NOVA

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PBS

First Flower

PROGRAM OVERVIEW

NOVA presents the search for the first flowering plant.

The program:

- recounts how one scientist discovered what might be the first flowering plant fossil, *Archaefructus liaoningensis*.
- follows the search for evidence of the first flowering plants in the Hengdaun Mountains of China, the most biodiverse temperate forest in the world.
- states that mosses, pines, and firs dominated the Earth for 300 million years until flowering plants became prevalent—but how and when this change occurred is a mystery.
- shows how flowering plants flower and produce the new generation—fruit—that allows the plant to adapt to a different set of circumstances.
- shows how *Archaefructus'* separate pollen-producing organs and female organs may have evolved to be joined.
- recounts the journey and discoveries of early 1900s botanist Ernest H. Wilson, who collected more than 20,000 plant specimens from China.
- suggests a hypothesis for how the first flower may have evolved.
- introduces a botanist who disagrees that *Archaefructus* is the first flowering plant and describes how her technique of sifting through ancient sediments has revealed a 120-million-year-old flower.
- explains another botanist's method of analyzing leaf vein patterns and pollen structure to reveal clues to plant evolution, and notes that the first pollen shows up on rocks of the Cretaceous period 134 million years ago.
- reports on radioactive decay measurements of ash beds surrounding the *Archaefructus* fossil site that date it to the early Cretaceous rather than the Jurassic Period it was first believed to have evolved in.
- describes the original method used to organize the plant family tree—by comparing features of plants—and explains how plant DNA analysis has rewritten that record.
- reports that DNA analysis identifies *Amborella trichopoda*—a plant only found on New Caledonia—as the oldest living flowering plant.
- states that *Archaefructus* appears older than *Amborella* based on pollen, leaf, and flower analysis.

BEFORE WATCHING

1 Have students bring in flowering plants and distribute them among groups. Ask students what the flower is for *(seed formation leading to plant reproduction)*. On the board, draw and label the parts of a flower. Make a chart with each part's function. Have students locate the following parts on their flowers: anther and filament (stamen); the stigma, style, and ovary (pistil); and the petals (corolla). Discuss differences in reproduction between flowering and non-flowering plants.

2 Organize students into three groups. As students watch the program, have each group take notes on one of the following: the geography and ecology of the area featured in China; the technologies, materials, and procedures used to study and date plant findings; and plant classification.

AFTER WATCHING

1 Have students refer to their notes as you lead a discussion concerning the evolution of flowers. Ask students to provide examples of plant diversity. What accounts for that diversity? What techniques do scientists use to determine the evolution of the first flowering plant? How has DNA fingerprinting changed plant classification?

2 One scientist in the program studies how changes in leaf vein patterns can provide clues to plant evolution. Advanced leaves often have straighter veins to more effectively provide sugar to the plant, whereas earlier leaves have more wandering vein patterns. Have students bring in leaves. Discuss the function of leaf veins and ask students to draw and describe vein patterns, noting which ones they think are examples of earlier or later evolution and why.

CLASSROOM ACTIVITY

Activity Summary
Students extract DNA from bananas.

Materials for Each Team
- copy of "Extracting DNA from Bananas" student handout
- 1 large banana
- 1¼ cups distilled water
- 1 teaspoon clear detergent soap containing EDTA
- ¼ teaspoon table salt
- 15 ml isopropyl alcohol (91 percent)
- blender
- 2 16-ounce plastic cups
- 1 plastic spoon
- 1 set of measuring spoons
- 1-cup measuring cup
- 1 #4 cone paper coffee filter
- 1 rubber band
- 2 250 ml beakers
- 1 plastic pipette or eyedropper
- 1 thin glass rod

Background
Cells are the functioning units of living things. Cells reproduce, in part, by making and passing DNA (deoxyribonucleic acid) from parent cells to offspring. DNA in the cells has the instructions required for the cells to carry out their functions. All DNA is made up of the same physical and chemical components. The order of the bases—adenine, thymine, guanine, and cytosine—"spells out" directions necessary to make a specific organism that has distinctive characteristics. In the program, DNA is extracted from plants and then analyzed to help classify plants and generate a more accurate family tree.

