Banking on Seeds

LEVEL: Grades 3-7
SUBJECTS: Science, Social Studies (History), Language Arts
SKILLS: Analyzing, comparing similarities and differences, describing, developing vocabulary, identifying, listing, observing, planning, predicting, taking responsibility, understanding cause and effect, valuing

MATERIALS

GATHERING: five or six winter-type squash (a variety of spaghetti squash, acorn, pumpkin, Hubbard, and butternut is ideal); knife; newspaper; wax paper; photocopies of attached ***Banking on Seeds*** sheet.
STORING: airtight, quart glass jar with rubber-gasket lid that can screw down; colored markers; three or four baby-food jars.
PLANTING: dried seeds from class seed bank; a packet of commercial seeds of the same variety; 10-pound bag of potting soil; newspapers; small milk carton for each student plus three extra cartons; drawing paper and supplies; transparency of attached ***Parts of a Seed*** sheet. **Optional**: clear plastic soda bottles.

VOCABULARY

cotyledon, dicot, embryo, endosperm, genes, genetic diversity, hybrid, hybrid vigor, monocot, seed bank, seed coat

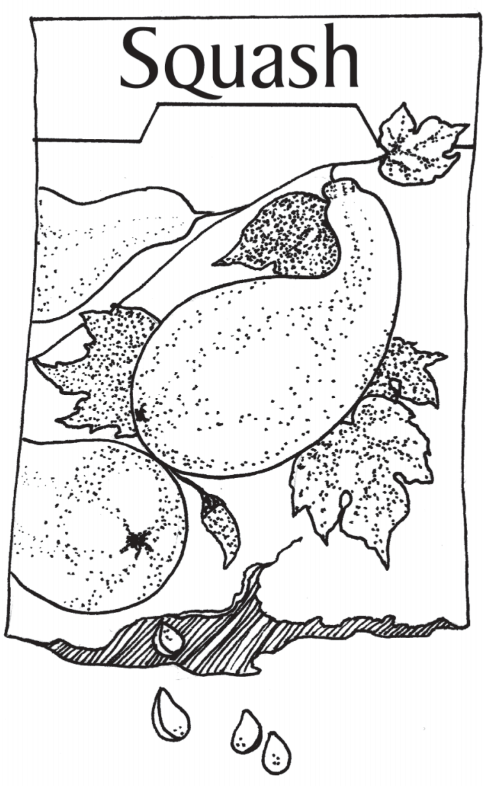
RELATED LESSONS

Seed Surprises
We're into Pumpkins

SUPPORTING INFORMATION

Few of us ever stop to think about the importance of seeds to our health, welfare and everyday lives. We could not live without them! Scientists, growers and other concerned people around the world have a message for us: "Save seeds! Our future may depend on it."

Seeds have been important throughout history. Many early peoples used them as money, jewelry, dyes, spices, ornaments, and to barter for things they needed, not to mention for eating and planting.



American Indians valued and protected seeds long before European settlers arrived in the New World. About 2,000 years ago, North American Indians had introduced maize (corn), beans, squash, and other crops from Central and South America. They knew seeds meant food, and food meant survival. Over time, they learned to plant seeds in prepared ground and keep the weeds away. They saved seeds from the healthiest plants for the next growing season.

Ancient peoples in other parts of the world also learned to grow plants for food. The arrival of Columbus and other European explorers started a great food exchange between the Old World Europeans and the Native peoples of North America and South America. Europeans brought many foods, which contained their seeds to plant here, that were new to the Americas. Some of these foods were lettuce, watermelon, onions, wheat, coffee, and bananas. When

BRIEF DESCRIPTION

The critical role that seeds play in the world is explored through creating a seed bank and comparing uses of seeds.

OBJECTIVES

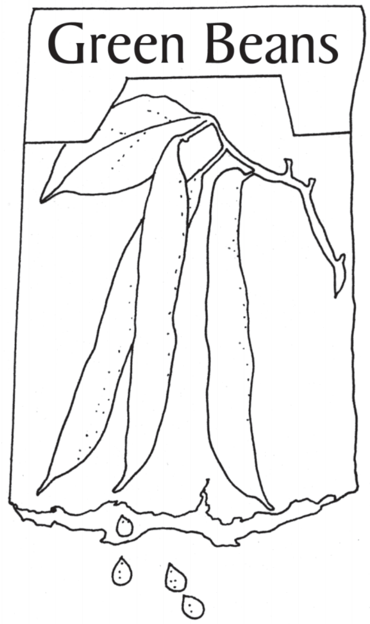
The student will:
- give examples and compare the use of seeds by people in the past, today, and potentially in the future;
- gather, store and plant seeds;
- create a seed bank and explain its importance; and
- label the basic parts of a seed.

