PLANTS AGAINST THE WORLD

INTRODUCTION:

Plants are a convenient source of food for many organisms. Unlike animals, plants use the process of photosynthesis to convert light energy from the sun into the chemical energy present in food. Without plants, animals would not be able to exist. Specializing on eating plants is called **herbivory**, and plant eaters are called **herbivores.**

What are some common herbivores that you can think of?

Are there structural and physiological characteristics that herbivores share? Please list the characteristics that you think of (example: mouths adapted for chewing, crushing, and grinding).

In response to the constant attack by herbivores, plants are not entirely defenseless. They employ a range of defenses to prevent herbivores from attacking.

- Mechanical defenses: thorns, spines, hairs, thick coating on leaves
- Low water content or low nitrogen content -- makes them a less attractive food source
- Chemical defenses -- **secondary compounds** or **allelochemicals**

Secondary compounds can have a variety of effects

- reduce digestibility
- taste bad or are **unpalatable**
- toxic

Usually, there are some herbivores that are resistant to the effects of a particular secondary compound. Resistance to secondary compounds evolves when one or more individuals in a herbivore population have a mutation that allows them

to detoxify or otherwise cope with the toxic effects of that compound. Because these individuals are able to use the plants producing that compound as a resource, they may have an advantage and be able to leave more offspring than herbivores without the mutation. These resistant herbivores may evolve to become **specialists** on plants with that compound. Specialists feed on one or a small number of closely related plant species and ignore other plants. An example of a specialist is the silkworm, *Bombyx mori*, which feeds almost exclusively on mulberry leaves. Herbivores that don't specialize on a particular plant are called **generalists**. Many grasshoppers are generalists.

What might be some potential advantages to a herbivore of being a **specialist**? a **generalist**?

Some secondary compounds are used by humans. Many humans enjoy the taste of the plant secondary compounds in spices. Others enjoy the physiological or psychological effects of plant compounds such as those found in coffee, tea, and chocolate. Some secondary compounds may also be useful as medicines.

What are some plants you can think of that might have secondary compounds that deter herbivores? List them here. Why do you think they might contain antiherbivore compounds?

In addition to the plants you thought of, some common plants that contain secondary compounds with possible antiherbivore effects include:

Allium sativum (garlic) -- contains a variety of compounds which may have antiherbivore effects including
allicin (strong oxidant with powerful odor)
ajoene
diallyl disulfide
S-allyl cysteine
S-allyl mercaptocysteine

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Nicotiana tabacum (tobacco) -- contains the alkaloid nicotine, which mimics acetylcholine at the neuromuscular (nerve/muscle) junction in mammals, and results in twitching, convulsions, and death. In insects, the same action is observed, but only in the central nervous system ganglia.

Caffea arabica (coffee) -- contains caffeine, which is an alkaloid. The effect on mammals is to stimulate the central nervous system, increase heart rate, and cause blood vessels to constrict.

***Capsicum* sp.** (chili) -- capsaicin, which depletes and prevents reaccumulation of substance P, which is thought to mediate pain response. Hence, although it often causes a painful burning sensation, it is also used as a topical pain remedy.

There are many other plants with potential antiherbivore secondary compounds that are not listed.

QUESTION:

What effect do different plant secondary compounds have on potential herbivores?

STEP ONE:

Write one or more hypotheses regarding the above question. In order to form hypotheses, think about what you might predict will happen if herbivores try to eat a plant with the secondary compounds that you are testing. Will all the compounds have the same effect?

Write your hypothesis/es here:

STEP TWO:

You may have thought of many hypotheses about how plant secondary compounds affect herbivores. In this activity you will use the following methods to test the hypothesis that secondary compounds in garlic, chili, coffee, and tobacco influence how much a generalized herbivore will eat.

Day one:

1.) Cut out a square piece of graph paper. The square should be 5 blocks long and 5 wide.

2.) Cut out a square piece of lettuce using the square of graph paper as a guide. **Do not throw your piece of graph paper away.** You will need it later in the experiment.

3.) Dip the lettuce square in one of the four treatments (tobacco, garlic, chili, coffee), or dip it in water as a control.

4.) Let the lettuce square dry on a paper towel (about 10 minutes).

5.) Get a paper cup, piece of plastic wrap, and rubber band.

6.) Place your lettuce square inside the cup.

7.) Place a cricket inside the cup. Cover the cup with a piece of plastic wrap, and secure it with the rubber band. Poke 5 or 6 small breathing holes in the plastic wrap.

