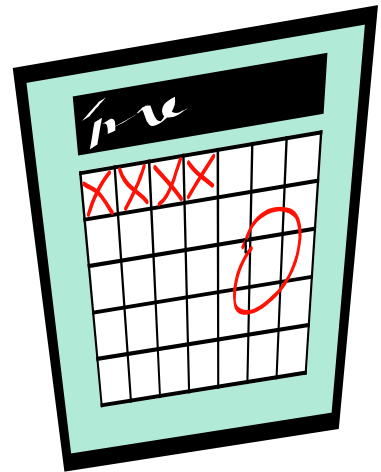
SCIENCING

Observing and communication:

- How many days did it take for the seeds to sprout?
- Did you need to water any cups or containers? If yes, how much?

Comparing:

- Which soil type was best for germinating seeds?
- Which soil type kept moist the longest?
- Which variety of seed sprouted first?
- Which plant and soil type had the best growth?
- How does the clay soil with added sodium compare to the other clay soil?
(It should be slower to germinate and have a tendency to crust over the seeds.)



Comparing and Organizing:

- Did the seeds perform differently in different soil types?
- Did the plants perform differently in different soil types?
- Sort plants and soil types in different ways.

Inferring and Relating:

- What information does a farmer need to know to select the right crop for his soil type?
- How can a farmer evaluate his soil as to its suitability for certain crops?
- Can a farmer change his soil to increase food production?

ACTIVITY D: How Well Does Your Plant Grow? Worksheet

Type of Seed or Plant: _____ Date Planted: _____

Be sure to identify the soil type for each planting below. Draw and describe what is happening at each observation time.

OBSERVATION DATE	Soil #1:	Soil #2:	Soil #3

SESSION FIVE

WATER, WATER EVERYWHERE

PURPOSE

- To understand the importance of water to agriculture and plant life
- To understand how water moves into, through and out of plants
- To understand the source of water for agriculture
- To explore the relationship of irrigation practices to food production

BACKGROUND INFORMATION

Throughout history, water has played an important part in agriculture. The supply of water has determined where irrigation and grazing were possible to sustain agriculture and develop civilizations. When agriculture was able to flourish so did farms, cities and communities.

The growth cycle of a plant consists of seed, sprout, seedling and mature plant. Without water, crops cannot germinate and grow. Soil, light, water, and air are where plants get the nutrients and energy they need to continue to grow and make food. Often plant growing failures can be traced to bad water management. Too much water in the soil drives out air and shuts off the oxygen supply causing root damage or death. So, farmers water deeply, but as infrequently as possible to allow air to enter the soil between irrigations. Also, farmers speed up drainage by adding organic matter to heavy soils such as clay. Successful farmers know when and how much water is needed for their crops.



Most irrigation in the United States occurs in the West, where summer precipitation is low. One of the problems with irrigation is maintaining an adequate water supply during the growing season. In many areas, the annual rainfall pattern is such that the water for irrigation falls during the non-growing season and must be stored for summer use. Water storage sources are surface stream, rivers and lakes from rainfall and melting of the mountain snow pack, and ground water pumped from the aquifers. Surface and ground water both originate from moisture in the earth's atmosphere.

The term “irrigation” is the process of putting water into the soil to make plants grow. There are three basic ways to irrigate - surface, micro-irrigation, and sprinkler. Surface irrigation includes methods such as border-strip and furrow where water flows on top of the soil. Micro-irrigation techniques such as drip, bubbler, and spray deliver a measured amount of water through an emitter located near each plant. Micro-irrigation techniques can be located above or below the ground. Sprinkler irrigation includes the use of a mechanical device which sprinkles water over the crops to simulate rain.

The method of irrigation used depends on many factors including geographical location, crop, soil, climate and economics. Farmers and ranchers are continually testing new technologies to maximize their production and economic return. Farm management practices to increase water application efficiency includes improved plant varieties, laser leveling to make their fields level or sloped, selection of irrigation systems to ensure optimum efficiency for specific crops, and water recycling programs.

Irrigation water is measured in acre-feet. An acre-foot of water is enough water cover an acre of land one foot deep and is equivalent to 326,000 gallons. Most crops are irrigated with two to four acre-feet of water per acre per year. Coincidentally, suburban land covered with houses and landscaping uses about the same amount of water per acre.

Here is a sampling of the amount of water it takes to produce certain crops in a deep, permeable, well-drained soil under average conditions+. Do you know the water requirements for the major crops in your area?

CROP	WATER REQUIREMENTS (in inches annually)
Alfalfa	49
Beans	20
Field Corn	23-27
Pasture	49
Rice	37
Small grains	16-29
Tomatoes	22-28

+Estimated water requirements for crops in the Sacramento Valley Region, California. The range reflects the variable planting dates and growing season for the individual crops.

ACTIVITY A:

How Does Water Move in Plants?

OBJECTIVE: Participants will predict and observe how plants react to water and how water travels in plants.

MATERIALS YOU WILL NEED

Activity A-1:

Wilted plant, especially good are tomato or marigold plants – 1 plant
or wilted cut flowers i.e. daisy or marigold

6-8 inch bowl or saucer – 1

Water – 1 pint

Pitcher – 1

Activity A-2:

Celery stalk with leaves and/or white flower i.e. carnation, daisy, 1-2
flowers or stalks

8 ounce glass jar or container – 2

Food coloring – 1 box of four colors

Warm water – 1 pint

Pitcher - 1

GETTING READY

- Obtain all necessary materials.
- Activity A-1: A week to ten days before the meeting, withhold water from a plant and allow it to wilt. Tomato and marigolds work well for this observation. OR select a cut flower that will wilt and easily recover i.e. daisy, marigolds. Caution: Do not allow the plant to dry out so much that it dies.
- Activity A-2: For better and faster observation, place the celery and/or flower in colored water at least 3 days before the meeting.