The DNA extraction students will perform is called a gross extraction. This is because the DNA product students isolate will not be pure DNA. The string-like DNA precipitate may also contain RNA. The extraction is genomic in that it contains all of the DNA from the cells, not separate strands of DNA.

Procedure
1. Before the activity, place the alcohol in sealed test tubes (enough tubes so there is one for each team) and chill by placing the test tubes in a beaker containing ice cubes and some water.
2. Distribute the student handout, review the procedure and key terms with students, and discuss any questions. Explain that crushing the bananas separates connected cells and exposes them to the soap and

LEARNING OBJECTIVES

Students will be able to:

- understand that DNA is in living and once-living things.
- explain how DNA can be extracted from plant matter.
- describe DNA's physical appearance.

KEY TERMS

- **DNA**: Deoxyribonucleic acid, which is the hereditary material in cells that contains the instructions for producing the cell and enabling it to function.
- **extraction**: A procedure to obtain a substance by chemical or mechanical action.
- **filtrate**: The material collected after it passes through a filter.
- **precipitate**: Solid material that comes out of solution as a result of a chemical or physical change.

CLASSROOM ACTIVITY (CONT.)

salt. The soap helps break down cell membranes and release the DNA, the salt helps bring the DNA together, and the cold alcohol helps the DNA precipitate out of solution so it can be collected.

3 Demonstrate the following:
- Show what it means to stir gently and not cause the solution to develop a froth or foam.
- Demonstrate how to fold the coffee filter over the cup and secure it with a rubber band so that the solution can pass through the filter and be collected in the cup. Leave about one inch between the bottom of the cup and the bottom of the filter.

4 Remind students to get their test tubes with alcohol only when they are ready to use them, and stress the importance of carefully following the procedure.

5 Organize the class into teams. Have students gather their materials and begin their extractions. Consider keeping the blenders, the beaker with the test tubes containing alcohol, the soap, and the salt in one general area. You may also want to prepare a batch of blended bananas for the entire class and distribute the mixture to teams.

6 After student teams have completed the activity, have them share their results. Were all teams able to extract DNA from the banana? Ask students to describe what the DNA looks like. Why is it important for scientists to be able to extract DNA from an organism?

7 As an extension, have students try to isolate their own DNA using the instructions in the "See Your DNA" at www.pbs.org/nova/teachers/activities/2809_genome.html

STANDARDS CONNECTION

The "Extracting DNA from Bananas" activity aligns with the following National Science Education Standards (see books.nap.edu/html/nses).

GRADES 5–8

Life Science
- Reproduction and heredity

GRADES 9–12

Life Science
- The cell
- The molecular basis of heredity

Video is not required for this activity.

Classroom Activity Author

Developed by WGBH Educational Outreach staff. This activity originally appeared in a slightly differently form on NOVA scienceNOW's "Artificial Life" Web site.

ACTIVITY ANSWER

Student Handout Questions

1 Describe the appearance of the DNA you extracted. *The DNA will appear white, string-like, and sticky (in that it will wrap onto the glass rod).*

2 Summarize the main steps involved in extracting DNA from bananas. *Students might answer that they crushed the bananas to help release the DNA and made a solution—water, shampoo, and salt—to free the DNA from other components. They may note that the shampoo broke apart the cellular and nuclear membranes, which released the DNA, and that the salt helped the DNA strands come together. They may also note that they used coffee filters to remove large particles, and alcohol to precipitate out the DNA. (DNA is not soluble in alcohol.) Lastly, they may note that they observed the final product, the DNA, on a glass rod.*

3 Do you think your results would be different if you used a vegetable or fruit other than bananas? Explain. *DNA can be easily extracted from many different plants. The amount of DNA extracted depends upon many factors, including the number of cells crushed, and whether the cells can be easily broken apart.*

LINKS AND BOOKS

Links

NOVA— First Flower
www.pbs.org/nova/flower
Profiles a modern-day plant hunter, features a slide show of some common garden flowers that originated in China, presents a comparison of a modern flowering plant to the Archaefructus *fossil, and offers a matching game of plants and their pollinators.*

Anthophyta: Fossil Record
www.ucmp.berkeley.edu/anthophyta/anthophytafr.html
Considers the origin of flowering plants.

