



## **Response to Stimuli**

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### **Research Host:**

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### **Grade Level:**

High School

## **Response to Stimuli**

The following lab unit was designed in response to a change in the biology curriculum from a phylogenetic approach to a systematic approach. Reviewing instruction in consideration of the new curriculum presented the ideal opportunity to adapt some of the standard labs to more student-driven investigations.

### **Objectives:**

Students will be able to:

- investigate the responses of various organisms to stimuli in their environment.
- model collaboration in developing research questions and goals.
- develop a hypothesis and experiment based on agreed-upon goals.
- reach a conclusion based on experimental data.
- use the results of a series of experiments from different research labs to form a general conclusion.

Prior to this lab unit students should have become familiar with the characteristics shared by all living organisms. Student skills needed include use of microscope, wet mount preparation, and reading pH paper.

### **Suggestions for Teachers**

#### **Lab 1: What, How, Who?**

##### **Purpose:**

Students will begin to develop, through collaboration, an informed speculation about the responses of organisms (of various levels of complexity) to stimuli.

##### **Objectives:**

Students will be able to:

- develop a list of organisms placed in order of complexity.
- develop a list of stimuli and possible responses to stimuli.

##### **Materials:**

Request that the librarians prepare a rolling cart of reference materials about living organisms and their needs and environment. Ask that they include a variety of organisms beginning with one-celled organisms and extending to mammals. It might be a good idea for the instructor to add some textbooks other than the class text to this resource cart.

##### **Preparation and Procedure:**

Divide class into groups of about seven students each. Students are given 10 to 15 minutes to complete each part of their assigned tasks.

#### **Brainstorming Part 1**

Half the groups will brainstorm a list of stimuli that living organisms might experience and a correct list of responses.

The other half of the groups will compile a list of 12 living organisms, placed in order from the most simple to the most complex. The most simple must be a one-celled organism and the most complex must be a mammal. The other ten organisms should be as different from each other as possible. (The instructor may choose to address the terms of phylum and class prior to this lab. If these terms are familiar to the students they can be used in this task assignment but they are certainly not a necessity.)

When the groups' lists are completed, have each group take 10 to 15 minutes to re-evaluate and edit their lists.

### **Brainstorming Part 2**

Re-form new groups of about seven members each with no more than three repeating members from a previous group.

Using the information brought to the new work groups from Brainstorm Part 1 and the information from the library resources available, groups should choose an appropriate stimuli and response that could apply to each level of organism.

When the group's decisions are made, have them enter the information onto Table 1 (below).

Combine the results of each group in the class. Form a table of class results on the board. Have the class study the table. Are there any significant differences? What are the similarities? Have each group write a concluding paragraph about the similarities and differences in the class results.

### **Safety:**

None.

### **Where to Go From Here:**

This is the first of three labs in this lab unit; the three are designed to be used together, each giving the students' skills and information that they will need in the next.

## Student Activity

### LAB #1: What, How, Who?

#### Brainstorm #1

Your group will do one of two tasks. Check which task your group is assigned.

1. Brainstorm a list of stimuli that living organisms might experience and a corresponding list of responses; **OR**
2. Develop a list of 12 living organisms. They should be placed in order from the most simple to the most complex. The most simple should be a one-celled organism, the most complex should be a mammal.

When your list is completed, review it with the members of your group and edit as needed.

#### Brainstorm #2

1. Meet with your new group. Your group should have no more than three repeating members from Brainstorm #1. If you do, notify your teacher.
2. Use the information brought to the new work groups from Brainstorm #1 and the information from the library to choose an appropriate stimuli and response that can apply to each level of organism
3. When your group has decided on an appropriate stimuli and response enter the information into Table #1 (below).

**Table 1:**

Organism	Stimulus	Response
#1		
#2		
#3		

#4		
#5		
#6		
#7		
#8		
#9		
#10		

As a class, combine the results of each group. With your teacher, form a table of class results on the board. Study the table. Are there any significant differences? What are the similarities? As a group, write a concluding paragraph about the similarities and differences in the class results.

## Suggestions for Teachers

### LAB #2: Who?

**Purpose:**

The purpose of this investigation is to become familiar with the structure and behavior of a specific living organism. Students will apply information from previous labs in order to form more accurate conclusions.

**Objective:**

Students will be able to:

- learn in depth about a specific organism and to apply the results of the collaborations in Lab #1 with the information obtained in Lab #2 for a conclusion about the responses of a specific organism.

