

Planarian Behavior: A Student-Designed Laboratory Exercise

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Objectives

1. Know that different types of stimuli can affect planarian movement.
2. Distinguish between kinesis and taxis.
3. After preliminary observations, state a hypothesis to predict or explain planarian movement in response to an external stimulus. Test the hypothesis and reach a conclusion.

Introduction

Planarians are in the flatworm phylum, Platyhelminthes. Most planarians are free-living and are common in freshwater habitats. They are also found in marine and terrestrial environments. Planarians display bilateral symmetry, meaning the right and left halves are approximately mirror images of each other. The nervous system of planarians consists of an anterior “brain” consisting of large ganglia. Two ventral nerve cords run the length of the body from the ganglia. Between the ventral nerve cords are transverse nerves arranged like a ladder. In the anterior end are two eyecups containing photoreceptors that are stimulated by light. Also in the anterior end are pits containing chemoreceptors that respond to certain chemicals. A typical planarian has a digestive space known as the gastrovascular cavity. This highly branched cavity is the site of both digestion and circulation of nutrients. The gastrovascular cavity is often referred to as the intestine or gut. Planarians have a single opening, the mouth, found on the ventral surface. This is the site for both ingestion of food and discharge of wastes.

Two typical types of movement are kinesis and taxis. Kinesis is a nondirected movement in response to environmental factors such as light, temperature, moisture, or chemicals. When an organism is in an unfavorable location, it may increase its speed, angle of movement, or amount of turning. If effective, the actions will remove the organism from the adverse location. When more suitable conditions are encountered, the animal simply moves less and stays in that area. Kinesis results in random movement into better locations. Taxis, on the other hand, involves directed movements; that is, animals detect the source or differences in intensity of some factor, then they move accordingly. This movement can be toward or away from the stimulus. Positive taxis is a movement toward a stimulus; negative taxis is a movement away from a stimulus. Taxes are frequently identified with the environmental condition to which the organism is responding. Examples of taxes are thigmotaxis, phototaxis, chemotaxis, gravitaxis, and rheotaxis. Taxes are quite simple responses to a stimulus, yet they are not as random as kinesis because they involve movement in a definite direction. There are several different types of planarian taxes that you can observe in the laboratory:

1. Thigmotaxis

Thigmotaxis is a response to touch. Place a planarian in a container of water. After the planarian begins to swim, touch it gently with the pipette. Observe the response.

2. Phototaxis

Phototaxis is a response to light. Photoreceptors in the eyecups can detect direction as well as the intensity of light. Planarians usually orient themselves to light so that the two eyecups are equally stimulated. Shine a light into one end of a container of water. Place a planarian in the water. Observe the response. Note whether it moves toward or away from the source of light. Is the planarian positively or negatively phototactic?

3. Chemotaxis

Chemotaxis is a response to a chemical stimulus. Planarians use chemoreceptors to locate food. They move either toward or away from concentrations of dissolved chemicals associated with food. Place a small pinch of food in one corner of the container of water. Place a planarian at the other end of the container. Observe the response. Does it respond to the food? If so, does it move toward or away from the food? How does the planarian respond to the different kinds of food?

4. Gravitaxis

Gravitaxis is a response to gravity. Place a planarian in a container of water. Take a depth reading of the location of the planarian with a ruler. Observe where the planarian is located. Does it seem to be benthic (bottom dwelling) or planktonic (free-floating or slowly swimming near the surface)?

5. Rheotaxis

Rheotaxis is a response to water current. There are several methods to observe rheotaxis:

- Connect a piece of rubber tubing to the air jet. Turn on the air jet slowly to make a gentle current in the center or end of the pan of water. Then place the planarian in an

- area of water with no current. Note the direction in which the planarian orients and moves with respect to the current.
- b. Place the planarian in the pan of water. Connect a piece of rubber tubing to the air jet and turn on the air jet slowly to make a gentle current. Point the end of the tubing at the anterior or posterior end of the planarian. Note the direction of movement of the planarian.
 - c. Place the planarian in a circular Petri dish that is filled halfway with water. Then make a gentle, circular current in the container by squeezing air out of a plastic pipette or by blowing air out rubber tubing connected to the air jet. Observe the direction the planarian moves. After it is moving in one direction, with or against the current, reverse the direction of the applied current. Again, observe the direction the planarian moves.

Once you are familiar with the information in the introduction, you are ready to begin.

Observation

Handle the planarians with care. Place three planarians in a container of water by gently sucking them into a plastic pipette and gently expelling them into a container of water. Note how they move for five minutes.

Choose a stimulus that you think will cause a planarian response. You do not have to use a stimulus that is already mentioned; you may want to observe responses to an entirely different stimulus. Observe the response of the three planarians to the stimulus you choose until you see a pattern of movement. What is the movement? Does the movement appear to be a kinesis or taxis?

Problem

What could cause the planarians to move the way you observed? What behavioral response to a stimulus do you want to test? You do not have to use one of the taxes already mentioned. If you do use one of the taxes, you are encouraged to design your own experiment. Also, you may prefer to test a kinesis rather than taxis.

Hypothesis

State a hypothesis to predict or explain how planarians will respond to a stimulus that you choose.

