

Modified AP Lab 12: Mealworm Behavior

In this lab you will observe some aspects of animal behavior. This lab will use mealworm insects. Mealworms are the larval form of the mealworm beetle, *Tenebrio molitor*, a species of darkling beetle. They go through four life stages: egg, larva, pupa, and adult. <https://en.wikipedia.org/wiki/Mealworm> This lab will also help you to become familiar with scientific process, working in lab groups, using equipment, making observations, collecting and analyzing data, and organizing ideas.

Background:

(Answer all embedded questions in using complete sentences in the **BACKGROUND** section of your lab notebook).

Ethology is the study of animal behavior. Behavior is an animal's response to sensory input and falls into two basic categories: **learned** and **innate** (inherited).

Orientation behaviors place the animal in its most favorable environment. In **taxis** the animal moves toward or away from a stimulus. Taxis is often exhibited when the stimulus is light, heat, moisture, sound, or chemicals. Taxis movements may be positive (consistently toward a stimulus) or negative (consistently away from a stimulus).

A **chemotaxis** is a movement in response to the presence of a chemical stimulus.

- a. What benefit would an organism gain by responding to chemicals in their environment?
- b. What kind of organisms may exhibit this behavior?

A **phototaxis** response is a movement in response to light.

- c. What benefit would an organism gain by responding to light in their environment?
- d. What kind of organisms may exhibit this behavior?

A **geotaxis** response is a movement in response to gravity.

- e. What benefit would an organism gain by responding to gravity in their environment?
- f. What kind of organisms may exhibit this behavior?

Kinesis is a movement that is random and does not result in orientation with respect to a stimulus. If an organism responds to bright light by moving away, that is taxis. If an animal responds to bright light by random movements in all directions, that is kinesis.

Agonistic behavior is exhibited when animals respond to each other by aggressive or submissive responses. Often the agonistic behavior is simply a display that makes the organism look big or threatening. It is sometimes studied in the laboratory with *Bettas* (Siamese Fighting Fish).

Mating behaviors may involve a complex series of activities that facilitate finding, courting, and mating with a member of the same species.

Part 1: Observation of Mealworm Behaviors

1. Obtain a petri dish, place 10 mealworms with a small amount of bedding material, and cover.
2. Observe the mealworms for a few minutes. Make notes on their general appearance, movements about the dish, and interactions with each other in your lab notebook. Notice if they seem to prefer one area over another, if they keep moving, settle down, or move sporadically. Note any behaviors that involve 2 or more mealworms. Try to make your observations without disturbing the animals in

any way. Do not prod or poke or shake the dish, make loud sounds, or subject them to bright lights. You want to observe their behavior, not influence it or interfere with it.

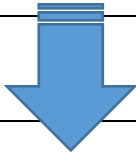
3. Record any specific behaviors that relate to orientation/taxis, kinesis, agonistic behaviors, or mating in your lab notebook under **MEALWORM OBSERVATIONS**.
4. Make a detailed sketch of a single mealworm in your lab notebook.
 - a. Give your drawing a title.
 - b. *After* you've drawn the invertebrate, do some research and label as many anatomical parts on your meal-worm as you can.

Part 2: Mealworm Kinesis

QUESTION: Do mealworms exhibit kinesis or taxis behaviors in response to water?

1. Obtain a "choice chamber" and label one end side A, and the other B.
2. Line Side A with a moist piece of filter paper and Side B with a dry piece of filter paper. Leave the middle connector empty.
3. Place 5 mealworms in each side of the choice chamber and cover each chamber.
4. Create a data table like **DATA** Table 1 in your lab notebook to record their location.
5. Count how many mealworms are in each location of the choice chamber every 30 seconds for 10 minutes and record the data in your lab notebook.

Data Table 1: Mealworm Kinesis

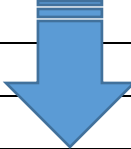
Time (min.)	Number of Mealworms on Side A (Wet Chamber)	Number of Mealworms on Side B (Dry Chamber)	Number of Mealworms in Center Between Chambers	Observations / Notes
0.0	5	5	0	
0.5				
1.0				
1.5				
2.0				
2.5				
3.0				
Continue 				
9.0				
9.5				
10.0				

6. **GRAPH** your group's data using a line graph.
 - a. Independent Variable : _____ (label on the X-axis)
 - b. Dependent Variable: _____ (label on the Y-axis)
 - c. Make sure your graph has an appropriate Title, labeled axes, units, and a legend/key

7. **ANALYSIS**

- a. How do you know if moisture made a difference in the mealworm's behavior? You need a statistical hypothesis or Null Hypothesis. Write a **Null Hypothesis** in your lab notebook.
- b. Gather more data. A minimum sample size of 30 mealworms is needed to be able to perform a chi-squared analysis of the data. Gather **Class Data** using a second data table like Data Table 2 below.

