Lab 16. Mendelian Genetics: Why Are the Stem and Leaf Color Traits of the Wisconsin Fast Plant Inherited in a Predictable Pattern?

Introduction

When dogs are bred, the result is puppies, and when racehorses are bred, the result is a foal. The same is true for plants. When one pea plant fertilizes another pea plant, each seed that is produced will become a pea plant and not a tulip, a rose, or a geranium. Species produce more of their own kind because each species passes down a specific set of traits from generation to generation. These traits make each species unique. But to anyone who has bred racehorses, dogs, or pea plants, it is abundantly clear that there are differences among members of the same species. Where do these variations come from, and how are these traits passed on from parents to offspring? These questions baffled scientists for hundreds of years, until Gregor Mendel was able to explain how traits are inherited.

Gregor Mendel identified the rules that govern heredity by crossing (breeding) individual pea plants with different versions of a trait and then documenting which version of that trait was inherited by the offspring. He also tracked the inheritance of specific versions of a trait over many generations. Once he gathered enough data, he was able to develop a set of rules that he could use to predict the traits of an offspring based on the traits of the parents. These rules are now known as Mendel's model of inheritance and are still used by scientists and medical doctors today. In this investigation, your goal will be to develop a model of inheritance that explains how traits are passed on from parent to offspring, much like Mendel did.

Your Task

Use a computer simulation to cross Wisconsin Fast Plants with different traits in order to identify patterns in the ways these traits are inherited. Once you have identified these patterns, you will need to develop a model that explains how traits are inherited in this organism. You will then need to test your model to determine how well it allows you to predict the traits of offspring.

The guiding question of this investigation is, **Why are the stem and leaf color traits of the Wisconsin Fast Plant inherited in a predictable pattern?**

Materials

You will use an online simulation called *Observing One or Two Traits in Wisconsin Fast Plants* to conduct your investigation. You can access the simulation by going to the following web page: *www.fastplants.org/legacy/genetics/Introductions/two-trait.htm.*

Safety Precautions

1. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires, and shock hazards. Use only GFI-protected circuits.
2. Wash hands with soap and water after completing this lab.
3. Follow all normal lab safety rules.

Getting Started

Your goal for this investigation is to develop a model that explains why the traits of the Wisconsin Fast Plant are inherited in a predictable pattern. Biologists determine how traits are passed from parent to offspring by (1) crossing (breeding) two individuals with specific traits (e.g., plants with purple or green stems and plants with dark green or light green leaves) and then recording the traits of their offspring in the next generation, (2) looking for patterns in the way specific traits are passed down from generation to generation, and (3) using these data to generate a model that explains why they are inherited in this manner. They then test their model to see how well it can predict the outcome of other crosses.

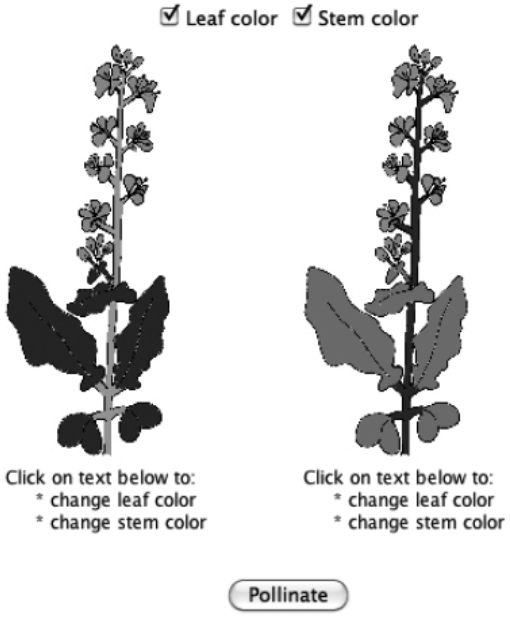
In the field, this type of research can be slow because a single generation can take anywhere from several weeks to several years. Fortunately, we can speed up the process of developing an explanatory model inside the classroom by using a computer simulation that allows you to breed pea plants and observe the results of your crosses in a matter of seconds.

The *Observing One or Two Traits in Wisconsin Fast Plants* simulation (see the figure on the following page) enables you to do the following:

- Choose if you want to look at stem and/or leaf color of pea plants.

- Cross (breed) parents with different traits. (To cross the plants, click on the "Pollinate" button. You will see a bee travel between the two plants to indicate that the plants are being crossed.)
- See the 64 progeny (offspring) of the two plants that you crossed.
- Choose any two plants from the 64 progeny and cross them as well.
- Go back to any screen and repeat a cross. They will be labeled F2a, F2b, F2c, and so on.
- Perform a test cross with a parent plant and one of its offspring. A test cross involves breeding an individual of the dominant phenotype with an recessive phenotype individual to see what genotype the dominant parent is based on the trait ratios of the offspring

A screen shot from the *Observing One or Two Traits in Wisconsin Fast Plants* simulation



Remember, your first step in this investigation is to use this online simulation to identify patterns in the way the steam color and leaf color traits are inherited in Wisconsin Fast Plants. Once you have identified some patterns, you need to develop a model that you can use to explain them. Your model, like Mendel's, will likely consist of several different postulates. A postulate is a tentative claim. Mendel's model of inheritance included four postulates. The first postulate was, "Specific traits are determined by an inheritable unit that is passed down from parent to offspring." You can use the first postulate in Mendel's model of inheritance as one of the postulates in your model of inheritance.

Once you have developed your model, you will need to determine if it is valid or not by testing it with the online simulation. You will know when your model is valid because a valid model allows you to predict the traits of offspring. Your model, in other words, should enable you to predict the traits of the next generation of plants based on the traits of the parent plants. If your model allows you to make accurate predictions, then it is valid. If your model results in inaccurate predictions, then it is flawed and will need to be changed.

Investigation Proposal Required? ☐ Yes ☐ No

Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of identifying patterns,
- how scientists attempt to uncover causal mechanisms,
- the value of looking at proportional relationships when analyzing data,
- the difference between theories and laws in science, and
- the importance of imagination and creativity in science.

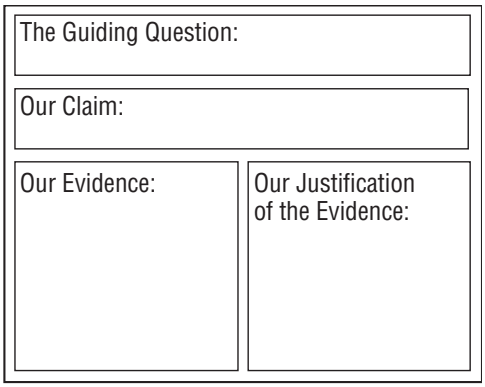
Argumentation Session

Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure on the following page.

To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

Argument presentation on a whiteboard



- How did you use the simulation to collect your data?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!