SUGGESTED GROUPING

Small or large group; opportunity for participants to observe.



ACTION (Observing, Communicating, and Inferring)

Activity A-1:

1. Show the participants the wilted plant or cut specimen. Ask them to predict what will happen if water is added.
2. Place the plant in a bowl and water heavily OR place the cut specimen in a container of water.
3. Place all in a location where participants can observe it during the meeting and/or over a period of time.

Activity A-2:

1. Place the freshly cut celery stalk and/or flower in a container of warm, colored water.
2. Place in a location where participants can observe it during the meeting and/or over a period of time.

TIP: For best results, be sure to freshly cut the stem of the specimen before placing it in water.

SCIENCING

Observing and Communicating

Activity A-1:

- Describe what happened to the wilted plant or cut specimen when the water was added. Did you predict the result?

Activity A-2:

- Describe what happened to the celery and/or flower. Cut the stem of the celery crosswise to observe. Describe what it looks like? Did the color of the flower change?

Inferring and relating

Activity A-1:

- Why do plants become dehydrated?
- Where does the moisture go?
- What do you think happens to food crops during a drought?
- What do farmers have to do if it does not rain for a long time?
- When does the farmer know when it is time to water his crop?

Activity A-2:

- Why do plants need water?
- How do you think the food coloring got inside the celery and/or carnation?

MORE FACTS: Water travels to all parts of a plant through tubes called xylem vessels. It is lost from holes in the leaves called stomata and evaporates. This helps to pull more water up through the plant. The flow of water through a plant is transpiration. The food coloring shows how water flows inside the tubes of the celery and/or flower.)

ACTIVITY B:

Is There Water Underground?

OBJECTIVE: Participants will explore ground water and learn that not all water is visible on the surface. Terminology is water table, ground water, aquifer, artesian well, and spring.

MATERIALS YOU WILL NEED

Clear glass jar or liter bottle (top cup off) – 1 per groups
Three types of soil i.e. sand, clay, and potting soil
Water – 1 quart
Food coloring, blue
Medicine Dropper or/and straw – 1 per group
Pencil – 1 per participant

GETTING READY

Obtain all necessary materials. If in small groups, you will need a set of the materials for each group.



SUGGESTED GROUPING

The demonstration could be set up for group observation or with small groups, of 2-3, to separately explore ground water.

ACTION (Observing, Communicating, and Inferring)

1. As a demonstration or in small groups, fill a glass jar with two inches of each of the three different soil types as a first layer of sand, then a layer of clay, and then two inches of potting soil.

TIP:
The water may run around the edges of the jar at the layer of clay.

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2. Slowly pour water into the jar. Have the participants observe how the water moves through the three materials.
3. Continue to add water until half of the sand layer is saturated. This represents ground water.
4. Give the participants the challenge of getting water out of the jar without tipping the jar. Only a pencil and a medicine dropper or straw may be used.
5. Have participants draw what occurred in the jar and label the different layers including water level. Introduce the terms: ground water, water table, and aquifer.

(The water in the soil is the ground water. The top of the ground water is called the water table. The sand containing the water is the aquifer.)

SCIENCING

Observing and communicating:

- What happened when the water was added to the jar?
- Which layer absorbed the water?
- Are all layers saturated with water?
- Did the water pour through or run off the layers?

Applying and inferring:

- What does the pencil and medicine dropper represent?
- How does a farmer capture ground water for irrigation?
- What are other ways that water comes out of the ground?
- How could someone demonstrate an artesian well and/or spring?

MORE FACTS: An *artesian* well flows naturally because of the water pressure exerted on the water in the aquifer. Pressure exerted by the inflowing water causes the aquifer to rise in the well without pumping.

Springs are different because there is no pressure involved. The water flows out of an aquifer where the aquifer touches the surface of the ground.

ACTIVITY C:

How Does the Water Flow?

OBJECTIVE: Participants will observe and compare different methods of irrigation.

MATERIALS YOU WILL NEED

Aluminum pans, approximately 7"x7" size- 3
Aluminum pans, approximately 9"x12" size – 3
Soil, any type, one inch deep in each pan
Water, 2 gallons
Liquid measuring cup – 1
Spray bottle – 1
Paper cups, 8 ounces - 1
Nail or ice pick
Small blocks of wood to raise the end of each pan - 3

GETTING READY

- Obtain all the necessary materials. You will need a complete set of the above materials for each group if each group will be doing all types of irrigation. If they are divided into three groups with each group doing a different irrigation method, only one set of supplies will be needed.
- If the participants are young, you may want to use the nail or ice pick to poke small holes at one end of the smaller aluminum pans for drainage.
- This activity can be messy therefore an outside place would be easier to manage and clean up.
- The types of irrigations systems illustrated are as follows:
 - ❖ Spray bottle represents a “sprinkler”
 - ❖ Paper cups with one or more small holes at bottom represent a “micro-irrigation” system, and
 - ❖ “Surface” irrigation has water only being delivered at one side of the pan with the use of furrows, and cross-checks.



SUGGESTED GROUPING

Groups of 3-4 participants or divide group into three groups and have each group do a different irrigation system.