8.) Place the cup in a quiet place overnight.

Day two:

9.) Remove the lettuce square. Place the lettuce square on the same piece of graph paper you originally used to measure it.

10.) Count the number of squares that can be seen (areas of the leaf that have been eaten). If it is more than half of a square, count it. If it is less than half, do not count it.

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STEP THREE:

Compile everyone's results in the table provided. Compute the average number of squares eaten for each treatment. Graph your results. Discuss your conclusions.

SQUARES EATEN	CHILI	GARLIC	TOBACCO	COFFEE	CONTROL
TOTAL					
MEAN					

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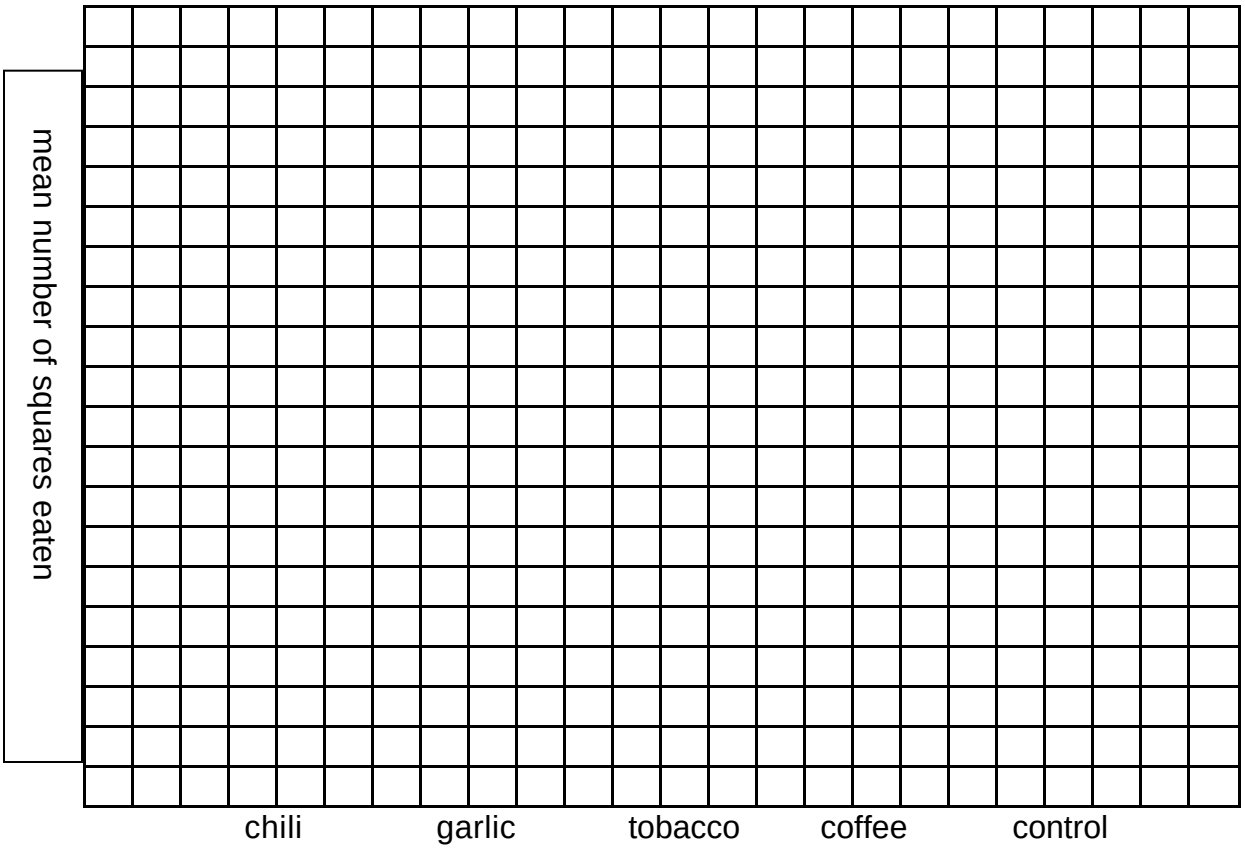

Please answer the following questions.

1.) Do the data support or falsify your hypothesis/es? Please explain.

2.) Were there any unexpected results? Can you think of any possible explanations for your unexpected results?

3.) Did the experiment and its results suggest any follow-up questions? If so, please list them.

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