Plant Reproduction

Purpose: Students will read about, discuss and perform two types of plant propagation – seed planting (sexual) and stem cuttings (asexual). The genetic differences in these process as well as the advantages and disadvantages of each technique will be apparent to students.

Time: 2, 45 minute sessions

Level: 7th grade

Materials:

- Internet access
- Seeds *(soybean seeds and corn kernels work well but any seed that sprouts will do!)*
- Jeweler size plastic bags *(these can be purchased from craft stores, online or might even be free from a jewelry store)*
- Cotton balls
- Water
- Hole punch
- Yarn or string
- Clean scissors
- Soil or potting mix
- Planting pots
- Stock Plant – used to take stem cuttings. Plants that will provide a high success rate:
  - Herbs – Mint, basil
  - Coleus
  - Swedish Ivy
  - Pothos Ivy
  - Grape Ivy
  - English ivy
  - Geranium
  - Philodendron
  - Wandering Jew

Minnesota Science Standards and Benchmarks

7.4.3.1.1 Recognize that cells contain genes and that each gene carries a single unit of information that either alone, or with other genes determine the inherited traits of an organism

7.4.3.1.2 Recognize that in asexually reproducing organisms all the genes come from a single parent and that in sexually reproducing organisms about half of the genes from each parent.

Background

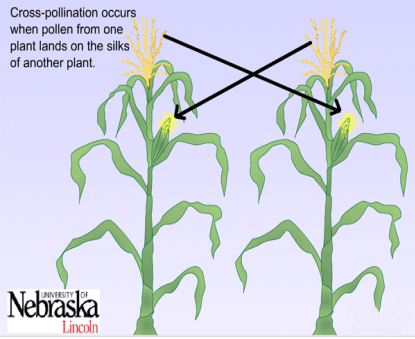
Plants provide perfect living specimens for comparing sexual reproduction (AKA propagation) and asexual reproduction. Focusing on plants that provide edible products (fruits, vegetables, flowers, etc.) can assist in engaging students and peaking their interest – it seems that everyone can relate to FOOD!

Many times seeds are thought of as lifeless objects without "vital signs." However, each seed contains genetic information from a male and female parent. This information is contained in the small (sometimes microscopic) embryo inside of the seed. The development of a seed can be attributed to the flower, pollination and fertilization processes (see attached student reading *Seed to Seed 101*). Corn is a common agricultural plant grown in Minnesota that can be used to demonstrate the seed production process. The steps are described below.

1. Corn seeds (or kernels) are planted in the soil.
2. With proper nutrients, light and water, this kernel develops into a plant that contains both male and female parts of a plant. The male part is called the **tassel** and is found at the top of the corn plant. The female parts of the corn plant, called **silks,** are found in the shoot that will develop into the ear of corn – the ear shoot.
3. The tassel holds pollen. This pollen is transferred to the female ear shoot that contains 750-1000 ovules that each produces a silk. If a pollen grain reaches a silk then a kernel will develop. Each kernel that develops on an ear of corn is a separate individual with different genetics. However, the kernels on an ear of dent corn will all look very similar because plant geneticists and crop scientists have done years of plant breeding and selection to limit the trait variation. Farmers want to produce the corn with the highest yields (production) and also plants that can survive droughts, resist insects and disease, and have the same number of days to maturity. For these reasons, there is limited variation in the offspring (kernels) produced.

Students will research the flowers of vegetable and fruit plants and illustrate how the genetics from the parent plants produce a new seed, which will develop into a new plant.

Plants also have the ability to reproduce without utilizing the genes from parents. This process of reproduction is called asexual reproduction. Plant scientists routinely refer to asexually reproduction as vegetative propagation. In asexually propagation, a complete plant can be regenerated from a severed piece of stem, root, a bud, leaf or even a small group of certain plant cells. The new plant that is generated will be genetically identical to the plant that it was "cut" from. The phenomenon of asexually propagation can be easily



demonstrated in a classroom using stem cuttings. Students cut off a small portion of the stem of a plant (see Stock Plant lists for examples). This "wounds" the plant and cuts off the water supply. When this cutting (removed portion of the plant) is placed in soil or water and provided with light – new roots will be developed and a new plant will be on its way! Roots are most likely to develop at a stem wound that is in firm contact with moist soil. When a plant is wounded, hormones called auxins collect briefly around the wound and cause cell division so that it begins to form embryonic root tissue. This tissue develops into fully functioning roots and the plant will continue to grow leaves, stems and additional plant parts identical in genetic make-up to the parent plant.