ACTION (Observing, Communicating and Comparing)

1. The object of this activity is to let the participants explore how to irrigate soil with a limited amount of water. They will predict and determine which method is best for the soil type.
2. Poke holes in the end of the smaller pans for drainage. Place one inch of soil in each of the smaller pans. The pans can be slightly elevated or flat but should be all the same. The larger pans are used to set the smaller pans inside to capture the water that drains through the holes.
3. Instruct the participants to “design” an irrigation system . . . surface, micro-irrigation, and/or sprinkler using the supplies available.
4. Have participants predict which irrigation method will be the most effective with this type of soil.
5. Each pan can only use a maximum of 1 pint of water (2 cups) to irrigate the soil. The soil needs to be wet but not soggy with very little run off or water through the drain holes of the pan.
6. Have the participants record the amount of water applied to each irrigation system or pan. STOP when the water appears through the drain holes.

SCIENCING

Observing and communicating:

- What is the type of soil?
- Does it easily absorb water? Or does the water run off?
- How much water was used for each irrigation system at the time of the water passing through the drain holes?
- Did the soil move in the pan? (*This is called erosion.*)



Comparing:

- Which irrigation system did the best job in wetting the soil? Why?
- What are the differences in amount of water for each irrigation system?
- Were there different designs for the surface and micro-irrigation systems? If yes, how were they different?

Applying, inferring and relating:

- Would the results be the same with a sandy soil? Clay soil? Compost soil?
- What happens to runoff water at the farm?
- What factors determine the type of irrigation system to use?
- Why do farmers need to be concerned about how much water they use to irrigate?
- Is erosion is good thing? Why? Should the farmer try to avoid erosion?

Relating:

- Participants could continue to experiment by using the variables such as the pans level or slightly elevated, different soil types, furrow design, amounts of water, or length of time. A farmer needs to consider these variables when selecting an irrigation system.



ACTIVITY D:

How Do Radishes Grow?

OBJECTIVE: Participants will become “farmers” and grow radishes and determine how much water is needed.

MATERIALS YOU WILL NEED

Radish seeds – 3-4 seeds per person
Potting soil – same type for all containers
Container - 16 oz plastic cups, 6” tall milk cartons, or liter/gallon soda bottles with tops cut off - 1 per person
Water - 1-2 gallons
Liquid measuring cup – 3 or 4 to share
Trowel - 3 or 4 to share
Bucket – 1 - 3 gallon for group
Pencils - 1 per person
Activity D: “How Do Your Radishes Grow?” Worksheet

GETTING READY

Obtain all necessary materials. Important: Potting soil should be pre-mixed with water to be the same wetness.



SUGGESTED GROUPING

Each participant should have their own radish seeds to plant.

ACTION (observing, communicating and comparing)

1. Wet potting soil to be wet but not soggy or dripping.
2. Fill container 3/4 full of potting soil; all containers should be the same size with the same depth of soil.

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3. Place 2-3 seeds in center of container; 1/4 inch deep; cover with soil.
4. Record where the container is kept i.e. light exposure and temperature.
5. Water, as needed. Measure and record amount water each time; date.
6. Observe when seeds sprout; record date.
7. Thin radishes, two inches apart, in each container.
8. Observe growth of leafy foliage. Record daily growth on chart.
9. Ready to harvest in 3-6 weeks depending upon variety.

TIP: Best crops occur with soil temperatures of 50-60 F degrees; rich, loose soil with constant moisture for non-stop growth; a sunny location and planted outside in early Spring or late Fall. Radishes can also be grown inside by a sunny window.

SCIENCING

Observing, communicating and comparing:

- Was it easy to grow the radishes?
- How many days until the radishes sprouted?
- How did you know it was time to water?
- How much water and how often was it watered?
- How big were the radishes?
- Which radish had the most leafy foliage?
- What was the difference in temperature and light and the need for water?
- Whose radish was ready to harvest first?

Applying and Inferring:

- How did you know your radish needed to be watered?
- What would happen if you didn't water enough or over watered your radish?
- When did you know it was time to harvest your radish?
- Can a radish over mature?
- What are signs of over maturity?
- If you repeated growing a radish, would you do it differently the next time?

Relating:

- What does a farmer need to consider when he grows his crop?

ACTIVITY D: How Do Radishes Grow?

Worksheet

Location of plant: _____ Date planted: _____

Sun? Yes No How many hours of sun per day? _____

Temperature? Hot Cool Cold

Watering Table: Record date and amount of water given to plant. Measure the water by $\frac{1}{4}$ cup, $\frac{1}{2}$ cup, $\frac{3}{4}$ cup, or 1 cup.

Date	How much water?	Date	How much water?	Date	How much water?
TOTAL		TOTAL		TOTAL	

Plant Growth Chart: Draw a picture of your radish plant as it grows. Record day seed germinated or sprouted above the soil. Record height of plant, number of leaves and color.

GERMINATION Day: _____	Day: _____	Day: _____	Day: _____	Day: _____	Day: _____
Day: _____	Day: _____	Day: _____	Day: _____	Day: _____	Day: _____

SESSION SIX: GROWING FURTHER

PURPOSE

- To gain an understanding of the importance of insects in agriculture.
- To gain an understanding of what is DNA (deoxyribonucleic acid), the basis of genetic engineering or biotechnology
- To further explore the interface of agriculture, the environment, and urban and rural settings.
- To further discuss how science and society can affect issues such as land use, biotechnology, water quality and quantity, and sustainable agriculture.

BACKGROUND INFORMATION:

Insects are everywhere and play an important role in agriculture. Some are pests that cause damage to plants and others are beneficial or helpful to agriculture. There are four types of beneficial insects: predators, parasites, pollinators and poopers. *Predators* such as ladybugs, praying mantis and lacewings prey on other insects. *Parasites* destroy pest insects by laying their eggs on or inside of them. *Pollinators* such as bees, butterflies and wasps are important to plants because they pollinate flowers so they can produce fruit and seeds. *Poopers* also known as decomposers provide nature's own recycling. They eat, digest and excrete (poop) dead plant material. This allows nutrients in the plant to be returned to the soil.