ESTIMATED TEACHING TIME

GATHERING:
Session One: 45 minutes.
Session Two (next day): 30 minutes.
STORING:
30 to 45 minutes (about a week later).
PLANTING:
Two sessions: 45 minutes each.

the Pilgrims arrived later, they also brought seeds for trees and plants. They knew seeds were important to their future. The Pilgrims also learned about new kinds of plants from American Indians, who gave them "seed potatoes" and seeds for corn and taught them new methods for planting seeds and growing, harvesting and storing crops. Travelers and explorers took the seeds back with them, and farmers in western Europe began to grow those crops. From the Americas - South and North - to Europe also went corn, tomatoes, pecans, beans, squash, sunflowers, peanuts, tobacco, cacao, sugarcane, pineapples, avocados, and pumpkins. This exchange of foods - and the seeds they contained - changed the world's eating habits forever.

As time passed, seeds became more than survival and more than tasty, new foods to enjoy. Seeds became business. By the 1790s seed companies were doing a good business in the young United States. Around 1800 the Shakers, who were members of a religious community, sold the first mail-order vegetable seeds. Seed catalogs, books and magazines were means for people besides farmers to learn how to grow plants. People who moved west grew gardens on their homesteads. Early gardeners started out with seeds borrowed from others, bought from a store or ordered from a catalog. Farmers who lived close to town often grew vegetables to sell in the cities that developed. All these growers traded seeds and methods with other growers when they could. County farming groups also sent seeds to their members and suggested trading among themselves to keep the seeds pure.



These seeds had to be stored, which was not always an easy task. Stored in cellars too dry, seeds would shrivel, which meant poor growth or yield. Stored in cellars too wet, seeds would sprout or rot. People learned the best way to store seeds was in a dry, (but not too dry), cool place that is not subject to extreme hot or cold. They learned that the length of time dry seeds can be stored depends on the kind of seeds. Some, such as onion seeds, could be stored for one year. Others, such as squash, pumpkin or cucumber, could be stored for five to 10 years. Still others, can last centuries. They learned that stored seeds cannot sit in cold storage forever. If the varieties are to remain alive, they must be grown and new seeds harvested for storage.

After storage, the seeds have to be tested to see if they will sprout. People have learned to take a random sample of the seed (usually 50 or 100 seeds) and place them either in moist warm soil or rolled up in moist warm towels for two to four days. The sprouted seed are counted and the percent viability is calculated. The farmer can then figure the amount of seed to be planted to get a good population of plants. For example, with 50 percent viability, twice as much seed needs to be planted as compared with 100 percent viable seed.

The old way to improve crops over a period of years was to keep planting seed selected only from those plants in the field showing the greatest degree of a desirable trait such as resistance to plant disease, high yield, or high quality of produce (taste, color, shape). A new and faster method of improving crops was discovered in 1909 by Dr. George Shull, a plant scientist. He intentionally cross-pollinated corn plants from two very different lines of plants, each with its own distinct characteristics. The resulting seeds produced plants that contained the characteristics of both parents but were far better. He may have crossed a line of corn plants that always produced very fat, short ears of corn with a line of corn plants that always produced very long, thin ears. Producing long, fat ears may have been his objective. The resulting hybrid plants produced ears that were longer and fatter than either line of the parent plants. That resulted in more corn being produced by the hybrids on the same number of plants. This phenomenon is known as hybrid vigor. Any trait or combination of traits can be selected for and bred into hybrids; stronger stems, shorter stems, more seed, less seed, larger seed, smaller seed, larger blossoms, disease resistance, larger leaves, sweeter fruit, more tender skins, new colors of fruit or flowers, etc. Hybrid plants are stronger, more vigorous, and more productive that traditionally open pollinated plants.

Producing hybrids today is a much more complex and exacting science. Seed lines are inbred (bred within their own line) for a number of generations to concentrate the genes desired by the plant breeder. These inbred lines are crossed to produce what is known as F_1 hybrids. F_1 hybrid plants will display the traits desired and the hybrid vigor desired. However, the seeds of hybrid plants will not breed true and will revert back to the traits of the inbred lines from which they were created. Therefore, seeds from hybrid plants cannot be saved to produce those same outstanding plants but must constantly be created anew.

