AP® INVESTIGATION #12

INTERACTIONS: BEHAVIOR– TEACHER'S GUIDE

Kit # 36W7412

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ABSTRACT

Organisms orient to stimuli that are important to their survival. Movement toward or away from important stimuli (taxis) depends upon both the sensory and motor abilities of the organism. This lab explores the chemotactic behaviors that fruit flies and/or pill bugs exhibit when exposed to the controlled environment of a choice chamber. Students identify patterns in the behaviors and make inferences based on the composition of the tested materials and the organisms' responses. Students then determine what materials and experimental paradigms will be tested further.

GENERAL OVERVIEW

The College Board has revised the AP Biology curriculum to begin implementation in the fall of 2012. Advanced Placement (AP) is a registered trademark of the College Entrance Examination Board. The revisions were designed to reduce the range of topics covered, to allow more depth of study and increased conceptual understanding for students. There is a shift in laboratory emphasis from instructor-designed demonstrations to student-designed investigations. While students may be introduced to concepts and methods as before, it is expected that they will develop more independent inquiry skills. Lab investigations now incorporate more student-questioning and experiment design. To accomplish this, the College Board has decreased the minimum number of required labs from 12 to 8 while keeping the same time requirement (25% of instruction time devoted to laboratory study). The College Board has defined seven science practices that students must learn to apply over the course of laboratory study. In brief, students must:

1. Use models
2. Use mathematics (quantitative skills)
3. Formulate questions
4. Plan and execute data collection strategies
5. Analyze and evaluate data
6. Explain results
7. Generalize data across domains

The College Board published 13 recommended laboratories in the spring of 2011. They can be found at: http://advancesinap.collegeboard.org/science/biology/lab

Many of these laboratories are extensions of those described in the 12 classic labs that the College Board has used in the past. The materials provided in this lab have been prepared by Ward's to adapt to the specifications outlined in AP Biology Investigative Labs: An Inquiry-Based Approach (2012, The College Board). Ward's has provided instructions and materials in the AP Biology Investigation series that complement the descriptions in this College Board publication. We recommend that all teachers review the College Board material as well as the instructions here to get the best understanding of what the learning goals are. Ward's has structured each new AP investigation to have at least three parts: Structured, Guided, and Open Inquiry. Depending on a teacher's syllabus, s/he may choose to do all or only parts of the investigations in scheduled lab periods.

The College Board requires that a syllabus describe how students communicate their experiment designs and results. It is up to the teacher to define how this requirement will be met. Having students keep a laboratory notebook is one straightforward way to do this.

RECORDING DATA IN A LABORATORY NOTEBOOK

All of the Ward's Investigations assume that students will keep a laboratory notebook for student-directed investigations. A brief outline of recommended practices to set up a notebook, and one possible format, are provided below.

1. A composition book with bound pages is highly recommended. These can be found in most stationary stores. Ward's offers several options with pre-numbered pages (for instance, item numbers 32-8040 and 15-8332. This prevents pages from being lost or mixed up over the course of an experiment.
2. The title page should contain, at the minimum, the student's name. Pages should be numbered in succession.
3. After the title page, two to six pages should be reserved for a table of contents to be updated as experiments are done so they are easily found.
4. All entries should be made in permanent ink. Mistakes should be crossed out with a single line and should be initialed and dated. This clearly documents the actual sequence of events and methods of calculation. When in doubt, over-explain. In research labs, clear documentation may be required to audit and repeat results or obtain a patent.
5. It is good practice to permanently adhere a laboratory safety contract to the front cover of the notebook as a constant reminder to be safe.
6. It is professional lab practice to sign and date the bottom of every page. The instructor or lab partner can also sign and date as a witness to the veracity of the recording.
7. Any photos, data print-outs, or other type of documentation should be firmly adhered in the notebook. It is professional practice to draw a line from the notebook page over the inserted material to indicate that there has been no tampering with the records.