Because not all insects destroy crops, it is important for farmers to be able to identify the pests and control them without destroying the beneficial insects. More and more farmers are incorporating *integrated pest management* (IPM) in their farming practices. It is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

IPM is only one way farmers are addressing agriculture issues affecting the environment and society. Many farmers are adopting a long term goal of research and development of *sustainable agriculture* to produce plenty of high quality food; protecting and enhancing the soil, water, and other natural resources, building a thriving rural economy and preserving a good life for farm families and communities. This includes such practices as direct marketing; growing a diversity of annual and perennial crops; reducing the use of synthetic fertilizers; determining farm practices on monitoring and testing; maintaining ground cover year around to enrich the soil, create habitat for beneficial insects, and decrease erosion; managing irrigation to decrease nutrient leaching; managing pests ecologically with minimal pesticide use; and protecting water

quality on and beyond the farm. The farmer of the 21st century must be willing to adopt new practices and improve old ones if he is going to survive in the current social and environmental climate.

How do you define *biotechnology*? *Genetic engineering*? *Recombinant DNA*? What exactly do these terms mean? Do they refer to different things? It depends on whom you listen to! The popular press refers to the new methods of genetically altering plants (or animals), sometimes as biotechnology, sometimes as genetic engineering, sometimes as recombinant DNA. But many definitions of biotechnology have been used over the years and this often leads to confusion. Historically, *biotechnology* meant the use of organisms to perform a task or to describe industrial processes that use organisms to perform a task. By these definitions, wine-, cheese-, yogurt- and bread-making are all examples of biotechnology because they involve the use of organisms, bacteria or yeast, to convert a natural product, like milk or grape juice, into a more desirable fermentation product like yogurt or wine. *Genetic engineering*, a term frequently used in the popular press to refer to the new methods of genetic manipulation, originally referred to the participation of a human in the process of genetic exchange among organisms. By this definition, humans have been genetically engineering their food for thousands of years if they participated in choosing the plants that were involved in the sexual cross that gave rise to the next generation. *Recombinant DNA* techniques are the new methods developed for modifying genetic information, that utilize for the most part the same machinery (enzymes, substrates) used in the cell, but in this case the work is carried out by scientists in the laboratory. These technologies permit scientists to identify specific information in the plant cell, remove it from the donor cell and re-insert it either back into the genetic material of the cell from which it came or a different one. The popular press and others to refer to the modern methods of genetic experiments in the laboratory employ all of these terms, biotechnology, genetic engineering and recombinant DNA, despite their historical usage.

What are *DNA*, *RNA* and *protein*? Plants and animals are made up of large numbers of individual cells; the human body contains trillions of cells. Each cell contains the genetic information that instructs that cell what to do. Those instructions come in the form of genes, which are just like recipe cards that dictate the specific characteristics of an organism, whether you have brown or blue eyes and whether a plant has red or yellow fruit. The recipes are stored in the cell of every living organism in a long string-like molecule called DNA, which is made up of chemical units. It is the order of those chemical units that dictates what characteristics an organism has. If genes are the recipes, the ingredients in the recipes represent the RNA and the final product made from the recipe, a cake for example, is the protein. RNA is the necessary intermediate between DNA and protein; you cannot make a cake without flour, eggs, butter and water. In a cell, you cannot make proteins without the RNA intermediate. The final product, the protein, is the workhorse of the cell and performs all the functions necessary for the cell to survive, perform its jobs and multiply itself. The order of letters in the DNA specifies what the protein will be, just as the recipe specifies whether you will end up with a cake or bread.

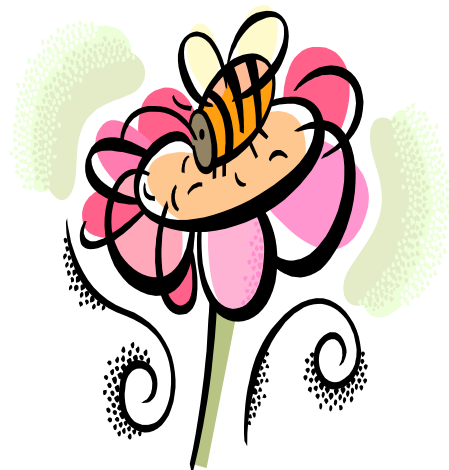
For more information about biotechnology, visit University of California website <http://www.ucbiotech.org>.

ACTIVITY A: BEES AND MUCH MORE

OBJECTIVE: Participants will gain an understanding of the important role insects play in pollination of plants.

MATERIALS YOU WILL NEED

Pipe cleaners - 3 per participant
Talcum Powder - 8 oz container
8 oz foam or paper cup - 1 per participant
Colored chalk – 2 or 3 pieces or powdered paints
Transparent or double sided tape – 3 or 4 rolls
Nails - 5 or 6



GETTING READY

- Obtain all necessary materials.
- Put each piece of chalk in a baggie and smash into a powder. Make 2-3 different colors along with the white talcum powder to make the experiment more dynamic.
- Cut 1/3 of the pipe cleaners into 3” pieces.

SUGGESTED GROUPING:

Individuals



ACTION (*Communicating and inferring*)

Explain to the participants that they are going to construct an insect and then investigate how it will pollinate a flower.

1. Participants will make an insect by bending one pipe cleaner into a butterfly shape and attaching it to a second pipe cleaner by twisting the top of the second pipe cleaner around the center of the butterfly shape. Insect must be small enough to fit inside the 8 oz cup.
2. Participants will make a flower, by using a nail; poke a hole in the bottom of a cup. Sprinkle a teaspoon of talcum, chalk powder or powdered paint in the bottom of the cup.