Shull's hybrids revolutionized agriculture throughout the world. Most farmers do not have the time or special facilities required to produce hybrid seed. Hence, large companies produce hybrid seed, which is sold to farmers in many countries for planting. Corn, wheat, rice and other crops have strains of hybrid seed available. The advent of hybrid seed created a large part of the big increases in crop yields during the past 60 years.

People began breeding crops that would ripen all at one time. They bred them for their unique strengths. The new, improved seeds teamed up with new inventions in farm machinery for startling results. For example, American farmers produced less than 20 bushels of corn an acre (a parcel of land about the size of a football field) in 1930. By the 1990s, hybrids and other technologies had pushed that figure to more than 125 bushels an acre. Almost all of the corn grown in the United States today is hybrid corn. It is taller, healthier, more disease resistant than other varieties of corn and produces larger ears of more uniform kernels.

Having seeds of many different varieties within a species gives us genetic diversity. Genetic diversity is key to the hybrids that meet our needs. With a variety of plants from selective species, scientists can create many qualities and breed new hybrids. The hybrid seeds are bred to grow into plants that have the best qualities of each parent. Hybrids are important for growing enough food for an increasing population, and producing plants that grow in various climates and soil types, resist pests, ripen all at the same time, or yield giant fruit.

The hybrids that were first sold in the 1930s make up most of the commercial crops grown in industrialized countries. But "modern" hybrid seeds have been a mixed blessing. Just as different plant varieties have their unique strengths, they also have weaknesses.

As new plant varieties are developed, diseases, pests, droughts, and other threats can attack the new crops. Then, plant scientists may need to come up with yet more new varieties that can better resist these problems. They often need to go back to older varieties of seeds to find qualities that are solutions to today's problems. Some of the seeds from long ago were not as productive, but they resisted pests, diseases and other problems very well. If scientists can combine qualities from some of those older seeds (called "heirloom" seeds) with modern seeds, we are better able to guard against crop disasters. An example of how serious this problem can be happened in 1970. Almost 80 percent of U.S. corn acreage was planted in the same type of hybrid corn without knowing that it was very susceptible to a strain of the fungus that causes corn leaf blight. An epidemic of blight developed and killed more than half of the crop in some Southern states.

Thanks to seed banks, emergencies like this do not have to spell total disaster. Seeds are stored in special places called seed banks, so that if some disaster wipes out or threatens certain plants, plant breeders have a source of seeds. Pests, floods, drought, plant diseases, and fires are some of those threats.

Most countries have at least one seed bank, and the International Plant Genetics Resources Institute indicates that there are more than 1,000 worldwide. In seed banks, seeds from thousands of different plants are stored on temperature-controlled shelves. Our nation's only long-term seed storage facility is the National Center for Genetic Research Preservation in Fort Collins, Colorado. It is coordinated by the Agricultural Research Service, the principal research agency of the United States Department of Agriculture. Federal, state and private organizations and research units work to maintain the many varieties of backup seed samples at the national laboratory. The laboratory collects all that it can find. Even so, today it holds seeds for only 3 percent of the varieties of vegetables that were for sale in 1902.

Gardeners and individuals can be seed savers, too. Heritage Farm near Decorah, Iowa, has thousands of varieties of heirloom seeds that individuals have saved. Heirloom seeds are very important to the future of our country. In case of major crop failures, they mean new seed supplies for a hungry nation. That's banking on seeds. There are other reasons for saving seeds.

As time went on, uses for seeds changed. When coins were minted from metals, they replaced seeds for currency. When artificial dyes were created, natural dyes from seeds and plants were used less and less. Yet even today, we continue to use seeds for much more than eating and planting. Dyes, spices, ornaments, lubricants, jewelry, waxes, feed for animals, stimulants, drugs, and genetic engineering are a few of these uses.

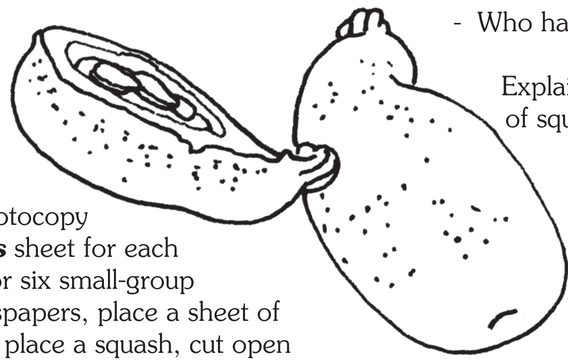
Today, people are growing plants from seeds without soil. This is called hydroponics (growing plants in a nutrient solution without soil), which was an idea used by ancient Aztecs, Chinese and Babylonians. Many hydroponic greenhouses grow vegetables throughout the year in areas where seasonal changes make it impossible to grow them in the ground. We are still making discoveries about new ways to grow and use seeds.