The processes of planting seeds and also taking stem cuttings are easy and fun activities for students to complete. The plants that result are perfect for inquiries, discussions, and experiments on genetics and the environment.

Procedure

Session 1 – Sexual Reproduction - Seed Genetics

1. Tell students to look around the room. Ask students:
    a. What differences do you see in your classmates? *(hair color, eye color, skin color, height, foot size, etc.)*
    b. Why don't we all look the same? *(genetics from our parents)*
    c. Why don't you look identical to your siblings – you have the same parents? *(Each parent only passes on half of their genetic information. So siblings receive different combinations of their parents' genes)*
2. Display a variety of seeds and/or seed packages and ask students to contemplate what these seeds have in common with humans and genetics. Have students share their thoughts.
3. Inform students that seeds are the offspring of plants. Just like a human baby, a seed contains genetic information from a male parent and a female parent.
4. Instruct the students to read *Seed to Seed 101*. Inform students to think about the steps in the process of seed formation as they read. After students are finished reading have them record in their notebook or a journal, using words and pictures, how a plant produces a seed.
5. Have students (working in teams or individual) select a seed and research (using the internet or print resources) the flower structure of the specific plant the seed belongs to. Instruct students to diagram and describe how the specific plant produces a seed. As the teacher, you can model what you want students to diagram and describe using the Background information on corn. Have students share and compare their results.
6. Instruct students that they will be planting their seed and observing how the embryo inside the seed develops into a plant that contains the genes from its parents**. Model the steps below:**
    a. Punch a hole in the top of a small jewelry sized plastic bag.
    b. Dip a cotton ball in water. Give the cotton ball three "flat" squeezes to remove excess water.
    c. Place the cotton ball inside the plastic bag.
    d. Place two seeds in the plastic bag, one on each side of the dampened cotton ball.

e. Tie a string or piece of yarn through the hole punched in the top of the plastic bag. Wear the string and bag like a necklace.

DO NOT close or seal the plastic bag – the seed needs air to sprout!

The seeds should soon swell up from the moisture and germination should take place in about three days.

7. Assist students making their necklaces and encourage them to wear them – the body heat assists in germinating (sprouting) the seed.
8. Each day have students record in their journals the changes they observe in their seeds. Review the reproduction process and have students use their knowledge of genetics to hypothesize how closely the new developing plants would resemble their parents.
9. Once one of the seeds has germinated, remove the other seed. There is only enough room and moisture to support the growth of one seed.
10. The seed can be transplanted into soil by cutting off the bottom of the bag, pulling out the germinated seed (cotton ball and all), and transplanting to a container with soil.

Session 2 – Asexual Reproduction – Stem Cuttings

1. Ask students to list as many differences and similarities between plants and humans. Have students work in teams or individually to record these items in a Venn Diagram or other graphic organizer.
2. If it is not brought up (which it probably won't be!) ask students if humans can regenerate body organs. Ask students:
    a. If you cut off your finger, does a new one grow back? *NO!!*
    b. If you cut your toe, does a new toe sprout where the old one was cut? *NO!!!*

    Plants are able to generate a new plant from just a small piece of stem, leaf, or other plant tissue.
3. Use the **Background** information to explain the process of asexual reproduction (AKA vegetative propagation). Have students work in teams or individually to list the similarities and differences between this asexual reproduction method and the sexual reproduction method (seeds!) that they learned about previously. Once again a Venn Diagram or other graphic organizer works well.
4. Prompt students to compare the genetic differences in the offspring of a new plant produced from a seed (sexual reproduction) and a cutting (asexual reproduction).
    a. Is the new plant produced from a seed genetically identical to its parents? (*No – it is a combination of genes from both parents)*
    b. Is the new plant produced from asexual propagation genetically identical to its parents? (*YES – no genetic variation exists because the new plant is coming entirely from one "parent" or "stock" plant.)*
5. Inform students that they will be creating new plants that are genetically identical to a parent plant. Model the steps below:

a. Fill a small container (2 inch pot or small cup with holes in the bottom) with potting soil.
b. Find a section of plant stem that is 4 inches long and has about 2-4 leaves.
c. Find a node on this section of stem. A node is where the leaf attaches to the stem. This is where new roots will form so the cut will be made just below the node.
d. Using a clean, sharp scissors, cut the stem about ½ inch below a node at an approximate 45 degree angle. The angle increases water intake for the cutting.
e. If there is a leaf at the node you cut below, gently remove it.
f. Place the cutting in the container with soil. The roots will form from the bottom node, so be sure that the node is below the surface of the soil and the remaining stem and leaves are above the surface of the soil.
g. Water the soil immediately. Apply water until you can see it flow out the holes in the bottom of the container. Place the container with the cutting in bright, indirect sunlight.

6. Monitor the cuttings daily – make sure they are moist (not soaking wet) and receive plenty of light. Each day have students record in their journals the changes they observe and monitor root growth. Compare this development to their seeds. Review the reproduction process and have students use their knowledge of genetics to hypothesize how closely the new developing cutting resembles its parent. (It should be exactly the same!)

Additional Activities

- Organize a field trip to a local nursery to see seed propagation and asexual propagation in person. Have the owner and propagators explain the advantages to both methods.
- Have students design their own experiments that focus on analyzing the genetic variation and environmental factors in plants. Some experiments:
  - Compare planting media (potting soil, top soil, sand, water, etc.) to see how it affects plant growth of both seeds and cuttings.
  - Take different cuttings (stem, leaf, flower, etc.) from the same plant and analyze growth and appearance
- Explorers and plant collectors of the past and present use the technique of taking cuttings to document and move plants around the world. Lead students in brainstorming about why asexual propagation is a useful tool for plant transportation. Use *The Plant Hunters* at www.ars.usda.gov/is/kids/story4/sotry4/htm for inspiration

Seed to Seed, 101

Where do seeds come from? Flowers are the key. Although we humans enjoy their beauty, fragrance and, in some cases, nutrition, flowers are not here to please us! Their sole function is to produce seeds. The color, size, shape, smell, and other characteristics of flowers are vital to this effort. Flower structure can vary greatly, but there are a number of basic parts. The female organ, the **pistil,** is generally in the center of the flower. Its sticky **stigma,** which traps pollen, is held up by the tube-like **style.** This leads down to the **ovary,** inside of which are **ovules,** which contain female egg cells. The male parts, the **stamens,** typically surround the **pistil.** The **anther** on top of the stamen produces pollen, which contains male sperm cells. During pollination, pollen is moved from male to female flower parts by wind, bees, birds, bats, and a host of other animals. Flowers entice pollinators — using bright colors, designs, special shapes, and aromas — to the promise of sweet, nutritious nectar inside. When a pollen grain lands on the stigma, a tiny tube grows from it down to the ovary. Sperm cells then travel through this tube to an ovule, and there joins with an egg cell in a process called **fertilization.** The fertilized ovule will become a seed, and the ovary, a fruit. Without this process, the cycle of life would cease!

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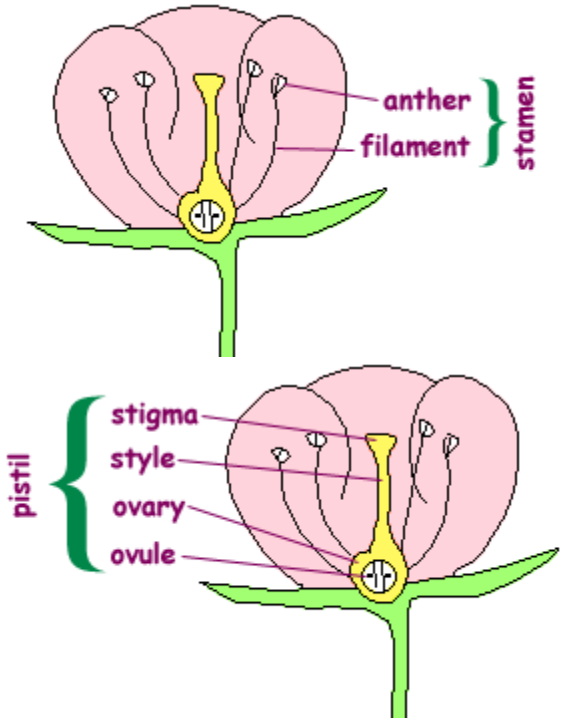

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