3. Wrap double sided or transparent tape, STICKY SIDE OUT, around the 3” piece of pipe cleaner. Insert the taped pipe cleaner through the hole in the bottom of the cup, with the “sticky” taped end protruding inside the cup. Bend the pipe cleaner to be securely fastened in the cup.
4. Participants will pollinate the flower by flying the insect in and out of their flower cup as well as others – allowing it to touch the powder and taped pipe cleaner.

Sciencing

Observing and communicating

- What do the “sticky” taped pipe cleaners and cups represent?
- Describe what happened to the sticky pipe cleaner.
- What happened to the ‘insect’?
- How many different “flowers” did their insect visit? How do they know?



Observing and comparing

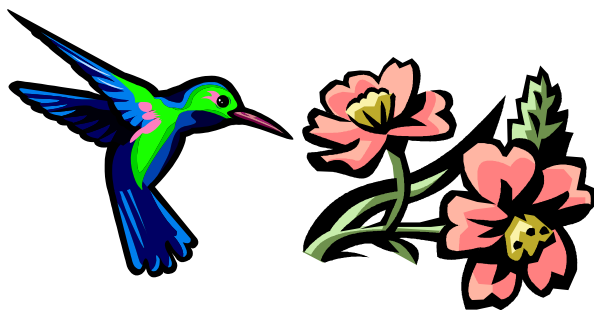
- What “insect” collected the most pollen?
- What characteristics make some insects better at pollination than others?

TIP:

Inside the flower is a pistil which is sticky like the tape. The pistil allows the pollen to stick to it and be used to fertilize eggs in this or another flower.

Communicating and Inferring

- How do participants think this relates to real flowers?
- Why is pollination important?
- Do all plants need pollination to reproduce?
- Can you list some pollinators of plants?
(bees, butterflies, moths, bats, hummingbirds, beetles and flower fly)
- If there were limited number of pollinators or they died, what were happen?
- What might affect the number of pollinators in a certain area?
(climate, habitat, air & water pollution, farm management)
- What insects do farmers bring into their fields and orchards to increase pollination?
- How can it be said that honey is made from plants?



ACTIVITY B: FRIEND OR FOE?

OBJECTIVE: Participants will learn the difference between beneficial and pest insects, and explore a technique of integrated pest management.

MATERIALS YOU WILL NEED

Friend or Foe? Activity Cards
Camera or drawing paper & pencil
Computer with access to the Internet
Black film canisters, one per individual
Cotton balls
A variety of scents i.e. peanut butter, orange juice, scented soaps or lotions, chocolate, lemon scented furniture polish, perfume, vanilla, peppermint or other types of extracts or flavorings

GETTING READY

- Obtain all necessary materials.
- Copy and cut the Friend or Foe Activity Cards.
- Find websites or pictures that identify beneficial insects.
- Prepare the film canisters by placing in each one a cotton ball that has been dipped into a scent. Make two canisters of each scent and then mix them up.

SUGGESTED GROUPINGS

Individuals or pairs

ACTION: (Observing, communicating and organizing)

Part I:

1. Take a walk in a garden. What insects do you see?
2. Do you see plants being eaten by insects?
3. Draw pictures and/or use a camera to take pictures.
4. What makes an insect a pest?
5. What is a beneficial insect?
6. Sort the Friend or Foe? Activity Cards or pictures as pests or beneficial insects.
7. Determine how the beneficial insects are helpful.

TIP:

Be kind to your fellow participants' noses. Do NOT use harsh smelling cleansers or ammonia-based products.

Part II:

1. Tell them they are going to be insects. Their goal is to search out their partner insect using only their sense of smell.
2. Give each participant a “scented” film canister.
3. Without talking or sharing, slightly open their own containers and smell the scent. What is it?
4. Now, walk around the room and smell the other participants’ containers. How long does it take to find the other matching scent?

SCIENCING

Observing, Communicating, and Organizing

Part 1:

- Is it easy to tell the difference between a pest and a beneficial insect? How?
- How do some insects help us grow food?
(pollinators, parasites, predators, and poopers)
- What does a pest do to plants? *(feed on your plants and disrupt their growth or harm them in a way that makes them less healthy)*

Part II:

- How easy was it to find your partner or “insect” of the same scent?
- Do you think insects use scent recognition? Can you think of examples?
(ants leave a trail of scent to find their nest; scent, as known as pheromones, is used to find potential mates, etc.)
- What are some other ways insects may communicate with each other? Or find food sources?
(making noise or sounds, attracted to specific colors,)

Inferring, Relating and Applying

- Do you think there are more beneficial or harmful insects?
(Of 100 insects, only about 2-3 of 100 are harmful.)
- What might affect the number of insects around a plant?
(moisture, temperature, habitat, maturity of plant)
- Do you think there are ways to attract beneficial insects to gardens? How?
- How can farmers use this knowledge to manage pests in their crops?
- When does a farmer know a pest is threatening his crop?
- What happens when a farmer sprays chemicals to kill insects in his crop?
- Is there a way he can only kill the pests?
- What do you think “integrated pest management” means?

ACTIVITY C: TODAY & BEYOND (Biotechnology)

OBJECTIVE: Participants will learn how to extract DNA for a living thing as the first steps in becoming a genetic engineer.

MATERIALS YOU WILL NEED

1/3 cup of chopped fresh, white onion	1/4 cup water
1/2 tsp salt	1 blender or small food processor
1 zip-loc* plastic freezer sandwich size bag	1 Tbsp liquid dishwashing detergent
1/8 tsp meat tenderizer	2 Tbsp sand
Isopropyl (rubbing) alcohol	1 twist-tie or paper clip
1 small, clear glass (1-3 ounces)	Candy or meat thermometer
Source of hot water	
Cloth for straining (wash cloth, tightly woven cloth or several layers of cheesecloth)	

GETTING READY

- Obtain all necessary materials.
- Put alcohol in freezer overnight.