What will the future bring? Will we grow crops in outer space for more research to create new plants, new products, new medicines, and cures? If the history of seeds continues as it has, the answer can be yes. We're banking on seeds to do it!

GATHERING

GETTING STARTED

Purchase a variety of squash (it adds more interest for students if you use an assortment of squash varieties) and gather a knife, newspapers, and wax paper. Photocopy the ***Banking on Seeds*** sheet for each student. At each of five or six small-group stations, spread the newspapers, place a sheet of wax paper on them, and place a squash, cut open horizontally. Save one squash to cut open with the whole class. (Note: Separate Getting Started sections are provided before the STORING and PLANTING sessions.)



PROCEDURE

SESSION ONE

1. Beginning in one large group, display one type of squash, cut open horizontally. Ask:

    - What is this? *(A squash.)*
    - What might this squash have in it? *(Flesh, stringy pulp, and seeds.)*
    - Is it a fruit or a vegetable? *(By botanical definition squash are fruits because they have seeds.)*
    - What are seeds? *(Seeds are containers of young plants and food they need until they can make their own - all inside a protective coating.)*
    - What can seeds be used for? *(Seeds are a way to grow food, and many seeds are actually food themselves: peas, rice, peanuts, corn, beans, wheat, sunflower seeds, and toasted pumpkin seeds are examples of some seeds we eat.)*
    - What is the name of this kind of squash?
    - Who has eaten this before? What does it taste like?
    - What do you know about where squash came from? *(Squash is native to the New World or the Western Hemisphere and originated in Central and South America. It was being grown there long before European settlers arrived.)*
    - Where does it grow today? *(In gardens and fields in many countries throughout the world.)*
    - Who has grown squash at home?

    Explain that students will study different kinds of squash.

2. Divide students into small groups for each station. Have groups examine the inside of their squash and discuss the questions on the ***Banking on Seeds*** sheet together as they complete their sheets individually.

3. Ask students to clean the seeds by wiping them dry on newspaper. Have each student take three seeds from their group's squash. Then spread the remaining seeds on the piece of wax paper and place them in a sunny place to dry for about a week. Draw their attention to the difference, if any, in the seeds of the various varieties.

4. Tell students to imagine they are settlers who brought their three seeds to a new place a hundred years ago. The seeds are very valuable. It is their job, as settlers, to protect the seeds and keep them safe until this class period (or a certain time) the next day. Ask:

    - Why are these seeds so important to settlers? *(Seeds represent food for their families and animals and perhaps crops to sell to others.)*
    - How will you, a settler, guard and protect your seeds? *(You have no plastic containers, plastic wrap, aluminum foil, glass is rare and expensive, screw tops have not yet been invented, and paper is scarce and expensive.)*

SESSION TWO (next day)

1. Check to see who still has their seeds. Ask:

    - How did you protect your seeds?

- As a settler 100 to 300 years ago (before there were general stores), what could happen if you lost or damaged your seeds?

- As a settler, can you get or buy more seeds if yours are lost or damaged? Why or why not?

- Can you buy seeds today? Where? *(A seed company, garden store, nurseries, most grocery stores, and more.)*

2. Discuss seed uses with students. List their responses in a visible place under the headings past, today, and future. Ask:

   - How do you think people used seeds in the past? Students may need some prompting. *(Money, jewelry, counting, games, to barter, planting, dyes, ornaments, medicine, spices, food, oil.)*

   - How do people use seeds today? *(May include all of the uses from the previous question plus new drugs, lubricants, waxes, mixed animal feeds. Some people grow, sell, store, or study seeds as a career.)*

   - How might seeds be used differently in the future? *(For growing in space, for more research, making more new plants, making new products, discovering new medicines.)*

   - Why do you think seed uses change over time? *(Expanding or new technology brings changes. For some past uses other materials became available and replaced seeds [as money and counting tokens, for example].)*

   - Would it be possible for us to live without seeds? Why or why not?

   - What could happen if all the seeds in the world were destroyed? *(Some plants could be grown by grafting or cuttings.)*

   - How can disasters like pests, floods, drought, plant diseases, and fire affect seeds? *(Most have negative affects but fire and flood can stimulate germination of some types of seed.)*

   - If you were a scientist and wanted to protect and save a large variety of seeds for future generations, how would you do it? Be specific. (Try to get students to describe something similar to a seed bank.)

