Lab 16. Mechanisms of Inheritance: How Do Fruit Flies Inherit the Sepia Eye Color Trait?

Introduction

In the 1800s, farmers often cross-pollinated specific types of plants or mated livestock with specific traits in an effort to produce offspring with more desirable traits. Their selective breeding process, however, did not always lead to the desired outcome. These farmers were often unsuccessful in their attempts to produce offspring with specific traits because they did not understand the mechanisms that control how traits are passed down from parent to offspring. The inheritance of traits also baffled the scientists of that time, until Gregor Mendel was able to explain the rules that govern heredity in 1865.

Mendel was able to explain how and why specific traits are passed down from generation to generation by breeding pea plants. He first cross-pollinated individual pea plants with specific traits and documented the traits of their offspring. He then cross-pollinated individual offspring and documented the traits that shown up in the next generation. By doing this, he was able to identify patterns in the ways traits are passed down from one generation to the next. He then developed several rules that he could use to explain the patterns he uncovered in the ways traits are inherited; these rules are now called *Mendel's laws* and can be summarized as follows:

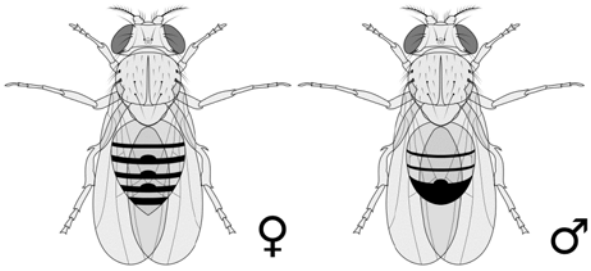
- Inheritable units called *genes* determine traits.
- A gene comes in different versions called *alleles*.
- An organism carries two alleles for each trait.
- The two alleles segregate during *gamete* (a reproductive cell such as a sperm or an egg) production, so each gamete only carries one allele for a specific trait.
- When gametes unite during fertilization, each contributes its allele, so offspring inherit one allele from each parent.

There are several different models of inheritance that are based on Mendel's laws. These models include dominant-recessive, incomplete dominance, and codominance. What makes these models of inheritance different from each other is how each one describes the interaction or behavior of the alleles once they have been passed down from parent to offspring. The *dominant-recessive model of inheritance* suggests that when an individual inherits two alleles and the two alleles differ, then one is fully expressed and determines the trait (this version of the gene is called the dominant allele) while the other one has no noticeable effect (this version of the gene is called the recessive allele). The *incomplete dominance model of inheritance* suggests that the interaction that occurs between two different alleles results in a hybrid with an appearance somewhere between the phenotypes of the two parental varieties. The *codominance model of inheritance* is similar to the incomplete dominance model, but in the codominance model both alleles affect the phenotype of the individual in separate and distinguishable ways.

It is often difficult, however, to determine which of these three models of inheritance best explains how a specific trait is inherited. To illustrate this point, you will be studying the inheritance of a trait in fruit flies (*Drosophila melanogaster*). Fruit flies are very common. Most fruit flies have six legs, two wings, and two antennae (see Figure L16.1). Most fruit flies also have an orange-yellow body and red eyes. Scientist call flies with these traits the "wild type." Every once in a while, however, you might see a fruit fly with sepia (brown) or white eyes. In this investigation, you will need to determine how the sepia eye color is inherited.

FIGURE L16.1

Male and female fruit flies



Your Task

Use a computer simulation that allows you to "order" fruit flies with specific traits from a supply company and then "breed" them to see how the sepia eye color trait is passed down from parent to offspring. From there, you will need to decide how the allele for sepia eye color interacts with other alleles for eye color (such as the allele for red eyes). You will then decide which model of inheritance (dominant-recessive, incomplete dominance, or codominance) best explains how the sepia eye color trait is inherited in fruit flies.

The guiding question of this investigation is, **How do fruit flies inherit the sepia eye color trait?**

Materials

You will use an online simulation called *Drosophila* to conduct your investigation. You can find the simulation by going to the following website: *www.sciencecourseware.org/vcise/drosophila.*

Safety Precautions

Follow all normal lab safety rules.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

Your teacher will show you how to use the *Drosophila* online simulation before you begin designing your investigation. The first step in the investigation is to learn how the sepia eye color trait is passed from one generation to the next. To accomplish this task, you must determine what type of data you need to collect using the online simulation, how you will collect these data, and how you will analyze the data. To determine *what type of data you will need to collect*, think about the following questions:

- What types of flies will you need to work with during your investigation (e.g., males or females, flies with red eyes or flies with sepia eyes)?
- What type of measurements or observations will you need to record during your investigation?
- How will you identify a pattern in the way the sepia eye color trait is inherited?

To determine *how you will collect your data*, think about the following questions:

- How many times will you need to breed the flies?
- How many generations of flies will you need to follow?
- How often will you collect data and when will you do it?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data*, think about the following questions:

- How will you determine if the results of your cross tests match your predictions?
- What type of graph could you create to help make sense of your data?

The last step in this investigation is to test the model of inheritance that you think best explains the inheritance of the sepia eye color trait. To accomplish this goal, you can use the simulation to determine if you can use your model to make accurate predictions about how the sepia eye color trait will be passed down from one generation to the next. If you can use your model to make accurate predictions about how the traits of the flies are inherited, then you will be able to generate the evidence you need to convince others that the conceptual model you decided to use is the most appropriate one.

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

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

- the importance of uncovering causes for patterns observed in nature,
- how scientists develop and use explanatory models to make sense of their observations,
- the nature of theories and laws in science, and

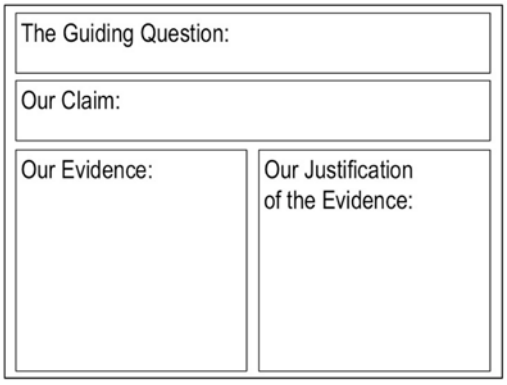
- the difference between data and evidence in science.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L16.2.

FIGURE L16.2

Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:

- What did your group do to collect the data? Why do you think that way is the best way to do it?
- What did your group do to analyze the data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- What did your group do to make sure that these calculations are correct?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

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. The 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!