**Materials:**

- microscopes
- hand lenses
- pH paper
- cotton swabs
- lamps
- metric rulers
- depression slides
- construction paper
- stereoscopes
- colored pencils
- petri dishes
- stopwatches
- thermometers
- cardboard

**Specimens Needed:**

Cultures of:

- *Spyrogyra*
- *Daphnia*
- *Amoeba*
- *Planaria*

And 2-6 of the following organisms:

- earthworms
- crickets
- mussels
- hydra
- white mice
- feeder goldfish

*Note:* Instructors will need to provide a large variety of live specimens for this activity. The variety should cover as many different levels of organization as possible. The total number of each specimen does not need to be great. Only small amounts of each specimen will be needed. The amount usually sold as a class set for 30 students will probably supply four or more classes. At least seven different specimens should be available.

This lab will also use viewing devices, colored pencils, and the library resources used previously. The viewing equipment should be visible in the room at the start of the lab.

**Preparation and Procedure:**

Present the live specimens that you have chosen to supply. Briefly discuss the order of complexity among the specimens. Emphasize the care of live specimens as an absolute necessity. Failure to do so should result in a failing grade on this activity and an alternate assignment to meet the objectives. Assign a specific specimen to each lab group.

**Safety:**

Use appropriate safety precautions with animals and equipment.

**Where to Go From Here:**

This is the second of three labs in this lab unit; the three are designed to be used together, each giving the students' skills and information that they will need in the next.

## Student Activity

### Lab #2: Who?

The specimens available represent a small part of the tremendous variety of living organisms. These organisms all share the basic characteristics of life. However, they each have very different ways of functioning.

#### Part A

1. Obtain the specimen assigned to your team. Different lab specimens will need different types of containers.
2. Observe your specimen in the container. Answer the following questions and decide what equipment would be appropriate for viewing the specimen and observing its behavior.

#### Questions

(answer these questions on an attached sheet)

1. Can you see the specimen with your unaided eye?
2. Are the details of the structure easy to see using only your eyes? If your answer is no, is it because of the size of the organism or because of its movement?
3. What is the general environment of the organism? That is, in what kind of habitat does it live?
4. What obstacles, if any, does the environment (habitat) create in viewing the organism?
5. Describe the classroom environment (habitat). Use a thermometer to measure the temperature of the environment. What is the pH of the environment?
6. Consider the answers to the previous questions. Consider the equipment that is available in your lab. Discuss the options with your lab partner. List the materials that you decide to use to observe the organism that you are studying.
7. Write out how you plan to observe the organism. Get your teacher to approve your procedure before starting Part B.

Teacher Approval: \_\_\_\_\_  
Signature/Date

## **Part B**

1. Add colored pencils to the materials list in Part A.
2. Obtain the materials that you have listed.
3. Examine your organism carefully. Draw the specimen in as much detail as possible. Color your drawing.
4. Return the specimen to its classroom environment (habitat).
5. Use the resource material to discover as much as you can about the needs of the organism you have observed. Summarize your information in the space below.

## **Questions**

(answer these questions on an attached sheet)

1. What is the most outstanding physical characteristic of the organism that you have observed?
2. What behaviors did you observe in your organism?
3. Was the classroom environment (habitat) a water or a land environment? If it is a land environment, was it a dry land or a moist land? What is the pH of the maintenance environment? Is the environment light, dark, or both? Does your organism prefer light or dark?
4. Summarize the needs of your organism in terms of the four basic habitat requirements:

Food	
Water	
Shelter	
Space	

Consider all of the information in the previous questions. List stimuli that might cause a response from the organism that you are studying. Develop a corresponding list of responses that might be provoked. Record your list below.

Stimulus	Response
Continue this chart on an attached page, if needed.	

## Suggestions for Teachers

### Lab #3: Who, What, How, and Show Me

#### **Purpose:**

This is the last of the three labs in this lab unit; the three are designed to be used together, each giving the students skills and information that they will need in the next. This lab concludes the unit and shows the student how to use information and observation to form a hypothesis and how to independently design and conduct an experiment to test their hypothesis.

#### **Objectives:**

Students will be able to:

- examine a specific stimuli and select a response an organism might have to the stimuli.
- design and conduct an experiment to test their hypothesis.

