

Planarian Experiments

Outreach Activity

I. Overview

This series of activities introduces students to the anatomy and physiology of planarians, an invertebrate flatworm. The first activity allows students to observe how planarians respond to stimuli (touch, light, and food), and learn about the different body parts of the planarian. Students can then conduct their own experiments using various concentrations of drugs, caffeine and sugar and measure how these drugs affect the behavior of planarians. The experiments allow students to investigate and discuss how certain drugs affect planarians and relate the results to how these drugs could affect humans.

II. Learning Objectives

- Describe the term 'taxis' and how organisms use taxes to find food and navigate their environment.
- Give examples of different environmental signals, which are important to simple organisms.
- Describe differences between planarian and human behavior in response to these drugs.
- Develop a hypothesis on how the planarians will respond to the different drugs that is testable with available materials.
- Carry out an experiment and collect data in data table.
- Analyze results to draw conclusions that relate drug dosage and behavior in both planarians and humans.

III. Adaptations/Accommodations

Safety

Students should be aware if they are sensitive/allergic to caffeine as they handle the solutions.

IV. Timeframe for activity

Activity 1: 15 min-20 min

Activity 2: 30 min-40 min

V. Advance prep and materials

Activity 1: Planarian Taxes Observations

Materials:

- Planarians (2-3/pair of students)
- Plastic pipettes
- Spring water
- Petri dish (1/pair of students)
- Magnifying glass (1/pair of students)
- Bloodworms (1 cube/pint sized tub of planarians)
- Pint sized plastic containers
- Flashlights (1/pair of students)
- Toothpicks (1/student)

Preparation:

- Place 10-20 planarians in a pint sized plastic container. 5-10 minutes before beginning activity, place a cube of frozen bloodworms in the plastic container so students can observe planarians eating the bloodworms.

Activity 2: Drug Experiments**Materials:**

- Planarians (3/student)
- Plastic pipettes
- Petri dishes (1/planarian)
- Spring water
- Sugar stock solution 54 g/L
 - 1 container (1 L) each of a 50%, 10%, and 1% solution of stock sugar solution
- Caffeine stock solution 160 mg/L
 - 1 container (1 L) each of a 50%, 10%, and 1% solution of stock caffeine solution
- Graph paper
- Stopwatches

Preparation:

- Mass 54 g of cane sugar
- Mix 54 g of cane sugar with enough spring water to bring final volume to 1L
 - Mix 500 mL of stock sugar solution with 500 mL of spring water to make 50% solution
 - Mix 100 mL of stock sugar solution with 900 mL of spring water to make 10% solution
 - Mix 10 mL of stock sugar solution with 990 mL of spring water to make 1% solution
- Caffeine pills generally come in pills of 200 mg caffeine. Mass a crushed pill then remove 20% of the mass so 160 mg of caffeine remains
- Mix 160 mg of caffeine with enough spring water to bring final volume to 1L
 - Mix 500 mL of stock caffeine solution with 500 mL of spring water to make 50% solution
 - Mix 100 mL of stock caffeine solution with 900 mL of spring water to make 10% solution

- Mix 10 mL of stock caffeine solution with 990 mL of spring water to make 1% solution

VI. Resources and references

Facilitator resources

- Planarian Taxes Observations Associated Lesson Plan:
 - <https://www.neuron.illinois.edu/units/what-can-i-learn-from-worms>
 - At the above page, click Lesson 2 Materials
- Drug Experiments Associated Lesson Plan:
 - <https://www.neuron.illinois.edu/units/what-changes-our-minds-drugs>
 - At the above page click on Lesson 3 Materials

VII. Activity Implementation

Activity 1: Planarian Taxes Experiments

Point students' attention to the drawings of the planarian anatomy. Ask students:

- What systems are similar between humans and planarians? Which ones are different?
- Why do you think neuroscientists, scientists that study the brain and nervous system, would want to use planarians in research?