For student-directed investigations, it is expected that the student will provide an experimental plan for the teacher to approve before beginning any experiment. The general plan format follows that of writing a grant to fund a research project.

1. Define the question or testable hypothesis.
2. Describe the background information. Include previous experiments.
3. Describe the experiment design with controls, variables, and observations.
4. Describe the possible results and how they would be interpreted.
5. List the materials and methods to be used.
6. Note potential safety issues.

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RECORDING DATA IN A LABORATORY NOTEBOOK (continued)

After the plan is approved:

7. The step-by-step procedure should be documented in the lab notebook. This includes recording the calculations of concentrations, etc., as well as the weights and volumes used.
8. The results should be recorded (including drawings, photos, data print-outs, etc.).
9. The analysis of results should be recorded.
10. Draw conclusions based on how the results compared to the predictions.
11. Limitations of the conclusions should be discussed, including thoughts about improving the experiment design, statistical significance, and uncontrolled variables.
12. Further study direction should be considered.

The College Board encourages peer review of student investigations through both formal and informal presentation with feedback and discussion. Assessment questions similar to those on the AP exam might resemble the following questions, which also might arise in peer review:

- Explain the purpose of a procedural step.
- Identify the independent variables and the dependent variables in an experiment.
- What results would you expect to see in the control group? The experimental group?
- How does a specific concept (XXXX) account for described findings (YYYY)?
- Describe a method that could be used to determine a given concept/observation (XXXX).

MATERIALS CHECKLIST

MATERIALS INCLUDED IN KIT

Units per kit	Description
1 vial/100	pH paper, 1-14 range,
1 pkg.	Filter paper, medium grade
8	Ward's dual magnifiers
1 pkg./20	Disposable Petri dishes
473 mL	White vinegar,
8	Animal behavior trays with lids
1 pkg./300	Cotton balls
1 pkg./100	Pipets
1	Instructions (this booklet)
1	* Redemption coupon for pill bugs (*Armadillidiidae*) and fruit flies (*Drosophila)*

For a list of replacement items, visit: www.wardsci.com, and click on the AP Biology tab for this kit/item #.

**** It is recommended that you redeem your coupon for live/ perishable materials as soon as possible and specify your preferred delivery date. Generally, for timely delivery, at least two weeks advance notice is preferred.***

MATERIALS NEEDED BUT NOT PROVIDED

Lab notebook
Clear plastic bottles (e.g., soda bottles) with caps
Household substances, condiments, foods with heavy odors
Masking tape
Clear plastic packing tape
Water
Funnel
Drosophila morgue (beaker filled with salad oil or alcohol)
Light
Alka Seltzer tablets
Safety glasses
Timers

OPTIONAL MATERIALS (NOT PROVIDED)

Fine paintbrushes
Cold packs or crushed ice
Aluminum foil
Dissecting microscopes
Other materials as determined by students' experiment design

This lab activity is aligned with the 2012 AP Biology Curriculum (registered trademark of the College Board). Listed below are the aligned Content Areas (Big Ideas and Enduring Understandings), the Science Practices, and the Learning Objectives of the lab as described in AP Biology Investigative Labs: An Inquiry-Based Approach (2012). This is a publication of the College Board that can be found at http://advancesinap.collegeboard.org/science/biology/lab.

CURRICULUM ALIGNMENT

Big Ideas

- **Big Idea 2:** Biological systems utilize energy and molecular building blocks to grow, to reproduce, and to maintain homeostasis.
- **Big Idea 4**: Biological systems interact, and these interactions possess complex properties

Enduring Understandings

- 2D1: 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.
- 2E3: Timing and coordination of behavior are regulated by various mechanisms and are important in natural selection.
- 4A6: Interactions among living systems and with their environment result in the movement of matter and energy.
- 4B4: Distribution of local and global ecosystems changes over time.

