Sex, Bugs, and Pollen's Role

Principle of Plant Biology #4

Reproduction in flowering plants takes place sexually, resulting in the production of a seed. Reproduction can also occur via asexual reproduction.

Plant sex is so integrated into our lives that we hardly think about it. When you eat fruit, you are eating a mature ovary. If someone gives you flowers, they are giving you plant reproductive structures. The yellow pollen which covers cars and makes people sneeze is full of plant sperm. When you see bees and butterflies hovering around flowers, they are carrying pollen from flower to flower, allowing sexual reproduction to take place. Plant sex is all around us.

Flowering plants (angiosperms) reproduce during sexual reproduction by making seeds. In a flower, the male parts (called stamens) hold pollen, which contains sperm. Once the pollen is mature, it must be transported to the female part of a flower. This is called pollination, and can be accomplished in a number of ways including being carried by the wind or transported by insects. The female parts of a flower (called pistils or carpels) contain eggs. When the sperm reaches an egg, they combine in a process called fertilization. The resulting fertilized egg (called a zygote) develops into a seed which is eventually released so that it can germinate and create a new plant. Sexual reproduction is important because it combines genes from both parents making the offspring genetically different from the parents.

Flowering plants can also reproduce through asexual reproduction. Certain parts of plants can produce new roots and shoots and these can develop into a new plant. This new plant has the same genes as the parent and is called a "clone". Gardeners often "clone" plants that have certain traits they like such as big, beautiful flowers or good tasting fruit.

In the following activity, you will use Wisconsin Fast Plants™ to study growth and reproduction in flowering plants. Wisconsin Fast Plants™ (*Brassica rapa*) are used because they grow and reproduce rapidly and have a life cycle of only 40-45 days. These plants are in the mustard family and are closely related to broccoli, cabbage, cauliflower and turnips. Many other plants can also be used.

Real-world Connection:
Plant reproductive structures are highly valued for their beauty and taste. In addition to their important role in culture, they also account for trillions of dollars in sales every year.

Activity: Plant Breeding

Planting the seeds:

1. Obtain one third of an egg carton (using only 4 holes in the carton) and number each compartment. Place the date and initials of your group on a label and tape it to the egg carton.

2. Obtain wicks for each section of the egg carton. Push a wick through a hole in the bottom of each egg carton so that half of each wick sticks out of the bottom.

3. Add potting soil to all sections until they are half full. In each of two sections add 3 seeds of one variety of Wisconsin Fast Plants™ and in the other two sections add 3 seeds of a different variety of Wisconsin Fast Plants™. Cover these seeds with a little more soil. Carefully sprinkle all the sections with water.

4. Place the cartons on a tray of water and make sure there is contact between the water and each section's wick. Now place these under the designated lights. Check the plants daily to make sure they have enough water. The lights should stay on all the time (24 hours).

5. Check the plants every three days to record quantitative measurements such as height, number of leaves, date of first flowers, numbers of flowers and pods. At the end of the plants' life cycle, count the number of seeds produced in each pod. Also, record qualitative data such as color of leaves, presence and location of hairs, color of flowers, etc.

6. After the seeds germinate (on about Day 4 after planting) thin the plants to two plants per quad or section.

Pollinating the flowers:

7. Once flowers start developing (Day 15-17) you must separate the plants of different varieties by placing a piece of cardboard between the plants since they cross pollinate. Use bee sticks or Q-tips™ to pollinate the flowers. Brush the bees or Q-tips™ into the flowers to pick up the pollen of the specific variety you want to use and then brush this onto another variety of plant flowers. Do this for 2-3 days.

8. One day after final pollination cut off any new flowers or buds (on the tip of the plant) so the plant can use its energy to make the seeds grow and mature. Do not cut off flowers that were pollinated. Keep watering and fertilizing the plants until Day 37.

Collecting the seeds and re-planting:

9. Stop watering on Day 37. Collect the pods, open them and count the seeds in each pod. Save the seeds.

10. Repeat the process for growing seeds above using the seeds you have collected from your cross. This time let the plants grow and record quantitative and qualitative data on this new generation of offspring. Note any differences in the new plants.

Student-Designed Experiments

Using the methods you learned in the activity above and the "Guide for Student Experimentation" below, design and carry out your own inquiry. Question topics you might consider include different pollination methods, different plant varieties, changing the amount of light, temperature, or fertilizer, etc.

Guide for Student Experimentation

Guidelines for Achieving Great Experiments

1. Ask a very specific, testable question.
2. Test a control for comparison (a group that does not receive the experimental treatment).
3. Use a sample size large enough to allow firm conclusions.
4. To understand a whole population, obtain a random sample of that population to avoid bias.
5. Replicate each part of the experiment (at least 3 times).
6. Hold all variables constant between trials except the variable being tested.
7. Collect quantitative data whenever possible.
8. Measure using metric units.
9. Gather data carefully and accurately.
10. Be objective and honest.

Introduction

Question:

Hypothesis:

Materials and Methods

Independent variable:

Dependent variable:

Experimental constants:

Control:

Protocol:

Results

Data collected:

Other observations:

Graph(s):

Discussion

Interpretation of data:

Conclusions:

Teacher's Guide to "Sex, Bugs, and Pollen's Role"

Links to National Science Education Standards

Grades 5-8:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- Structure and function of living systems
- Diversity and adaptations of organisms
- Science and technology in society

Grades 9-12:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry
- The cell
- Matter, energy, and organization in living systems
- Science and technology in local, national, and global challenges

Materials

Per Group:

- One third of an egg carton (4 compartments; any small pots or potting trays will also work)
- Wicks (order or make from 4 cm x 2 cm filter paper or felt strips)
- Watering mat or felt pad
- Watering tray, plastic shoe box or plastic sandwich container
- Several dried bees (or Q-tips)
- Toothpicks and glue for making bee sticks (or Q-tips)
- Fast Plant seeds (or other seeds)
- Metric ruler
- Cardboard for separating flowering plants

For Class Use:

- Potting soil
- Light box
- Variety of Fast Plant seeds (or other seeds)
- Water with fertilizer dissolved in it.

Teaching hints

1. Obtaining and preparing material:

The website http://www.fastplants.org/ provides instructions, resources, activities, directions for making equipment (such as a cheap light box), and new materials developed by Paul Williams. The materials needed for this experiment can be obtained from biological supply companies but most of it can be obtained from materials readily available in stores such as the potting soil, water mats (felt squares), egg cartons, wicks, Q-tips. Fast Plant seeds must be ordered from a supply company or from Paul Williams. Besides the Standard Fast Plant (Improved Basic), examples of variations for student experimentation include: Purple Stem-Hairy, Yellow-Green Leaf, Rosette-Dwarf, Tall Plant, and Variegated. These and others can be found listed at http://www.fastplants.org/intro.kinds.php.

There are many other websites that describe experiments and activities using Wisconsin Fast Plants™.

2. Successful student-designed experiments:

- Emphasize the "Guidelines for Achieving Great Experiments."
- Before students design experiments, tell them how much time they will have.
- Allow students to present their experiments and lead a short discussion about each one. Encourage other students to ask questions.

Web Resources

WELCOME TO FAST PLANTS® To know a plant, grow a plant!
http://www.fastplants.org/

Wisconsin Fast Plants Growing Instructions
http://www.fastplants.org/pdf/growing_instructions.pdf

Wisconsin Fast Plants Growth, Development and Reproduction Booklet
http://www.fastplants.org/pdf/activities/WFP_growth-development-06web.pdf

Acknowledgements

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