Explain to students that 20% of the planarians cells are stem cells, special cells that allow the planarian to regenerate lost or damaged tissue. Because these flatworms are easy to obtain, cheap, and easy to work with, scientists can perform experiments to see how they regenerate, particularly nervous system tissue. For this reason, scientists are eager to understand more about the planarian and the genes that allow it to regenerate tissue with the hope of

Have student place 2 planarians in a small Petri dish. Allow students to observe planarians without stimulation. Have them record their observations and drawings on their handout. As they are observing, encourage them to draw specific structures of the planarians that they can see, such as eyespots and internal organs.

After students have made their initial observations, allow them to make observations using the toothpick (touch stimulus), the flashlight (light stimulus), and the bloodworms (chemical stimulus). Students do not have to observe the same taxis at the same time, they can work at different paces on these observations. While they are observing, ask them:

- Do the planarians tend to move away/toward the light? Why do you think this happens?
 - Planarians live in murky rivers so they tend to avoid the light.
- Do the planarians tend to move away/toward the touch? Why do you think this happens?
 - Touch might signal to them a predator is nearby.

- Do all the planarians move towards the food? Why do you think happens?
 - The planarians are hungry and they sense the food via chemical signals so they move towards it.
- Do they move at the same rate towards the food? Why do you think this happens?
 - Planarians are individuals so some might take longer than others to sense the food.

After the observations, ask the students:

- How does the planarian's nervous system play a role in these taxis experiments?
 - When the planarian senses something, the nervous system receives a signal which tells its muscles to move either towards/away from a stimulus.

Activity 2: Drug Experiments

Tell the students that they will test the planarians' reactions to different drugs and compare it to humans' reactions to the same chemicals. Ask them:

- Based on their work with the taxis experiments, how they believe the planarians would respond to caffeine and sugar solutions?
 - Have them think about their own reactions to caffeine and sugar. While we have a separate circulatory and digestive system, the planarian flatworm does not have a circulatory system. That is, their body cavity does not have lining nor enclosed fluid. The pharynx (mouth) of the planarian leads directly to the digestive system, which is branched so that every cell of its body is close to the digestive tract. Oxygen and other nutrients are diffused to all cells through the digestive system; there is no transport system (such as blood) to carry oxygen, water, and nutrients to the planarian's cells.

Tell the students to write down some initial predictions of what they believe will happen when the planarian is placed in a sugar and/or caffeine solution. How will the planarian react to the chemical? Will it move differently than it does in plain Spring water?

Next, have the students choose which concentrations of sugar and/or caffeine they would like to test. In their data table, have them record which concentration of solution they choose to test. Review the procedure with them as written:

1. In groups of 3, each student will choose which solution to test, either the caffeine, the sugar, or the Spring water, which will act as a control.
2. Pour a small amount of pre-made solution (or water) into three separate Petri dishes. Place the Petri dishes onto lined graph paper. To measure the activity of the planarians in the different solutions, you will count how many times the planarians cross a line. Decide in your groups how you will count a "line cross" as there may be different ideas on what a line cross is!
3. Place one planarian into each of the three Petri dishes, staggering the time so that each planarian is placed in the new environment ~1.5 minutes apart from one another.

4. After ~4.5 minutes, begin the timer and count how many times the planarian crosses a line for one minute. Record the number of times they cross a line in your data table.
5. Repeat step 4 for the other 2 planarians.
6. Write or draw any observations about your planarians in your data table as well.
7. Remove the planarians from the different solutions and place into a fresh Spring water container.

After reading the procedure, students can begin to set up their experiment as noted in their procedure. Make sure the students have discussed with their group members how they will count the line crosses. Once they have finished with the experiment, the planarians should be placed in spring water so they can “detox” any of the drugs out of their bodies.

Discuss the results with the students:

- What surprised you about how the planarians reacted to the drugs?
- Were your hypotheses correct? Why do you think the results differed from the original hypotheses?
 - Explain to students that planarians are individuals so they may have had individual reactions to the drugs.

Have students clean up their work areas. It is important that all planarians are returned to plain spring water.

Additional Activities

Planarian regeneration

For students who are interested, they may perform a regeneration experiment. Have the students use the magnifying glass to observe the planarian in a Petri dish. With a coverslip, the students can then cut the planarian at a certain point(s) to create 2 or more planarians. Over the course of several days, they can monitor the planarians’ regeneration and see for themselves how efficiently the planarians can regenerate lost body parts.