   - From knowing what you do about money banks, what do you think a seed bank is? (Share and discuss some information about seed banks with students. See Supporting Information.)

3. Invite students to add the seeds they protected to the classroom collection of drying seeds. Ask, "How could we make our own seed bank to use later?" *(Dry and store the seeds.)*

STORING

Conduct this session approximately one week later or when the seeds have dried completely. Thoroughly dry seeds will break, not bend, when folded.

GETTING STARTED

Gather a quart glass jar with a tight-sealing lid; markers in three different colors; three or four baby-food jars with lids; and 30 or more squash seeds. Ask one or two students to use the three colored markers to code 30 or more squash seeds, marking 10 seeds with each of the three colors. For example, a red dot on 10 seeds, a green dot on 10, and a black dot on 10. Put all the marked seeds in one of the baby-food jars and shake to mix the colors.

1. To introduce genetic diversity hold up, then pass the jar of marked seeds. Ask:

   - What kind of seeds are all these? *(squash)*

   - What is different about them? *(They have different color dots. Some may be different varieties, with different natural markings.)*

   Imagine the seeds of different colors are really seeds of different kinds of plants. Plants, like all living things, are made up of cells. Cells have genes which carry information (genetic code) that determines an organism's characteristics. Having many different kinds of seeds, each with its own genetic code, provides genetic diversity. Genetic diversity means a variety of genes are available for breeding (mating).

2. Now let's imagine these seeds are all the squash seeds in the world, but the plants grown from the different squash seeds have different strengths. Suppose that plants from the black seeds resist disease well. The red seed plants resist drought. The green seed plants resist insects. In a visible place write, Black: resists disease; Red: resists drought; Green: resists insects. Ask, "Why is it important to keep lots of different kinds of squash seeds in storage?" *(To provide seeds for new production in case weather problems, diseases, pests, and other threats destroy growing crops.*

To provide seeds with genetic diversity for plant breeding.)

3. What could happen if we cross a plant from a black seed with a plant from a red seed? A plant from a red seed with a plant from a green seed? Add to the illustration by drawing lines to show the combinations.

Black: resists disease | Red: resists drought | Green: resists insects

New: May resist disease and drought

New: May resist drought and insects

This is an example of producing hybrids. We used seeds with different color dots to represent squash plants with different characteristics. By crossing (or mating) two plants, a new plant resulted that has the characteristics of each of the parent plants. The plant from a black seed resists disease. The plant from the red seed resists drought. By crossing these two, we get a new plant that resists disease and drought.

4. Have a volunteer separate the seeds by the color of the dot into three baby-food jars. Ask:

   - When might these different seeds be needed? *(When drought, disease, insects, or other things threaten or destroy existing crops.)*

   - How did the discovery of hybrids add to seed genetic diversity? *(It allowed genes of two different varieties to combine into a brand new variety.)*

   - Do you think the seeds would all be stored together in the same container in the seed bank? *(No, they are separated by kind and stored and labeled separately so they can be found easily.)*

5. Ask students to watch as you store the large group of unmarked, dried seeds in the air-tight jar at a low, constant room temperature, away from sun and direct heat. Begin by putting a note in the jar that tells the kind(s) of seed and the date they were stored. Screw the lid on as tightly as possible. If you are not sure of a tight fit, seal the edge of the lid with electrical tape. Explain to students that they are creating a small seed bank through storing their seeds for future use.

   Point out that even these seeds cannot sit in cold storage forever. If the varieties are to remain alive, they must be grown and new seeds harvested.

PLANTING

GETTING STARTED

Bring in a packet of commercial squash seeds, a 10-pound bag of potting soil, and newspapers (for covering potting areas). Have students save milk cartons from the school cafeteria (one for each student plus three more). Make a transparency of ***Parts of a Seed*** sheet. **Optional**: The use of clear plastic soda bottles will allow the students to see the seeds grow below the soil. Cut the bottles in half. Have students plant their seeds against the side of the bottle.

SESSION ONE

1. Remove the seeds from your classroom seed bank. List in a visible place a review with students of the steps involved in creating the seed bank. *(Growing and picking a fruit, gathering, cleaning, drying, labeling, and storing the seeds from the plant.)* Discuss how this is similar to the national seed bank program (see Supporting Information). Review how having seeds in storage can protect the food supply, if pests, diseases, floods, droughts, or other disasters destroy crops. Ask, "Under what conditions will your seeds grow best?"

