Corn Competition:
Introducing Germination & Growth

Teacher's Guide

Overview

Premise: Most students are familiar with seeds and plants, but compared to a generation ago, fewer students today have grown plants from seed. Seeing the influence of environmental conditions on germination and plant growth is a direct way to learn that plants, like other organisms, succeed better in some environments than others. However, genetic factors also play a role in plant growth and survival. Being able to identify a treatment (e.g., the addition of fertilizer) as the cause of a particular outcome (e.g., an unusually tall plant) requires good experimental design.

How Corn Competition Works: This module aims to capture the importance of a control in constructing scientific explanations. Unlike most **PlantingScience** modules, **Corn Competition** is not intended as a full inquiry experience; rather, it is intended to help students build skills in experimental design and empirically-based justification. Here, students make a critical choice between growing one or two sets of corn plants based on limited guidance. Only in growing two sets of plants, where one set is used as a control, can sufficient evidence be provided that the treatment was the cause of plants' good (or poor) growth. While using and identifying a control is necessary, explanations using everyday vocabulary are valued over use of scientific vocabulary in the absence of explanations. Based on similarities in the underlying biological processes, **Corn Competition** works best as an introduction prior to **The Wonder of Seeds** when students' pre-existing inquiry skills are limited or unknown.

Grade levels: Middle school and high school biology, AP biology, environmental science, AP environmental science, horticulture, botany, and other life science electives.

Class Time: Students will grow corn plants over three weeks. Half a class period is needed for the introductory briefing and one full class period is needed to measure plants and follow up on student reasoning as to how they know their treatment(s) caused greater plant growth. Plants may be grown at home or in the classroom; in-classroom plant care will require about 5-10 min each class period.

Computer Access: Blogging is optional for this module and is best suited as a final exercise when students will be continuing with **The Wonder of Seeds**. Let your scientist mentor(s) know if you are including the **Corn Competition** as a part of **PlantingScience** coursework – mentors may be surprised that a team is discussing a completed "experiment" when first meeting the team!

Assessment Schema: This module is designed as a low-stakes exercise with three point levels. The actual number of points can be based on how heavily this module is weighted relative to other coursework. If carried out as a preliminary exercise to **The Wonder of Seeds**, we suggest the **Corn Competition** be weighted such that the maximum number of points is no greater than 20% of the maximum for **The Wonder of Seeds**.

Additional Resources: ***Corn Competition Resources*** contains a bibliography of online videos, websites, books, and articles, organized by media type. Information includes sources of corn seed, gardening tips on growing corn, corn biology, and links to historical and cultural information about corn.

Crosscutting Concepts & Practices from the Next Generation Science Standards:

CONCEPTS	SCIENTIFIC PRACTICES
• **Matter is transported into, out of, and within systems (5-LS1-1)** • **A system can be described in terms of its components and their interactions (5-LS2-1)** • **Phenomena may have more than one cause, and some cause and effect relationships can only be described using probability (MS-LS1-5)** • **Cause and effect relationships may be used to predict phenomena in natural or designed systems (MS-LS2-1)**	• **Support an argument with evidence, data, or a model (5-LS1-1)** • **Construct a scientific explanation based on valid and reliable evidence (MS-LS1-5, MS-LS1-6)** • **Science knowledge is based upon logical connections between evidence and explanations (MS-LS1-6)** • **Analyze and interpret data to provide evidence for phenomena (MS-LS2-1)**

Disciplinary Core Ideas from the Next Generation Science Standards:

CORN GERMINATION & GROWTH

- **Organization for Matter and Energy Flow in Organisms (5-LS1.C)**
  - Plants acquire their material for growth chiefly from air and water (5-LS1-1)
- **Interdependent relationships in ecosystems (5-LS2.A)**
  - The food of almost any kind of animal can be traced back to plants. Organisms can survive only in environments in which their particular needs are met (5-LS2-1)
- **Cycles of Matter and Energy (5-LS2.B)**
  - Organisms obtain gases and water from the environment, and release waste matter (gas, liquid, or solid) back into the environment (5-LS2-1)
- **Growth and Development of Organisms (MS-LS1.B)**
  - Genetic factors as well as local conditions affect the growth of the adult plant (MS-LS1-5)
- **Organization for Matter and Energy Flow in Organisms (MS-LS1.C)**
  - Plants use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use (MS-LS1-6)
- **Interdependent relationships in Ecosystems (MS-LS2.A)**
  - Organisms are dependent on their environmental interactions both with other living things and with nonliving factors (MS-LS2-1)
  - Growth of organisms is limited by access to resources (MS-LS2-1)