#### **Materials:**

In addition to the materials used in Lab #2, there should be materials available that would allow students to test various responses. Some of these (but certainly not all) might be:

- vinegar
- fish food
- raw meat
- baking soda
- salt
- tape
- batteries and wire
- pen light
- thermometers
- water
- ice

For ideas, consult a good source book and available “cookbook” labs. This will give you many ideas on possible tests that might be tried and the materials that would be needed. It is possible to test response to light, gravity, chemicals, electric current, batteries, presence or movement of food and many others through relatively simple means. Excellent references include: *A Sourcebook for the Biological Sciences* (Morholt & Branwin, 1986; see especially Chapter 5); *Creepy Crawlies and the Scientific Method* (Kneidel, 1993); and *Classroom Creature Culture* (Hampton, et al., 1994).

#### **Preparation and Procedure:**

Students beginning to design their own experiments have one primary need-- encouragement. Maintain the spirit of experimentation. If it applies to the topic and can be done safely and evaluated meaningfully, then it is an experiment. Do not be inhibited

by your own knowledge of what is usually done or your certainty of a negative outcome.

Begin by reviewing the previous work done by the researchers. In Lab #1 the students collaborated to develop an informed speculation about the response to stimuli of organisms with various levels of complexity. In Lab #2 the students obtained information about a specific organism. They applied the results of their collaboration in Lab #1 with the information obtained in Lab #2 to form a conclusion about the responses of a specific organism. And in Lab #3 the students will pair up in groups of two and examine one specific stimuli that they expect to provoke a response in the organism they have studied. They will write a hypothesis about the stimuli and the expected response. They will design and conduct an experiment to test their hypothesis.

**Safety:**

Use appropriate safety precautions with animals and equipment.

**Where to Go From Here:**

These lab activities are intended to begin an independence of thought in student research. Many standard labs can be adapted to this systematic approach, which allows more student-driven investigations.

**References and Resources:**

1. Morholt, E. & Branwin, P. (1986). *A Sourcebook for the Biological Sciences*. New York: Harcourt, Brace, Jovanovich College Publishers.
2. Kneidel, S.S. (1993). *Creepy Crawlies and the Scientific Method*. Golden, CO: Fulcrum Publishing.
3. Hampton, C.H., Hampton, C.D., & Kramer, D.C. (1994). *Classroom Creature Culture*. Arlington, VA: National Science Teachers Association.

## Student Activity

### Lab #3: Who, What, How, and Show Me

#### Part A

1. Obtain a specimen of the same type of organism that you had for Lab #2.
2. Consult with your partner about the two previous labs. Choose a single stimuli that you expect to provoke a response.

#### Questions:

(answer these questions on an attached sheet)

1. List several stimuli and their corresponding responses that would apply to this organism.
2. Which of these stimuli/response pairs do you feel is the most important to the organism? Why?
3. Which of these stimuli/response pairs are you the most sure of?
4. Which of these do you have the most questions about?
5. Write a hypothesis about the response that you expect when this stimuli is changed or applied. Be specific in the amount of change and the kind of response that you would expect.

#### Part B

1. Discuss possible ways to prove the hypothesis that you wrote in Part A.
2. Evaluate the possible materials that are available.
3. Evaluate the kind of data that can be measured in each possible test that you can do.
4. Consider the safety and humane aspects of the tests that you can do.

#### Questions

(answer these questions on an attached sheet)

1. What types of tests would prove your hypothesis?
2. Is the material available for the types of tests that you have considered? If not, what is missing? Could something else be substituted for the missing material?
3. What measured data could you get from the tests that you are considering?
4. What would be the variable tested?
5. What would be the control?
6. What safety equipment or precautions would be needed?
7. Would any harm or pain come to the specimen because of the procedure?
8. What can you do to insure that the specimen will be healthy at the conclusion of the experiment?

**Important!** If you have any questions about questions #1-8, check with your teacher before proceeding to Part C.

**Part C**

1. Write a step-by-step procedure to test your hypothesis.
2. Show the variable, control, and all safety steps.
3. Establish a data table, chart, and graph or table of observations; you will write your data on the Table.
4. Develop a list of materials that you will need to do the procedure.
5. Obtain written approval from your teacher before proceeding with Part D.

Teacher Approval: \_\_\_\_\_  
Signature/Date

## **Part D**

### **Conclusion**

Carry out your experiment. Collect your data and write a conclusion that refers to your hypothesis.

### **Assessment**

Write a critique of the lab that you designed or present a poster of your research.