2. Invite students to plant several seeds from the classroom seed bank in their milk cartons filled with potting soil. In addition, have students plant commercial seeds in the three milk cartons. For all of the plantings, use the directions on the seed packet. Ask:

   - What conditions will your seeds need to grow? *(Water, soil, warmth.)*

   - Do you expect all the seeds to grow? *(no)*

   - Why might some of the seeds not grow? *(Some seeds may not sprout. Seeds planted too deeply or not deeply enough and too much or too little watering are factors that can make a difference. The commercial seeds may sprout better than the classroom seeds because of quality control in processing them. The seed package may tell the expected germination rate and how to plant.)*

SESSION TWO

1. Now the excitement begins! Encourage students to monitor the seeds daily, watching for signs of sprouting. Ask them to be particularly observant about how the new seedling looks from day to day. Students may want to draw what they see and measure the height of the seedlings daily. When they are two to three inches tall, study the plant parts - leaves, stems, roots. (**Optional**: See ***Parts***

of a Plant located in the Appendixes.)

When plants are 5 inches tall, study their plant parts again. Do all the plants look the same? Compare and contrast the seedlings from the commercial seed and from the seed bank seeds. (Commercial seed is specially grown and plants may be more consistent than those from your seed bank. Seeds from an actual squash are usually hybrids and might have some mixed characteristics.)

2. Now that students have seedlings to observe, examine and discuss the parts of a seed. Seeds have three parts - embryo, endosperm (food storage tissue), and seed coat. Use the transparency ***Parts of a Seed*** as a guide. Have students work independently or in small groups; ask them to make (and label with correct names) their own sequential drawings of how seeds sprout - from seed through seedling - to follow along with the discussion.

3. Students can plant the seedlings in a school garden or take them home for replanting. Remind them not to plant the seedlings outside until after the last freeze or frost date in your area. If they take seedlings home, encourage students to record seed growth by taking or drawing pictures and measuring. Challenge students to create their own seed banks with the seeds collected from the commercially-grown squash (seed packet). Do not have students save seeds from the hybrid squash grown from the classroom seed bank (Planting, Session One). Explain to students that the plants produced from those seeds will not resemble the parent plants.

EVALUATION OPTIONS

1. Students write a list and describe the steps involved in gathering and storing their seeds. *(Growing and picking a fruit, gathering, cleaning, drying, labeling, and storing the seeds from the plant.)* Have them describe what a seed bank is and why it is important. They also can illustrate each step of the growing process, seed through seedling.

2. Have students write a short story describing a future situation in which seeds from a seed bank were used to save a crop, where there was only one seed left to plant, where a "mystery seed" saves the day, and other similar situations.

3. Have students write about six ways in which people use seeds. They then circle the ways in which seeds also were used in the past. Have them describe two ways we use seeds today that are different from ways in which seeds were used in the past.

4. Have students draw or write about why they think seeds are important. In what ways might we use seeds in the future?

EXTENSIONS AND VARIATIONS

1. Using a variety of seeds, students can create their own expanded seed banks in airtight glass jars. Encourage students to bring in seeds from home. The preserved seeds can then be exchanged and planted by other students at home.

2. Have a seed-tasting party! How many seeds can students bring in that are edible foods? (Sesame, sunflower, poppy, seeds that grow on trees [pecans, almonds, and walnuts], seeds that grow underground [peanuts], coconut, peas, beans, rice, pumpkin seeds, pomegranate seeds, and more.) Investigate where they grow, their life histories, and when and how they are harvested.

3. Stage a mystery-seed event. Students bring a variety of seeds from home, put them into a class table top or bulletin board display, and challenge classmates to "name that seed."

4. Create seed mosaics. Students draw pictures or designs, then fill in their drawings by gluing on a variety of seeds.

5. Use a seed collection to launch study units on seed-dispersal methods, edible seeds, planting of seeds, and growing seeds.

6. Discuss seed-dispersal methods with students. Ask:

   - Since plants cannot move, how do seeds find new places to grow?

   - How does the seed coat of some seeds help them travel?

   After students have described their mechanisms for travel, share some of the ways seeds do travel.

   The outer seed covering often helps the seed move from one place to another. Some have fluffy hairs, wings, or blades to fly through the air. Others have hooks or burrs to attach to passing people and animals. Some (like coconuts) float and ride the ocean waves until they are washed ashore. Some smooth-coated seeds are carried and stored by squirrels and other animals, who then forget where they put them! They also are eaten by animals like birds and are distributed in their droppings.