Science Practices

- 1.3 The student can refine representations and models of natural or man-made phenomena and systems in the domain.
- 1.4 The student can use representations and models to analyze situations or solve problems qualitatively and quantitatively.
- 2.2 The student can apply mathematical routines to quantities that describe natural phenomena.
- 3.2 The student can refine scientific questions.
- 4.2 The student can design a plan for collecting data to answer a particular scientific question.
- 5.1 The student can analyze data to identify patterns or relationships.
- 5.2 The student can refine observations and measurements based on data analysis.
- 6.1 The student can justify claims with evidence.
- 6.4 The student can make claims and predictions about natural phenomena based on scientific theories and models.
- 7.2 The student can connect concepts in and across domain(s) to generalize or extrapolate in and/or across enduring understandings and/or big ideas.

LEARNING OBJECTIVES

- The student is able to refine scientific models and questions about the effect of complex biotic and abiotic interactions on all biological systems from cells and organisms to populations, communities, and ecosystems (2D1 & SP 1.3, SP 3.2.)
- The student is able to design a plan for collecting data to show that all biological systems (cells, organisms, populations, communities, and ecosystems) are affected by complex biotic and abiotic interactions (2D1 & SP 4.2, SP 7.2.)
- The student is able to analyze data to identify possible patterns and relationships between a biotic or an abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems) (2D1 & SP 5.1.)
- The student is able to analyze data to support the claim that response to information and communication of information affect natural selection (2E3 & SP 5.1.)
- The student is able to justify claims, using evidence, to describe how timing and coordination of behavioral events in organisms are regulated by several mechanisms (2E3 & SP 6.1.)
- The student is able to connect concepts in and across domain(s) to predict how environmental factors affect response to information and change behavior (2E3 & SP 7.2.)
- The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment that result in the movement of matter and energy (4A6 & SP 2.2.)
- The student is able to use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environments result in the movement of matter and energy (4A6 & SP 1.4).
- The student is able to predict the effects of a change of matter or energy availability on communities (4A6 & SP 6.4.).
- The student is able to use data analysis to refine observations and measurements regarding the effect of population interactions on patterns of species distribution and development (4B4 & SP 5.2.)

TIME REQUIREMENTS

Pre-Lab Prep: Redeem Live Materials Coupon	At least two weeks prior to lab
Part 1: Structured Inquiry – Chemotaxis	Total of 30 minutes*: 10 minutes set up 10 minutes observation and recording 10 minutes analysis *Optional: Teacher may decide to break this into two observation periods – 30 minutes for control (no stimulus in tray) and 30 minutes for experiment)
Part 2: Guided Inquiry – Test Variables of Student's Choice	Total of 20 minutes: 5 minutes set up 10 minutes observation and recording 5 minutes analysis
Part 3: Open Inquiry	Total depends on student/teacher scheduling and parameters of experiment

GENERAL SAFETY PRECAUTIONS

General Safety

- The teacher should 1) be familiar with safety practices and regulations in his/her school (district and state) and 2) know what needs to be treated as hazardous waste and how to properly dispose of non-hazardous chemicals or biological material.
- Consider establishing a safety contract that students and their parents must read and sign. This is a good way to identify students with allergies (e.g., latex) so that you (and they) will be reminded of specific lab materials that may pose risks to individuals. A good practice is to include a copy of this contract in the student lab book (glued to the inside cover).
- Students should know where all emergency equipment (safety shower, eyewash station, fire extinguisher, fire blanket, first aid kit etc.) is located.
- Require students to remove all dangling jewelry and tie back long hair before they begin.
- Remind students to read all instructions, Material Data Safety Sheets (MSDSs) and live care sheets before starting the lab activities, and to ask questions about safety and safe laboratory procedures. Appropriate MSDSs and live care sheets can be found on the last pages of this booklet. *(Note: There are no live material care sheets included in this particular lab.)* Additionally, the most updated versions of these resources can be found at www.wardsci.com. The most updated version of most MSDSs can usually be found on the chemical manufacturer's website.
- In student directed investigations, make sure that collecting safety information (like MSDSs) is part of the experimental proposal.
- As general laboratory practice, it is recommended that students wear proper protective equipment, such as gloves, safety goggles, and a lab apron.