TIP:

Look for a firm white onion with a tight outer skin and inner layers. Yellow onions dehydrate faster than the white variety.

SUGGESTED GROUPINGS

Individuals or pairs

ACTION: (Observing, communicating and organizing)

Have you ever wondered what DNA looks and feels like? Now is your chance to find out.

1. Chop a small fresh white onion into very fine pieces about 1/3 cup.
2. Add 1/4 cup of water, 1/2 tsp salt and chopped onion into a blender/food processor for 30 seconds on low speed.
3. Place mixture in zip-loc* freezer sandwich bag with 1 tablespoon of dishwashing detergent and 1/8 tsp meat tenderizer. In a pan of hot water and a thermometer, heat the plastic bag containing the onion mixture at 140 F for ten minutes.
4. Add 2 Tbsp of sand and grind between your hands or on a flat surface until the onion mixture is ground to a fine slurry.
5. Strain the well-blended mixture to a small, clear glass or other small clear container until it is 1/4 full. Add a pinch of salt, cover and shake hard for one minute.
6. Let it sit for one minute. Then carefully add cold isopropyl alcohol until the container is 3/4 full. The alcohol should float on top of the onion mixture.

7. At the layer between the onion juice and alcohol, you will see a whitish, snotty-looking substance. What do you think this could be?
8. Tear the paper off of a twist tie or use a paper clip and make a small hook. Reach in and hook the stringy white substance and pull it out. Sometimes it helps to stir gently to wind it onto the hook.

SCIENCING

Observing, Communicating, Organizing,

- When you chop the onion in the blender, what happened?
(When you chop the onion in the blender, you are breaking it up into small groups of cells.)
- What does the, meat tenderizer, salt, sand and detergent do?
(The meat tenderizer and salt further breaks down the cell membrane; the sand breaks open the cells and allows the nuclei to spill out; the detergent dissolves the wall of the nuclei and allows the DNA to spill out in long chains called chromosomes.)
- Why does the alcohol float? *(It is lighter than water.)*
- What do you think is in the bottom layer? *(water, protein and fats)*
- What is the stringy white substance? *(DNA)*
- Describe the DNA. Does the DNA clump together?
- What happens if you over-blend the onion? *(The nuclei will break open and the DNA chains will be ripped to smaller pieces by the blender. You will see the white, snotty-looking layer but you will not be able to remove the short DNA chains with your twist tie hook.)*

Inferring, Relating and Applying

- What do you think there are different steps and ingredients?
- What would happen if you left out an ingredient or step?
- Experiment with leaving out or changing steps or amount of ingredients. We've told you need each step, but is it true? Find out for yourself.
- Do all living things have DNA? Try other things.
- Which sources give you the most DNA? Experiment with other DNA sources. How can you compare them?
- Experiment with different soaps and detergents. Do powdered soaps work as well as liquid detergents? How about shampoo or body wash?

*Brand names are used as examples only; this is not an endorsement of any product.

The instructions for extracting the DNA from an onion was taken from the "Biotechnology and Food" (What's In Food) Food Safety Education Program, University of California, 4-H 4176.

ACTIVITY D: AGRICULTURE & SOCIETY

OBJECTIVE: Participants will explore how agricultural and society interface in the production of safe, wholesome food and clothing and shelter. Issues identified are biotechnology, land use, sustainable agriculture, and water quantity and quality.



MATERIALS YOU WILL NEED

Issue Cards, one per group
Collection of agriculture related newspapers and magazines identifying local issues
Access to the library for newspapers, magazines, and/or the Internet for further research

GETTING READY

- Obtain all necessary supplies. Issue cards may be copied onto heavy card stock or laminated.
- Read the newspapers and magazines for several weeks prior to the activity to identify agricultural issues of interest in your community. Save the articles for later reference.

SUGGESTED GROUPING

Two or more students per issue for discussion and/or debate.

ACTION (observing and communicating)

1. Have participants take a look at the local newspapers and magazines. Ask them to identify any agricultural related issues?
2. Have participants with a partner pick an issue card of interest.
3. Read the cards and follow any instructions on each.
4. Provide opportunity for participants to further research the issue at the library, and/or on the Internet. Read what different people and organizations have to say about these issues.
5. Have participants share their thoughts and findings with others.

SCIENCING

Observing and communicating

- What are some of the issues affecting agriculture in your community?
- What have you heard or read about in the news?
- What are your personal thoughts about these local issues or the ones identified on the issue cards?
- What improvements would you like to see in the foods you eat, clothing you wear or the materials available for shelter?

Inferring, relating and applying

- How do you know who to believe? What are their facts? How can you find out?
- Are the facts from a scientific, moral, or emotional viewpoint?
- How can these issues be addressed so everyone is a winner?
- How can science and technology help influence practices about growing food?
- If the world's population increases so much that our land can not produce enough food to feed everyone, describe ways that we could change what we eat and where we grow it?
- How can you become an informed citizen about local and national issues?

ACTIVITY D: Science and Society

ISSUE: LAND USE

Most settlements, later cities and towns, evolved because of the availability of water and land to produce food. The supply of water and the quality of the soil affected the production of food and enabled the population to grow. Agriculture and related industries expanded to support the growing numbers of people in the area. Now, it is not as important to have your food produced in your own backyard because transportation and food storage technology have improved. Food and supplies are transported far beyond the communities that created them.

Now, an issue that is affecting agriculture is cities and towns are expanding more into some of the best agricultural areas. Think of an area near your home or elsewhere that was once farmland but has now been developed for some other non-food producing use such as housing, business centers, parks, etc. As our population is getting bigger, there is less and less farmland available to produce food.