GOALS & TIMELINE

Goals:

- Observe seedling growth and development
- Identify conditions promoting plant growth
- Recognize the importance of a control in an experiment

Sample sequence:

- *Day 1:* Competition Briefing
- *Days 1-20:* Students set up seeds in pots and grow seedlings
- *Day 21:* Students bring in plants for measurements and explain results; optional blog posting

Student Handouts:
Corn Competition Student's Guide

Background: Students will implicitly generate ideas about how to grow the tallest corn seedlings by applying one or two treatments as they grow corn plants. Demonstrating that the tallest plants occurred due to treatments, and not by random chance, requires a control for comparison. The teachers' role is to (a) help students use sound reasoning and evidence to build explanations based on their results, while (b) highlighting the need for an experimental control in order to construct such explanations.

COMPETITION BRIEFING (Allow 20 min to half a class period)

Information to Provide: Introduce the module by framing the work as a competition for growing the tallest corn, not as an experiment. The ***Corn Competition Student's Guide*** will help students understand how they will be assessed without directly "giving away" the role of a control. Highlight the time available for growing plants, choice in the number of pots, and that students can use whatever information sources and treatments they choose to grow their corn.

Materials: After the briefing on what they will be doing, students will decide how many pots of seeds to grow and gather their materials. Students choosing two pots can fill a gallon-sized bag with vermiculite; students choosing one pot can fill the bag halfway. If the competition will be carried out in the classroom, seeds can be set up for growing at this time. Otherwise, students can take the materials home.

PLANT GROWTH PHASE (Allow three weeks)

What to Expect: Students can grow corn plants using any conditions of their choosing, by referring to any information source. Some students may not have a frame of reference for the features of a plant's environment. Students will need to be able to describe their treatments later. Therefore, you may wish to ask that they record such information in lab journals.

Logistics & Technical Notes

Teams: Teachers may ask that students work individually or in teams of 2-4. Within teams, students must grow their plants separately but could collaborate to identify the best growing conditions. Teams formed here should continue working together in any future inquiries.

Expected Growth: Corn plants can grow to a height of about two feet over three weeks.

Mold: Wet seeds are prone to mold in the dark or under cold temperatures. This is less likely for seeds surface-sterilized for 10 min in 1:9 bleach:water solution with a drop of dish soap.

Materials (per student)

- Ten corn seeds
- Two 4" diameter pots
- Vermiculite sufficient to fill both pots
- Gallon-sized zip-top bag
- Ruler
- Environmental treatments, such as:
  - Thermometer and heater/cooler
  - Lights (40W or higher, any color students choose)
  - Light timers
  - Fertilizer
  - Water
  - Acid or base solution and pH strips

COMPETITION JUDGING & DISCUSSION (Allow one full class period)

Preparation: A day or two before the judging will take place, provide students with the following instructions as a reminder and to help them prepare for the discussion:

Don't forget to bring your corn plants to lab/class on [DAY].

If you chose to grow two pots, bring only one pot of corn, and put your name on it.

Also turn in a 3"x5" index card with your name and answers to these questions:

(1) How many pots of plants did you grow?

(2) What did you do to the pots and plants? (What were your methods?)

(3) How do you know that what you did actually made a difference? (How do you know what caused your plants to grow as they did?)

Judging: Students will all measure their plants using a ruler. The heights of all plants (i.e., up to five) in the same pot will be added together as the *total height* of the plants. Students with plants in the highest one-third of all total height values for the class are **eligible** for the **maximum** number of points. Students bringing in live plants not in the top third will receive **half** of the maximum number of points, while students not bringing in any live plants will receive **no** points.

Discussion: Students will turn in their index cards and, as a class, discuss their answers to the questions. Each student eligible for the maximum number of points will get the **maximum** if they are able to implicitly or explicitly identify one group of their plants as a control (Question 2) *and* are able to identify a treatment as causing greater growth relative to that control (Question 3). Otherwise, the student will get **half** of the maximum number of points.