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We begin our investigation with a few simple questions. What do you know about fruit flies? Have you seen fruit flies outside the lab and, if so, where? Describe where and when you have noted fruit flies. Background information explains how the lab provides opportunities for students to review, scaffold, and apply concepts. Drosophila melanogaster is an organism that has been studied in the scientific community for more than a century. Thomas Hunt Morgan began using Drosophila melanogaster for genetic studies in The common fruit fly lives throughout the world and feeds on the fungi of rotting fruit. It is a small fly, and one could question why so much time and effort have been directed to this organism. Its genome has been sequenced, its physical characteristics have been charted and mutated, its meiotic processes and development have been investigated, and its behavior has been the source of many experiments. Because of its scientific usefulness, Drosophila is a model research organism. Its name is based on observations about the fly; the fly follows circadian rhythms that include sleeping during the dark and emerging as an adult from a pupa in the early morning. It has a black stomach. No doubt the dewloving, black-bellied fly will continue to make contributions to the scientific community and to student projects. These investigations explore the environmental choices that fruit flies make. A choice chamber is designed to give fruit flies two choices during any one test, although students could also think about how to build an apparatus that would give fruit flies more than two choices. Adult fruit flies are attracted to substances that offer food or an environment in which to lay eggs and develop larvae. Typically those environments are rotting or fermenting fruit. Adult fruit flies are attracted to bright light, and their larvae move away from bright light. Adult fruit flies also demonstrate a negative geotaxis; they climb up in their chambers or vials against gravity. Movement toward a substance is a positive taxis. Consistent movement or orientation away from a substance is a negative taxis. In most cases, the experiments done in the choice chamber will be chemotactic experiments, as indicated by the number of flies that collect on one end of the chamber or another in response to a chemical stimulus. In addition, some of the questions are likely to connect to big idea 1 if students explore the evolution of observed behaviors. As always, it is important to make connections between big ideas and enduring understandings, regardless of where in the curriculum the lab is taught. The concepts align with the enduring understandings and learning objectives from the AP Biology Curriculum Framework, as indicated below. Learning objectives indicate what students should know and be able to do as they conduct their laboratory investigations. Each learning objective integrates science practices with specific concepts and enduring understandings outlined in the curriculum framework. Reinforce the concept that all biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy. Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection. Interactions among living systems and with their environment result in the movement of matter and energy. Interactions between and within populations influence patterns of species distribution and abundance. If a culture vial is upside down even with flies in it, very few flies will escape before it is plugged again. An additional technique to avoid the problem of flies escaping is to refrigerate them before the transfer. If vials are chilled for at least 15â€”30 minutes before tossing, they are easier to transfer. Be sure that the chilling does not add moisture to the culture, as moisture can make the flies stick to the vials. How can you help students identify the difference without telling them? Is the chemotaxis a strong taxis? Does a geotaxis or phototaxis override the chemotaxis? During this discussion, you can assess if your students know what fruit flies are and when and where they have seen them. The class should make a list of when and where they notice fruit flies. Students should also view pictures of fruit flies to recall previous experiments with these model research organisms used in genetics or population studies. Although you are encouraged to develop your own means of assessment, the lab investigations in this manual include suggestions. Assessments can include question sets that you assign for homework, collaborative activities, and interactive online simulations. Have the students make observations about fruit fly behavior by conducting the following very simple geotactic experiment.

Students can work in small groups. Using fruit fly cultures, toss at least 10 flies into an empty vial. Do not anesthetize the flies before this or any of the behavior experiments. Observe the position of the flies in an upright vial sitting in a test tube rack on the lab table. Do not touch the vial while making observations. Invert the vial and observe the position of the flies after 15 seconds and after 30 seconds. Make a list of observed behaviors. Was there an orientation movement? If so, what was the stimulus? Could this be considered a taxis? You may start with general information about how to determine the sex of a fruit fly. How do you tell the difference between male and female flies? Is the sex of the fly important to your investigations? Look at the female and male fruit flies in Figure 1. Then look at the fruit flies in Figure 2. Can you identify which ones are female and which ones are male? Focus on the abdomen of the flies to note differences. Be sure to plug the vial as soon as you add the flies. Tap a culture vial push the vial down on a solid surface several times on the table to move the flies to the bottom of the vial. Quickly remove the foam or cotton top and invert an empty vial over the top of the culture vial. Invert the vials so that the culture vial is on the top and the empty vial is on the bottom, and tap the flies into the empty container by tapping it on a solid surface several times. Be sure to hold the vials tightly to keep them together. You must then separate the vials and cap each separately. Do not try to isolate every fly from the original culture. It is difficult to separate flies, and you may lose a fly or two in the process. When developing their own investigations, students should choose substances to test that are interesting to them. They may have experiences with fruit flies in their home and can think about what attracts flies. They also may want to find a substance that would repel a fly. They can bring substances from home to test, but make sure they obtain your permission to use the substances before they conduct their tests. The students should work in groups to determine the chemotactic response to various food items. They should share and graphically illustrate their results. Their questions might include the following: Does the age of a fruit fly affect the speed of their negative geotactic response? What wavelengths of light stimulate a phototactic response in fruit flies? However, it is suggested that students generate their own questions to explore. Isolate the materials and give the flies a choice. An F1 population of flies with white-eyed males and red-eyed females could be made available. Different ends of the chambers could be wrapped in transparent colored films or acetate. For example, ripe bananas could be compared to green bananas. Can you think of any organisms that respond differently? Students should verify the results of their experiment by conducting several trials and changing the position of the substances at the ends of the chamber. This preliminary investigation familiarizes students with the subject matter, and prepares them for the student-directed part of the investigation. Based on how you manipulated the vial, to what stimulus might the flies be responding? Do you think that they were responding to some chemical change in the vial? Did your observations generate other questions? A chemotaxis is a movement in response to the presence of a chemical stimulus. The organism may move toward or away from the chemical stimulus. What benefit would an organism gain by responding to chemicals in their environment? A phototactic response is a movement in response to light. A geotactic response is a movement in response to gravity. You will investigate fruit fly movement using a choice chamber that exposes the flies to different substances that you insert into the chamber. Because flies are very common in households in fact, fruit flies live almost everywhere that humans live , think about using foods or condiments that might result in a positive or a negative chemotactic response from the flies. What foods or condiments do you think would attract or repel flies? Do fruit flies exhibit a response to light or to gravity?

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