7. Tell students that 25 percent of the active ingredients in cancer-fighting drugs come from organisms found only in the rain forest (excerpted from World Rainforest Report, Oct.-Dec. 1995, Vol. XII., No.4). Modern chemists use compounds from many rain-forest plants as the basis of medicine, insect repellants, insecticides, flavorings, and dyes. Rain-forest experts estimate that only 1 percent of rain-forest plants have been tested for medicinal value. Ask students to make posters of plants and seeds from rain forests that may hold cures for cancer, AIDS, and even the common cold. They can use resource books and computers, write letters, or interview experts to find out what measures are being taken to bank rain-forest seeds to preserve and protect disappearing species where rain forests are being destroyed. Possible sources of information include zoos, museums and botanical gardens that have rain-forest displays; college and university botany departments; and organizations working to protect the rain forest (e.g., World Wildlife Fund, National Wildlife Federation, Rainforest Action Network, and others).

8. Have students research hydroponics (see Supporting Information), growing seeds in space experimentation, and genetic engineering work with seeds. What is being done? What are some of the results?

9. Sing the following song with students to reinforce the lesson concepts.

MIRACLE OF LIFE

Song tune: "Eentsy Weentsy Spider"
Lyrics used with permission from Beverly Bruns, Victoria, Texas

The itsy bitsy seed is a miracle of life
In-side each coat a plant waits just to sprout.
Put a seed in soil out comes a tap root
And the itsy bitsy seed now becomes
a growing shoot.

ADDITIONAL RESOURCES

Ashworth, Suzanne. *Seed to Seed*. Seed Saver Publishing. 1995. ISBN: 0961397772.

Black, Michael. *Seed Technology and Its Biological Basis*. CRC Press. 2000. ISBN: 0849397499.

Burpee Seed Company (seeds, plants and information about starting school gardens). West Atlee Burpee Company, 300 Park Avenue, Warminister, PA 18975. http://www.burpee.com.

Henry, Peggy. *The Great Seed Mystery for Kids*. Harper Collins. ISBN: 1880281112.

National Gardening Association, 180 Flynn Ave. Ste 3, Burlington, VT 05401. (802) 863-1308.

National Center for Genetic Research Preservation (formerly National Seed Storage Laboratory). Agricultural Research Service. North Plains Area, United States Department of Agriculture. 111 South Mason Street, Fort Collins, CO 80521-4500. (907) 495-3200. http://www.ars-grin.gov

Patent, Dorothy Hinshaw. *Biodiversity*. Clarion Books. 1996. ISBN: 0395687047.

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General Seed Information

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Seed Companies

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Burpee Seeds and Plants. 2002. http://www.burpee.com

DeKalb Seeds. 2002. http://www.dekalb.com

Evergreen Seed, Inc. 2002. http://www.evergreenseed.com

Flagstaff Native Plant & Seed. 2002. http://www.flagnativeplant.com

Garden Makers, Hard to Find Seed. 2002. http://www.gardenmakers.com

Harris Moran Seed Company. 2002. http://www.harrismoran.com

Horizon Herbs, LLC. 2002. http://www.chatlink.com/~herbseed/gizhome.html

Lawnseed.com. 2002. http://www.lawnseed.com

Native American Seed. 2002. http://www.seedsource.com

The New England Seed Company. 2002. http://www.neseed.com/store

Pioneer Hi-Bred International, Inc. 2002. http://www.pioneer.com

Plants of the Southwest. 2002. http://www.plantsofthesouthwest.com

Oriental Vegetable Seeds- Evergreen Seeds. 2002. http://www.evergreenseed.com

Park Seed Company. 2002. http://www.parkseed.com

Reisig Seeds, LLC. 2002. http://www.seedwheat.com (Site includes tour of seed facility.)

Seeds From Around the World. Seedman.com. 2002. http://www.seedman.com

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EDUCATOR'S NOTES

 Conceptual Framework Reference: I., I.F.3., II., II.C.1., II.C.6., II.C.7., IV., IV.E.1., VI., VI.A.2., VI.A.4., VI.B.1., VII.A.4., VII.B.1., VII.B.3.

