



H I G H S C H O O L

S T E A M , B I O L O G Y , W O R L D G E O G R A P H Y





G R O W I N G P A I N S

▶ **Driving Question:**

How do pollutants from common farming and household activities affect the growth and/or reproduction of plants?

▶ **Materials Needed:**

Science notebook, a fast-growing seed such as sunflower or bean sprouts, containers and soil for seeds, test material (Note: this is dependent on what chemical or environmental condition the students would like to test), oxygen probe, water-sampling containers, device with a camera

In this lesson, students will:

- determine how pollutants such as excess nitrogen runoff or common household chemicals affect the growth of plants.

National Learning Standards:

Science: LS2-2; LS2-6; LS4-6
 Social Studies: II,b; III,c; X,c
 Art: Cr2.3.IIa; Pr5.1.IIa; Cn10.1.IIa;
 Cr1.1.IIIa



SPINNING THE COCOON

Begin by asking students what humans need to survive. They should be able to recall that we need oxygen, water, food and some sort of shelter. Next, ask what plants and other species need to survive. Explain that these requirements are what allow all organisms on Earth to maintain homeostasis for their species or population. Define homeostasis, and ask students for ways that organisms maintain homeostasis. Some examples might be human beings sweating to stay cool or plants opening stoma to release excess gasses. Continue the discussion by asking students what might happen if an organism's environment changes so rapidly that their homeostatic mechanisms can't keep up. Students might say that plants wilt if they don't have enough water in their environment, humans may need IV infusions of fluids and electrolytes when they lose fluids during intense exercise, or even that an organism might die from rapid changes to its environment.

Explain that some environmental changes may cause an organism to be unable to reproduce or cause rapid cell growth leading to tumors. In other cases, the organism might benefit from the rapid environmental change. Ask for examples of environmental changes caused by both humans and nature and write answers on the board. Some examples of student responses might include changes in salinity, changing tidal patterns, introduction of chemicals via pollution, or increased plastic in the ocean. Discuss with students how each one of the items they suggest might have an effect on humans and other organisms, and whether these effects are positive, negative or both.

KERNEL OF KNOWLEDGE

According to the United States Environmental Protection Agency (EPA), about 40% of heavy metals, including lead, mercury and cadmium, in landfills come from electronic equipment such as discarded smart phone and computer components.



METAMORPHOSIS

Students will work in either partners or groups. They will begin by growing their chosen plant from seeds. Students should have one control plant and one that they will feed differently as their variable plant. Prior to beginning their project, students should write a hypothesis about plant growth in both the control and variable plant. Students will feed, water and provide sunlight according to growth instructions for the control plant, and then decide what change they'd like to make for the variable plant. Students may choose to introduce excess fertilizer, occasionally add a household soap or cleaner to the plant, or even lower the amount of "sunlight" to represent tall buildings or other plants blocking the sun. Students should decide what ecological disruption they would like to represent.

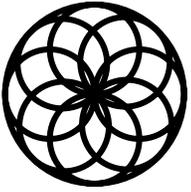
Note: Special care should be taken if students are handling chemicals such as fertilizers, soaps or household cleaners.

As the plants grow, students should take specific growth measurements, as well as draw or photograph changes in their plants. They should also keep precise records of what substances and the amounts applied to each plant. Other than the one variable, all other applications such as the amount of water or light should be consistent between the two plants. At roughly 30 days, students should take final measurements and create a final report. The report should show graphs or charts of growth, and should include their original hypothesis, a report of findings, and whether they accepted or rejected their hypothesis in the end. Students should also include some scientific reasoning for why they think their results occurred.

UPCYCLE

Waterway pollution is increasingly becoming worse. Students will utilize a local waterway such as a stream, creek or lake for this project. Note that special care should be taken around waterways to prevent drowning or potential bites from snakes and other organisms. An initial water sample should be taken and sent to a local university or to the [Noble Foundation](#) for testing. Students also should take an initial dissolved oxygen reading. Have students photograph and document the conditions of aquatic plants such as duckweed or algae, and make notes about the characteristics of the surrounding area, such as whether there are farms, neighborhoods or industrialized zones.

Twice weekly over the course of a month, students should document any changes to the surrounding environment, as well as any other conditions that seem pertinent. They may document information such as a farm appearing to fertilize or spread pesticides, or higher levels of smog or other contaminants on certain days or weeks. If any large change occurs, such as an algae bloom or a plant die-off, students should carefully take another water sample to be sent for evaluation. At the conclusion of their investigation, students should create a report of any changes to the aquatic plants, including a hypothesis of what caused the change. Significant changes to a waterway typically occur in the early spring near agricultural operations, so it may be best to time this exploration accordingly.



KALEIDOSCOPE

Ask students to hypothesize whether they believe the air quality is better or worse in densely populated areas. Have students research and find a map of the world that illustrates the air quality. Then allow students to create a video that:

- explains their findings,
- describes whether or not their hypothesis was correct, and
- offers possible solutions for improving the air quality in these troubled areas.



CAREER CONNECTION

Water Quality Chemist - Under general supervision, a water quality chemist performs analysis of physical, chemical and bacteriological elements present in a treated and untreated water supply. Working at a water treatment laboratory, they maintain detailed records of their observations, and diagnose, troubleshoot, and coordinate the maintenance and repair of instruments and equipment. This career requires a bachelor's degree and experience in the field.

Microbiologist - A microbiologist is a scientist who studies microscopic organisms, including bacteria, algae and fungi. Often, they study organisms that cause diseases and environmental damage, or that are of industrial or agricultural interest. A bachelor's degree or higher is required for this career.

Cartography - A Cartographer creates maps that can be topographic or spatial in nature. They have a wide range of possible career paths that can include the Department of Agriculture and the US Forest Service. Often, they can take scientific data that provides geographic imagery to better understand trends and provide possible solutions to environmental problems. This career requires a bachelor's degree.



CAREER HIGHLIGHT

Ryan Hreljac was only six years old when he first learned that many people in other countries don't have clean water to drink. So he began doing extra chores to help raise money to install a well for his pen pal in a foreign country. That initial effort led to the formation of the Ryan's Well Foundation, a nonprofit water charity that seeks to provide water to developing nations.