At the end of the lab:

- All laboratory bench tops should be wiped down with a 10% bleach solution or disinfectant to ensure cleanliness.
- Remind students to wash their hands thoroughly with soap and water before leaving the laboratory.

PREP TIP

- Live materrials are used in this lab. **Prior to starting this lab, submit your live/perishable material redemption coupon via mail, fax, or simply calling customer service at 1-800-962-2660. *It is recommended that you do this at least two weeks before the lab.***

PRE-LABORATORY PREPARATION

- **Redeem your coupon for all live materials to be delivered at least two weeks before you are ready to start this lab.**
- This kit contains a redemption coupon for both *Drosophila* and *Armadillidiidae*. Either organism can be used throughout the lab. It is recommended that you provide both for your students so they have expanded choices for constructing their own experiments. If you would like to assist students in making a "choice chamber" with two sections, instead of the behavior tray with five sections provided here, please see the instructions below. Students may find the two-chambered setup easier for performing geotactic experiments.
- Have students read the experiment ahead of time and have them bring in an approved stimulus of their choice for the Guided Inquiry part of the lab.
- If you are using *Drosophila*: Place the vial in the refrigerator or in an ice bucket at the beginning of class so that the animals will be moving slowly enough to handle by the time students need to fill the behavior tray. Leaving the *Drosophila* in the cold for more than 30 minutes will decrease their viability.
- Prepare an insect morgue to kill and dispose of insects. Typically, this is a beaker or flask containing either salad oil or 70% alcohol. Once the insects are dead, dispose of the morgue contents as recommended by your school. Generally, the contents can be flushed down a sink drain with copious amounts of water. NOTE: If you are using oil, treat it with dishwashing liquid/soap prior to pouring it down the drain.
- OPTIONAL: Prepare solutions of household materials for students to use in guided inquiry in stock bottles. Only allow students access to dropper bottles or other small bottles of solutions. Clearly label all bottles. Lab solutions of HCl or NaCl should be no more concentrated than 0.1 M. Volatile choices and other choices with strong odors might include alcohol (associated with fermentation), ammonia (nitrogen associated with decay), mercaptoethanol (sulphur associated with decay), soil with high humus content, wet yeast (associated with fermentation), apple cider vinegar, fruit juice, cedar chips.
- OPTIONAL - Construct a two-choice chamber as an alternative to the five-choice chamber provided:

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OPTIONAL PRE-LAB DEMONSTRATION

- Given the definition of "taxis," what do students think "geotaxis" refers to? Demonstrate geotaxis by having students observe a vial of *Drosophila*. Note what direction the flies move in. After a minute, invert the vial. Did the flies' behavior change? Why do students think this occurs?
- Give an example of data and results, including analysis of error (overlapping error – not statistically significant, non-overlapping-significant). Discuss T-test and chi squared test.

PRE-LABORATORY PREPARATION (CONTINUED)

Have students bring in clear, soft-plastic water bottles, 12-16 oz in size. For eight lab groups, collect at least 16 bottles with caps. Pair the water bottles by size (not all bottles must be the same size, but each two-chamber unit must have the same-sized chambers). Have students cut off the bottom of the bottles using scissors. Clean and dry the bottles thoroughly. Match the bottles end to end and tape them together using clear packaging tape. Label one side "A" and the other side "B". When testing substances, cotton balls are soaked in the testing material, inserted into either chamber, and the caps are screwed on tightly. Be sure to clean the bottles, bottle caps and bottle necks between tests.

BEFORE CLASS

1. Make copies of the Student Guide (copymaster pages).
2. Prepare your materials for the class demonstration to support your lecture or laboratory introduction.