The Huntington Library, Art Collections, and Botanical Gardens

Making Plant Clones

Overview

Students will select a plant to asexually propagate, and from a study of propagation techniques design an experiment to test the most effective methodology for encouraging new growth.

Introduction

Plants reproduce sexually via flowers, cones, spores, and other specialized structures. But commonly, more so than the animal kingdom, plants also reproduce **asexually** via mitosis—producing clones. Plants sometimes have specialized structures for this function, but can often be induced to asexually reproduce from non-specialized organs (roots, stems) or even from a small culture of cells. Humans have exploited asexual reproduction for a variety of reasons. Through cloning plants, we are able to buy seedless oranges or bananas, easily obtain a once-rare orchid, or make an apple tree that produces 2 different varieties. Propagation experiments are an ideal way to introduce or refine the scientific method in your classroom, as they lend themselves to a variety of inexpensive, easily designed, and easily observable possibilities.

Motivation

If a seedless orange doesn't have seeds, how are new ones grown? The answer involves cloning. Where has cloning been in the news lately? Much of the news has centered on cloning of animals or humans. Plant clones aren't as newsworthy because humans have been cloning plants for years and years. Many of the fruits that we eat are produced this way, like the seedless oranges. Plants even clone themselves--without human involvement--all the time. Arguably, the quaking aspen tree is the biggest organism in the world because of its ability to clone. There are stands of aspen on mountainsides, acres and acres wide, that all change color at the same time. They all share a common root system which continues to send up new shoots without producing flowers or seeds, and therefore the whole stand is genetically the same…one giant organism.

Your task will be to try to optimize the process of asexually propagating a test plant.

Objectives

Upon completion of the lab, students should be able to

1. Outline various methods of propagation.
2. Describe asexual reproduction including a discussion of cell division and differentiation.
3. Demonstrate effective propagation techniques.
4. Design and conduct a controlled scientific experiment.

Possible Materials

Note that some of these materials are not necessary for effective propagation, but are listed as a possible elements for comparative experiments.

- Pearlite, sand, vermiculite, soil, and/or other potting media
- Wooden or plastic stakes
- Small plastic pots or flats
- Root-tone or other rooting hormones
- Scissors

- Rubbing alcohol or ethanol
- Rooting heat mats
- Rooting gel
- Plastic wrap
- Source plants such as *Philodendron*, Tahitian Bridal Veil, Spider Plant, Mother of Thousands, *Zebrina*, *Coleus*, African Violet, Begonia

Associated California State Biology Standards
Investigation and Experimentation

Procedure
1. Demonstrate proper propagation technique for the students by following the steps below.
    a. Prepare the potting medium by filling a pot or flat and wetting thoroughly.
    b. Sterilize a scissors by rubbing with ethyl alcohol.
    c. Cut a section from the source plant. You may need to experiment to find which parts root easiest. Try starting with a leaf and its petiole (the stem that connect the leaf to the main "trunk").
    d. Reduce the surface area of the leaves on the cutting. Because the cutting lacks roots, water uptake will be slow. Reducing leaf areas lessens transpiration/water loss to compensate.
    e. Though usually not necessary, the cutting can be dipped in rooting hormone at this point.
    f. Place the cutting in the potting medium. Make sure a large area of the cutting is in contact with the medium.
    g. Repeat with more cuttings.
    h. When switching to different plants, re-sterilize the scissors each time to prevent spread of any diseases.
    i. Place the pot or flat of cuttings in a light area. Water frequently, keeping the medium moist. Cover the flat or pot with plastic wrap to increase humidity and prevent water loss.
    j. Check the progress of rooting on a weekly basis. When there has been a good amount of roots produced by the cutting, transfer to the garden or to potting soil in another pot.
2. After providing a demonstration, introduce the students to the materials they have available for propagation (from the materials list above).
3. Ask the students to form groups and come up with an experiment to test propagation techniques, determining the effectiveness of different methodologies. Students can explore variations of the procedure above to test different variables. The potting medium can be varied, using sand, rooting gel, pearlite, water, etc. Students may also experiment with heating mats to promote root growth, rooting hormones, levels of leaf removal, etc. The groups should write a proposal for the experiment (including hypothesis, materials, controls, variables, replicants, quantification, analysis, etc.) and turn it in to the teacher for approval.
4. Allow class time and space for completing the projects.
5. Students should formally write up the project and its results and briefly present it to the class.

Evaluation

The following questions are listed under the Analysis section of the student handout and may be used as part of a report, class discussion or assessment.

1. What is the control in your experiment? How many variables are you testing?
2. How much replication is necessary to support the validity of your results?
3. How will you quantify difference observed between your variables and your control?
4. Outline a procedure for inducing asexual reproduction in plants? Why is this procedure successful? Would it work with other or all plants? Why or why not?
5. Explain the process of cloning. What happens on a cellular level? Why are plants easier to clone than animals?

Extension Activities

1. Students can research and discuss (or write a paper on) the differences between animal and plant cloning. Why do plants asexually reproduce more easily and from so many different types of cells than do animals?

Test Preparation

1. Mitosis is a process by which
   - (A) microtubules are assembled.
   - (B) cytoplasm is divided.
   - **(C) the nucleus is divided into two nuclei.**
   - (D) the cell rests.

2. Cytokinesis in plant cells involves the formation of
   - (A) replicated chromosomes
   - **(B) a cell plate.**
   - (C) spindle fibers.
   - (D) centrioles.

Student Sheet: Making Plant Clones

Name:_____

Procedure

1. You teacher will demonstrate the proper technique for asexually propagating plants, or making clones.
2. After observing the process, you and your group should come up with a hypothesis and a plan to test one aspect of asexual propagation to help determine the most effective method for cloning. Your teacher will introduce you to some variations in the propagation technique and some of the tools available to you.
3. Write a proposal for the experiment (including hypothesis, materials, controls, variables, replicants, quantification, analysis, etc.) and turn it in to the teacher for approval.
4. Once your proposal is approved, you may begin your experiment. Complete the analysis section below.
5. Your teacher will instruct you as to how you will compile and report on your results.

Analysis

On a separate sheet of paper, please complete the following.

1. What is the control in your experiment? How many variables are you testing?
2. How much replication is necessary to support the validity of your results?
3. How will you quantify difference observed between your variables and your control?
4. Outline a procedure for inducing asexual reproduction in plants? Why is this procedure successful? Would it work with other or all plants? Why or why not?