BANKING ON SEEDS

Name:____

1. Describe what you see inside the squash.

2. What shape are squash seeds? Draw one here.

3. How are the seeds arranged? Draw the arrangement.

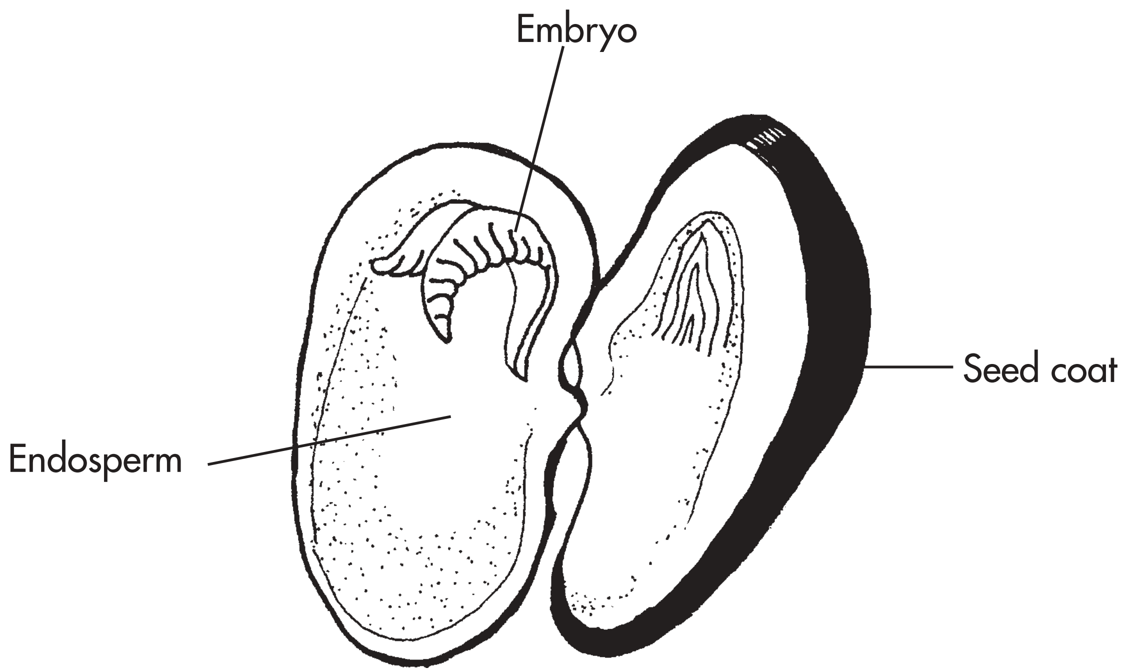
4. All plants and animals have special ways to protect their offspring. Which parts will become the next generation of squash?

5. How is the squash naturally designed to protect its seeds?

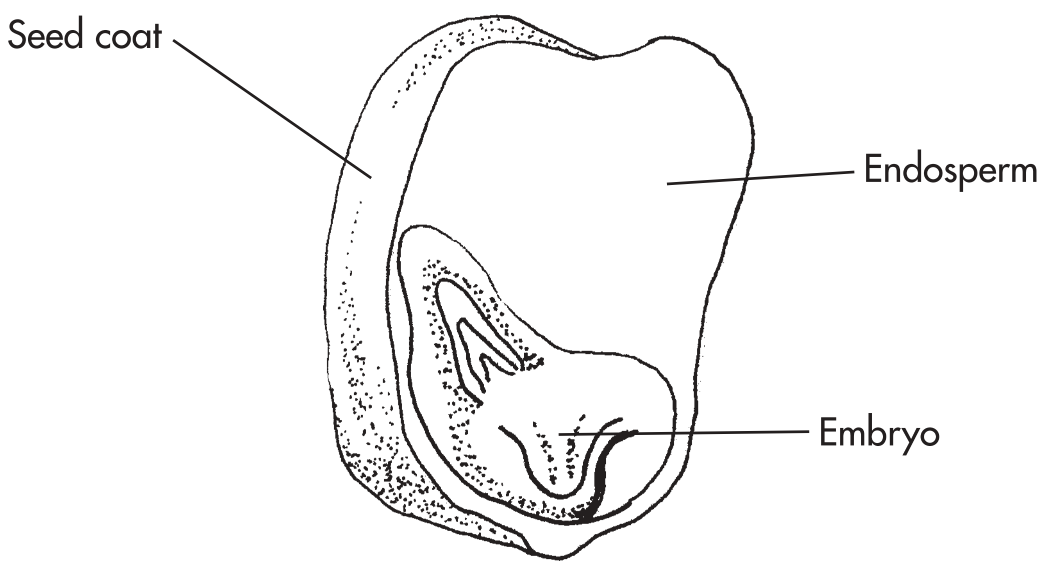
6. How many seeds do you guess or predict are in the squash? __________________

7. Carefully pick all the seeds from your squash. Dry them off and count them. How many seeds were in the squash? __________________
   Who in the group had the closest estimate? __________________
   How did he or she choose the number?

PARTS OF A SEED



Dicot (plant with 2 cotyledons)



Monocot (plant with 1 cotyledon)