Plant and Animal Adaptation Lab; SB4 a, e, f

Although plants are sessile organisms that cannot walk toward the sun or run from a hungry herbivore, they do respond to stimuli such as light, temperature, gravity, and touch. Plants also can defend themselves by evolving physical protection and even chemical protection against predation and stressful environmental conditions. These characteristics have allowed plants to adapt or change to become better suited to survive and reproduce in their environment.

Tropisms are growth responses in plants due to a certain stimuli. A change in a plant due to touch is called **thigmotropism**. This is common in climbing plants such as vines like kudzu or poison ivy. Most plants that respond to touch have tendrils that will wrap around wires, fences, or other plants like trees to gain support. **Phototropism** is the growth of a plant in response to light. Sunflowers are so named because the large flower on top of the stock will point in the direction of the sun and turn as the sun moves across the sky. The last tropism is **gravitropism (geotropism)** which is a plant's response to gravity. This tropism is seen in germinating plants where the shoots will grow up, while the roots grow down into the soil. Lastly, **hydrotropism** is intuitively a plant's response to the presence of water. What about heliotropism?

Some plants have adapted to live in extremely dry climates by becoming resistant to draught or a long period of time without water. These plants have evolved leaves that limit water loss from transpiration either by closing their stomata during the heat of the day or not having traditional leaves at all. Other common draught resistant plants can store water in specialized tissues. These plants are called succulents, common examples include cacti. Other plants can withstand flooding by having above ground roots like the mangrove trees that populate coastal regions where water levels are constantly changing.

Plants also have developed adaptations to ward off herbivory, or the eating of plant materials by an animal. Some plants have physical defenses such as think spines and thorns, while others have chemical defenses, like poisons. These chemical defenses can come in the form of secondary compounds called allelochemicals which have a variety of effects on herbivores, such as reducing digestibility, bad taste, or can even be lethal. Some common examples of plants with these effects are garlic, parsley, coffee beans, onions, chili, and other strong spices. Milkweed, which is a plant that monarch butterflies feed on, is what makes monarch butterflies poisonous to predators. Thus, the viceroy butterfly mimics the monarch in coloration and predators avoid both.

Although plants are well adapted to fight off most herbivory, resistance to these secondary compounds evolves when one or more individuals in an herbivore population have a mutation that allows them to detoxify or to become immune to the ill effects of the plant chemicals. As always evolution is an arms race between organisms to always stay successful and reproduce in a certain set of environmental conditions.

Directions: By evaluating the information given, your group will design an experiment that tests the effects of chemical defenses of certain plants on meal worms. These worms are herbivores who feed primarily on leaves, so you may have to make a chemical solution out of the plant(s) you wish to test. Make sure in your experimental design to include a hypothesis, replications of your test, and a control. You must also make at least two data tables and one graph showing and analyzing your results. You will be required to use LabQuest digital probes in your experiment, although the specific type of probe you choose to use will depend on your experiment. You may also decide to use LoggerPro software to help you to analyze the data. Be detailed in your scientific design, as your grade will be on your methods and analysis not your results. The purpose of this lab is to understand how plants and animals adapt to varying environmental conditions.

Materials that will be available to you include, but are not limited to choice chambers, plastic cups, petri dishes, vinegar and other solutions, plastic wrap, lettuce, bananas, potatoes, variety of spices, coffee beans, peppers, meal worms, crickets, source of light/heat, ice and any other reasonable request will be considered.

Part 1: A detailed lab report including the following: Observation/Background Research, Hypothesis, Experimental Design (include materials, diagram of the set-up, and step by step directions), Data Collection Tables, Analysis Graphs, Discussion.

Part 2: Post Lab Questions:

1. Explain the three tropisms found in plants and give examples of each that are not listed in the background section of this lab. Do you believe these adaptations are more or less important for plant fitness than the chemical defenses we experimented with on the crickets?

2. In the background information it stated that herbivores and plants were in an evolutionary arms race. What does that mean in terms of survivability? What is another example of an arms race between two other organisms in other trophic levels (think predator/ prey)?

3. There are several examples in nature of adaptations that increase an organism's fitness, which is its ability to survive and reproduce. Provide an example of what you believe is the best, most innovative example of a physical or chemical adaptation. Explain how it works, what it looks like, and how it benefits the organism.

4. Not all adaptations are physical features, name and describe two animal behaviors that can increase an animal's fitness.

5. What are the three ways organisms can be dispersed in an ecosystem? Describe and draw a simple diagram of each.

6. Humans have become the dominate animal in many biomes; how have our influences affected the availability of resources? How are organisms affected by the abundance or scarcity of resources?

7. Crows break the shells of certain mollusks before eating them. Hypothesizing that crows drop the mollusks from a height that gives the most food for the least effort, a researcher dropped shells from different heights and counted the drops it took to break them.

Height of drop (m)	Average number of drops required to break shell	Total flight height (number of drops × height per drop)
2	55	110
3	13	39
5	6	30
7	5	35
15	4	60

a. Which height provides the most food for the least energy for the crows? Justify your response.
b. If crows do fly to the most energy-efficient height, describe an experiment to determine if this is learned or innate behavior.