Data Table 2: Mean Mealworm Kinesis

Group	Number of Mealworms on Side A (Wet Chamber) after 10 minutes	Number of Mealworms on Side B (Dry Chamber) after 10 minutes	Number of Mealworms in Center Between Chambers after 10 minutes
1			
2			
			
Totals			
Means			

- c. Perform a **chi-squared statistical analysis**. Show your work.
- d. Correctly write a statement that either accepts or does not accept the Null Hypothesis. Remember to reference your exact chi-squared value as it compares to the critical value at x degrees of freedom and $p=0.05$.
- e. Calculate the average (mean) number of mealworms from the class data. Use those calculations to determine the **standard deviation** and **standard error of the mean** for our class data set. Show your work.
- f. **GRAPH** the class averages on a bar graph following appropriate graphing protocols. Be sure to add error bars ($2 \times SE_x$)

8. **CONCLUSION**

- a. Use the CIEvR model to write a Claim supported by Evidence and justified by Reason.
- b. Questions to consider as you write your conclusion paragraph:
 - i. Do mealworms demonstrate a preference for moisture?
 - ii. Did the mealworms exhibit evidence of taxis or evidence of kinesis? How do you know?
 - iii. Explain (justify) the physiological reasons for the behavior observed in this activity.
- c. Your evidence can come from your chi-square test or reference your standard error calculations or error bars.
- d. Your justification should come from a biological concept (statistical concepts or animal behavior referenced in the background)

Part 3: Design a Controlled Experiment

For this part of the lab, you will Investigate Mealworms' Response to a specific variable. Refer to the list below.

- Light vs. Dark
- Acid vs. Neutral
- Base vs. Neutral
- Salt vs. Neutral
- Caffeine vs. Distilled Water (Neutral)
- Apple (food) vs. No food
- Corn meal (food) vs. No food
- Background Color: Light vs. Dark
- Temperature: warm vs room
- Temperature: cold vs room
- Other: _____

1. Select a variable from the list above and formulate a testable **Investigation QUESTION** related to the concept of taxis. Record this in your lab notebook.
2. Develop a **HYPOTHESIS** concerning the mealworm's response to the factor. (If..then...because...) Record this in your lab notebook.
3. Use the **MATERIALS** available in your classroom to design a controlled experiment.
 - a. List your materials in your lab notebook.
 - b. Outline your **PROCEDURE** in detail (bullets or numbers) in your lab notebook.
 - c. Decide what data you will collect and design a **DATA TABLE** in your lab notebook.
 - d. Run your experiment.
4. **ANALYSIS**
 - a. Write a **Null Hypothesis**.
 - e. Perform an appropriate mathematical analysis of your data. (standard error, chi-square...) include the mathematical equation used for your calculations.
 - b. **Accept or Reject the Null Hypothesis**; use your statistical analysis to support this. Remember to reference your exact chi square value as it compares to the critical value at x degrees of freedom and $p=0.05$.
5. **GRAPH** – Decide on the type of graph you want to make. Make sure your graph has a title, labeled axes, units, and legend/key.
6. **CONCLUSIONS**
 - a. Use the CIEvR (Claim, Evidence, Reasoning) model to write your conclusion paragraph.
 - b. Be sure to address these questions in your paragraph:
 - i. Was your original hypothesis about the preference of mealworms correct?
 - ii. Did the mealworms demonstrate positive or negative chemotaxis, phototaxis, geotaxis, or kinesis? What is your evidence?
 - iii. Provide reasoning to support your conclusions.

GRADING RUBRIC for AP Lab 12: Animal Behavior

Component	Criteria for Excellence	Points
Part 1: Observation of Mealworm Behaviors	Detailed observations recorded in lab notebook	___ / 3
	Sketch of mealworm – hand drawn, color	___ / 2
	Labeled anatomy	___ / 2
Part 2: Mealworm Kinesis	Data Table 1: 5. Appropriate Title 6. appropriate data 7. units 8. relevant notes/observations 9. good use of space	___ / 5
	Graph of data with title, labeled axes, units, legend/key if necessary, good use of space	___ / 5
	Analysis: - Complete sentence format - Null hypothesis stated correctly - Statistical analysis – show work (2 pts) - Statement to accept or not accept the Null with explanation (2 pts)	___ / 6
	Conclusion: - Paragraph format - Answer all lab questions (3) - Physiological explanation for observed behaviors	___ / 5
Part 3: Design a Controlled Experiment	Appropriately written Investigation Question	___ / 2
	Hypothesis: “If...then...because...”	___ / 3
	Materials listed(bullets or numbers)	___ / 2
	Procedure (numbered steps, repeatable)	___ / 2
	Data Table 2 (same expectations as above)	___ / 5
	Analysis: - State Null Hypothesis - Mathematical analysis of data (2 pts) - Accept or Reject (do not accept) the Null with explanation (2 pts)	___ / 5
	Graph of data with title, labeled axes, units, legend/key if necessary, good use of space	___ / 5
	Conclusion: - Address your original hypothesis - Make a claim as to the type of behavior demonstrated - Use of evidence (data) to support your claim - Provide reasoning (justification) to link your evidence and claim - Well written	___ / 5
Total Points		___ / 57