Geologic Time Line
www.sdnhm.org/fieldguide/fossils/timeline.html
Presents a time line of Earth, highlighting geologic events and noting when different life-forms arose.

NatureWorks: Angiosperms
www.nhptv.org/natureworks/nwep14f.htm
Introduces different types of flowering plants and describes pollination.

Books

Evolution: A Beginner's Guide to How Things Adapt and Survive
by David Burnie.
Dorling Kindersley, 2002.
Examines the origin of life on Earth and how natural selection works.

The Private Life of Plants
by David Attenborough.
Princeton University Press, 1995.
Discusses natural history, plant diversity, and plant survival.

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David H. Koch HHMI cpb

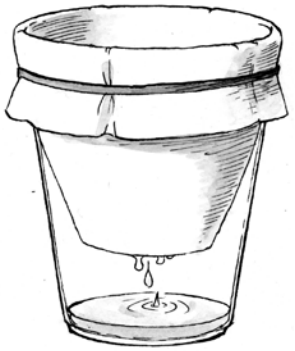
NOVA

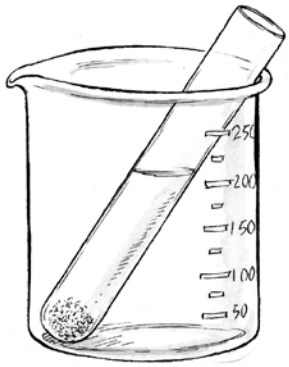
Extracting DNA from Bananas

All living things, including plants, reproduce by passing deoxyribonucleic acid (DNA) from parent cells to offspring cells. DNA is the genetic information that provides a blueprint for an organism's growth and development. Scientists are constructing a more accurate plant kingdom family tree by analyzing DNA from different plants, noting differences and similarities, and grouping the plants based on their DNA relatedness. In this activity, you will extract and observe DNA from bananas.

Procedure

1. Put 1 cup of distilled water and one banana in the blender. Blend for 25 seconds. Pour the mixture into a beaker.
2. Mix 1 teaspoon of soap and ⅛ teaspoon of salt in a plastic cup. Add 2 tablespoons of distilled water. Stir **gently** to avoid causing foam. Continue until the soap and salt are dissolved.
3. Add 2 tablespoons of the banana mixture to the cup containing the soap solution. Use a spoon to stir the mixture for 8–10 minutes.
4. Insert a filter into a clean plastic cup. Fold the top of the filter so that the bottom of the filter is about an inch away from the bottom of the cup. Put a rubber band over the rim of the cup to hold the filter on the cup.
5. Pour your mixture into the filter. After 5–10 minutes, some liquid, called the filtrate, should have collected in the bottom of the cup.
6. Get a test tube of cold alcohol. Use a pipette or eyedropper to collect your filtrate. Add it to the alcohol.
7. Place the test tube with the alcohol and filtrate in a beaker. Let it sit undisturbed for about four minutes. Do not shake it. Watch the white material come out of solution as a precipitate. This is the DNA.
8. Dip the glass rod into the tube, slowly rotating it to spool the banana's DNA around the rod. Observe the DNA in the test tube.





Questions

Write your answers on a separate sheet of paper.

1. Describe the appearance of the DNA you extracted.
2. Summarize the main steps involved in extracting DNA from bananas.
3. Do you think your results would be different if you used a vegetable or fruit other than bananas? Explain.