Talk to an older person or visit your planning department or historical society to further explore how your local community has changed. Ask them about areas that were once farmlands. What do you think of these changes and how are they related to the amount of food that can be grown in your community today? How have jobs or the economy been affected by less land being available for crop production or raising livestock? Besides food, what other benefits does farmland provide?

What is the current general plan for land use in your community? How much land has been identified for agricultural use only? What will your community look like in 20 years? How does science and technology play a role in making decisions about land use and zoning?

Should cities be able to expand to surrounding prime agricultural land forcing farmers to relocate? Thus, farmers would need to sell and move to areas with less urban influence. Is there other land available for farmers to produce crops at affordable prices for consumers? Deserts and mountain ranges are usually thought of as not very suitable for farming. Why? If a farmer was forced to raise crops on poorer soils or with less water, what practices and/or additional costs might the farmer have?

If the world's population increases so much that our land can't produce enough food to feed everyone, describe ways that we could change what we eat and where we grow it? How can science and technology help influence practices about growing food?

ACTIVITY D: Science and Society

ISSUE: WATER QUALITY AND QUANTITY

Having enough clean water is a matter of life and death, not only for human beings, but for all animals and plants. In drought years, we often see water rationing in urban & rural areas. Ground water levels in major aquifers have dropped steadily in past decades. There has been a loss of many wetland areas as more industry and homes have been built. There is an ongoing debate about water rights. What are the priorities for the need for water for agricultural production, the protection of the environment and enough water for urban use? Who should decide where the water goes?

As our country's population grows, so does our water consumption. Should expansion of cities be dependent upon the availability of water? Should areas with the most rainfall be forced to conserve water so populations in more arid climates can have an ample supply of water? How do we save water during the rainy seasons to provide water during drought or dry seasons? Who pays for the cost of transporting water to other regions? Should farmers go out of business or be forced to relocate if government regulations do not give them enough water to grow their crops? What can farmers do to stay in business to grow a profitable crop?

The quality of water is at risk. When water is polluted, it causes problems for people, other animals and plants. Most pollution is referred to as non-point source because there is no one point or place where all the pollution originates. Pollution originates from agricultural lands, urban areas, industrial plants, land erosion, sewage plants, landfills and more. Many states have instituted water quality monitoring programs to identify and address the specific problems of water pollution. Unfortunately, there are many streams, lakes, and underground sources of water that continue to suffer from pollution.

How can we continue to have enough clean water available for agricultural, the environment, industry, and homes? Who should decide where the water goes? What happens if we don't have enough clean water to share? How important is it to reserve water for wildlife and fisheries? What will happen if we continue to use more urban water and give less to agriculture? What will happen to our food and fiber supply? Do farmers have a role in water conservation? How do farmers conserve water?

What can you, as an individual, do to make a difference in the consumption of water and decreasing the causes of water pollution? How can science and technology help influence practices about use of water for growing food?

ACTIVITY D: Science and Society

ISSUE: BIOTECHNOLOGY

How do you think plants looked hundreds or even thousands of years ago? How have they changed? You can get more to eat out of a couple of corn kernels today than you could from a whole ear of corn a thousand years ago. Why?

Seeds contain all the information required to produce a new plant. This information is located with the plant genes or recipe. It is also known as the DNA or deoxyribonucleic acid. Over many years, plant breeders have used selective breeding of plants to produce better seeds that can produce bigger and better plants or fruits.

Today, we are beginning to use more molecular techniques or biotechnology to change our food supply. What is new are the tools that scientists use to modify organisms. Advancements now enable researchers to alter an organism's DNA with much greater precision, paving the way for many new applications of biotechnology.

Biotechnology can help one way by decreasing the use of chemicals in food production. For example, to reproduce some plant species, the stem or rootstock is used from another plant. In many cases, all the plants in a vineyard are identical to each other because they all came from the same "mother" plant. Unfortunately, these plants are usually susceptible to the same diseases as the "mother" plant. Sometimes a farmer will lose his entire vineyard when the plants all die from the same disease in a few days. To save his vineyard, a farmer will use fungicides or other chemicals to make sure that the plants do not become infected. What would happen if the fungicides or other chemicals were banned? As an alternative, biotechnology could create plants that are not susceptible to some common diseases and thus decrease the need to use some chemicals. Another example is often bulk seed available to farmers are treated with fungicides to increase the rate of germination. Scientists could create "seeds" through molecular techniques that would eliminate the need to fumigate. What do you think of this? Do you think changing the molecular structure of plants and seeds is a good idea? Are they still safe to eat?

Scientists can add genes of other plants to produce plants that are disease or insect resistance. In some cases, scientists can add genes of unrelated plants, microorganisms or even animals to a plant to try to make it better. Some people like this new biotechnology and others think it may be dangerous to our society.

What do you think? Can you think of good and bad things that could happen? What have you read or heard about in the news? What improvements would you like to see in the foods you eat? How can science and technology help influence the genetic structure of food to make it more economical to grow?

ACTIVITY D: Science and Society

ISSUE: SUSTAINABLE AGRICULTURE

Have you ever picked homegrown fruit such as apples, peaches or tomatoes? Did they look like the ones from the store? Were they “picture perfect” in shape, size and color, or did they vary a lot and have blemishes and maybe some worms or insects? Did you choose and eat the fruit carefully? If they had been in the store, would you have bought them? If you were the grocery store owner or the farmer, would you want to depend on them for your income?

Most consumers expect “perfection” in their fruits and vegetables. Excellent visual qualities (“perfection”) are clearly preferred but don’t come easily. Growers must use a variety of chemicals in order to create an abundant, visually desirable (i.e., marketable) product. Pesticides are used to control insects and weeds, and fertilizers and growth regulators are applied to increase the availability of nutrients for the plants. These practices produce greater yields but are costly to the farmer.