Prediction

Make a prediction based on your hypothesis. Consider the following before you start the experiment:

1. Be sure that you are testing one variable only.
2. Be careful when you move the planarians into the containers of water. Gently suck them up into a plastic pipette and expel them gently into the water.

3. Record the location or response of the planarians at definite timed intervals, for example every 10 seconds or every minute.
4. Have as large a population sample as possible. Use at least three planarians in the experiment.
5. Put the planarians at different locations when you place them in the container, if appropriate to your experimental design.
6. If you do an experiment to test rheotaxis, you can determine the velocity of water. Use a large container of water and place a Ping-Pong ball in the water. Use a stopwatch and ruler to measure the distance it moves in centimeters per second.
7. Describe the procedure in sufficient detail so that it can be repeated in the future. A good experiment must be repeatable.
8. Use the grid on the following page to determine specific location of the planarians.
9. Summarize the overall movement of the planarians. Use numerical data wherever possible.

Experiment

Materials and Methods

Design an experiment to test your hypothesis. Describe the procedure in detail.

Results

Mark the planarian location in the grids at timed intervals. Summarize the overall movement of the planarians. Use numerical data wherever possible.

Conclusion

Based on your results, draw a conclusion. Does it support your hypothesis or not? State your conclusion.

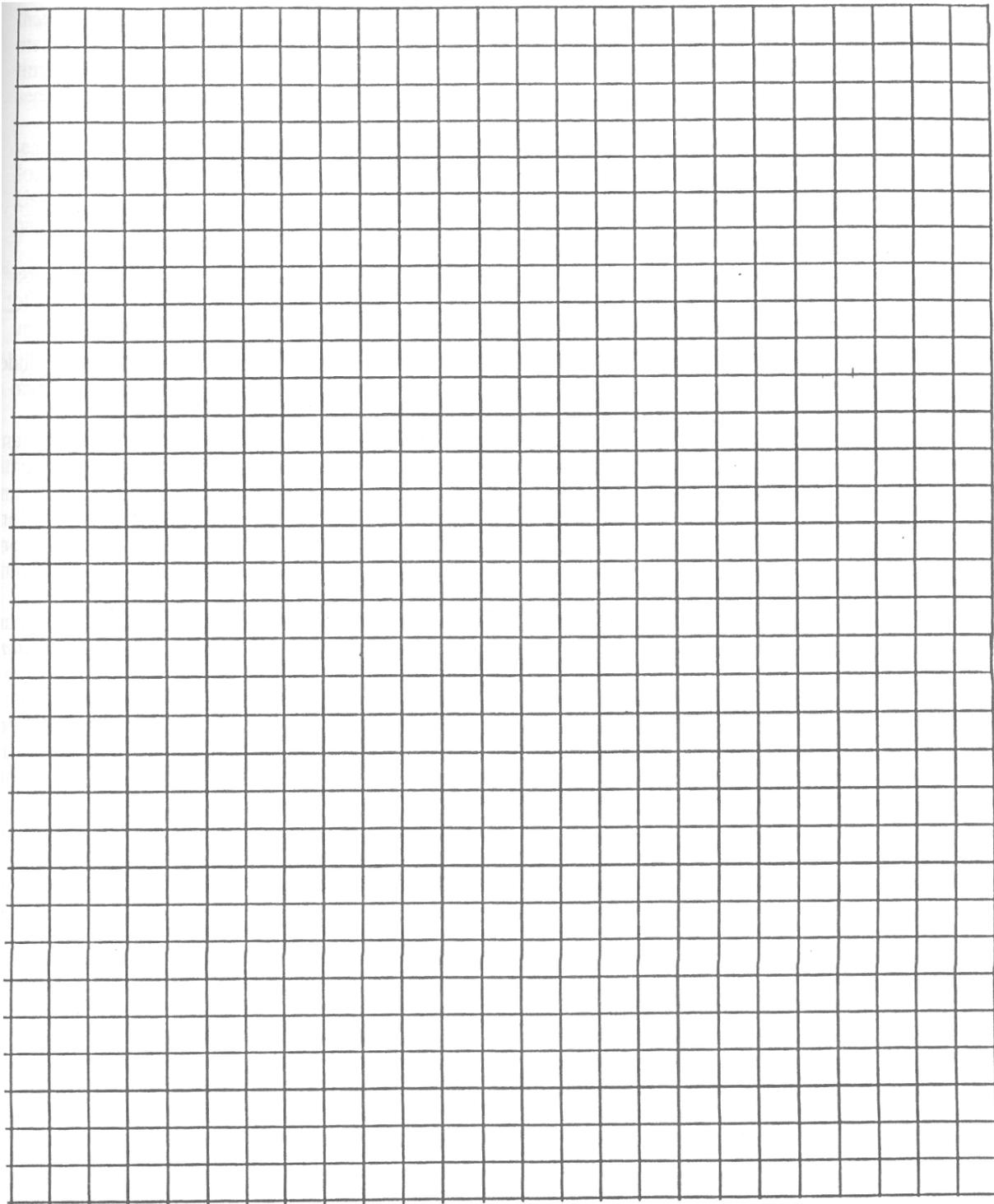


Figure 1. Grid to determine location of planarians.