Other farmers choose not use chemicals on their farm. This means they do not spray their fields with pesticides or spread any kind of chemical fertilizers. This type of farming is known as organic. The organic farmer feels it is cheaper to farm without chemicals and they are producing a healthier product. Organic foods are grown on a smaller scale thus the product is often more expensive than conventional grown produce.

What would you rather eat a food product with or without chemicals? Are you as a consumer willing to pay more for food if grown without any chemicals? How do you feel eating a beautiful piece of fruit knowing it has been sprayed with pesticides? Do you feel safer eating a “natural” piece of fruit knowing that it may be wormy or be affected by a number of different disease organisms? Why are foods grown organically usually more expensive to buy? Do you think we produce enough food organically to feed everyone in the United States?

Another issue is what farming practices are best for the environment? What is meant by sustainable agriculture? Producing plenty of high-quality food; protecting and enhancing the soil, water and other natural resources; building a thriving rural economy, giving farm families and communities a good life on the land is the long term goal of sustainable agriculture. More and more farmers are making sustainability a guiding principle. They persistently put the question to systems and tools both old and new . . . can we use them without wasting resources and stealing from future generations? Ecology based farming mimic’s nature to create an environment where biodiversity is high, plant nutrients are recycled, pests are monitored, soil is protected from erosion, water is conserved and not polluted, and tillage is minimized.

If the world’s population increases so much that our land can’t produce enough food to feed everyone, describe ways that we could change how we grow foods, and what we eat? How can science and technology help influence practices about growing food?

IT CAME FROM PLANTED EARTH

Evaluation (Page 1 of 2)

Please return to Jeanne George, 1754 Walnut Street, Red Bluff, CA 96080

NAME: _____ E-MAIL: _____

ADDRESS: _____ CITY/ZIP: _____

Thank you for piloting this revised curriculum! Please share with us your comments and experience by answering the questions below.

ACTIVITY	Presented		Age Appropriate		Students' Interest				
					Low				High
From Wheat to Flour	Yes	No	Yes	No	1	2	3	4	5
From Flour to Food	Yes	No	Yes	No	1	2	3	4	5
From Cream to Butter	Yes	No	Yes	No	1	2	3	4	5
Growing Wheat	Yes	No	Yes	No	1	2	3	4	5
Sorting Seeds and "Sorta" Seeds	Yes	No	Yes	No	1	2	3	4	5
Finding Seeds	Yes	No	Yes	No	1	2	3	4	5
Dispersal of Seeds	Yes	No	Yes	No	1	2	3	4	5
Looking at Lima Beans	Yes	No	Yes	No	1	2	3	4	5
It's Simple as 1,2,3	Yes	No	Yes	No	1	2	3	4	5
Does Cold, Cool or Warm Air Make a Difference?	Yes	No	Yes	No	1	2	3	4	5
Can Seeds Be Planted Too Deep to Grow?	Yes	No	Yes	No	1	2	3	4	5
Soil Mysteries	Yes	No	Yes	No	1	2	3	4	5
Soil Soup	Yes	No	Yes	No	1	2	3	4	5
Downhill Race	Yes	No	Yes	No	1	2	3	4	5
I am Soil	Yes	No	Yes	No	1	2	3	4	5
How Well Does Your Plant Grow?	Yes	No	Yes	No	1	2	3	4	5
How Does Water Move in Plants?	Yes	No	Yes	No	1	2	3	4	5
Is There Water Underground?	Yes	No	Yes	No	1	2	3	4	5
How Does Water Flow?	Yes	No	Yes	No	1	2	3	4	5
How Do Radishes Grow?	Yes	No	Yes	No	1	2	3	4	5
Bees & Much More	Yes	No	Yes	No	1	2	3	4	5
Friend or Foe?	Yes	No	Yes	No	1	2	3	4	5
Today & Beyond	Yes	No	Yes	No	1	2	3	4	5
Agriculture and Society	Yes	No	Yes	No	1	2	3	4	5

Continued

IT CAME FROM PLANTED EARTH

Evaluation (Page 2 of 2)

Please return to Jeanne George, 1754 Walnut Street, Red Bluff, CA 96080

For each activity presented, please respond to the following:

ACTIVITY: _____ **Presented by: Adult or Teen or Both**
(Circle One)

Grade Level: ____ **K-2 grades** ____ **3-4 grades** ____ **5-6 grades** ____ **Mixed**

Criteria	DisagreeAgree				
Easy to follow format	1	2	3	4	5
Activity instructions were clear	1	2	3	4	5
Supplies were easy to assemble	1	2	3	4	5
Curriculum objectives were met	1	2	3	4	5
Lesson was science inquiry or experiential learning	1	2	3	4	5
Increased the students' interest in science	1	2	3	4	5
Developed positive attitudes towards agriculture	1	2	3	4	5
Other:	1	2	3	4	5

Comments:

ACTIVITY: _____ **Presented by: Adult or Teen or Both**
(Circle One)

Grade Level: ____ **K-2 grades** ____ **3-4 grades** ____ **5-6 grades** ____ **Mixed**

Criteria	DisagreeAgree				
Easy to follow format	1	2	3	4	5
Activity instructions were clear	1	2	3	4	5
Supplies were easy to assemble	1	2	3	4	5
Curriculum objectives were met	1	2	3	4	5
Lesson was science inquiry or experiential learning	1	2	3	4	5
Increased the students' interest in science	1	2	3	4	5
Developed positive attitudes towards agriculture	1	2	3	4	5
Other:	1	2	3	4	5

Comments