

Chili Pepper Heredity:

Understanding the concepts of heredity, artificial selection, and natural selection using chili peppers

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For Bassett Middle School Grade 6, El Paso Texas, March 2007

TEKS Objectives

- 6.1 The student conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices
- 6.2 The student uses scientific inquiry methods during field and laboratory investigations
- 6.3 The student uses critical thinking and scientific problem solving to make informed decisions
- 6.4 The student knows how to use tools and methods to conduct science inquiry
- 6.11 The student knows that traits of species can change through generations and that the instructions and that the instructions for traits are contained in genetic material of organisms

References

I originally got the idea for using chili peppers as a laboratory subject from a lab written by Dr. Jerry D. Johnson at El Paso Community College (see attached lab for details).

Pictures for the PowerPoint presentation came from the following web site:

http://www.steve.gb.com/vegetable_empire/joy_of_pain.html

History, biology, and a couple of pictures of chili peppers were gleaned from the following web sites:

<http://www.straightdope.com/mailbag/mchili.html>

http://www.calantilles.com/capsicum_peppers.htm#Botany

<http://www.bbg.org/gar2/topics/kitchen/handbooks/chile/index.html>

Lesson Vocabulary

Genetics: the study of heredity

Heredity: the passing of traits from parents to offspring

Trait: a feature of an organism that is inherited from parents on the DNA

DNA: the genetic material that carries information about an organism

Recessive: a trait that is only visible when a dominant trait is not covering it

Dominant: a trait that is always seen, and will hide a recessive trait

Selective breeding: where people mate to organisms with desirable traits to make offspring with the same traits

Natural occurrence: something that exists in nature without being human-made

Adaptations: traits, or features that help organisms survive and reproduce

Natural selection: some organisms being more successful at surviving and reproducing because they possess traits that are more adaptive

This vocabulary was introduced to the students during the beginning of the unit in a power point presentation, but some terms were saved for introduction during the actual activities.

Materials Required

- Magnifying glasses (an alternative to the microscope)

- Paper towels to put the chilies on as we dissect them
- At least twelve individual chilies of as many different chili varieties desired - must have a variety of "hotness's" represented to make the activity work well.
- An instrument with which to dissect the chilies (knife of some kind)
- Two graduated cylinder to demonstrate how "Scoville Heat Units" are measured
- Paper and pencils for students to write down their observations and ideas

Preparation

Purchase and set-up of the chili peppers at the student work benches. Set up of all other materials should await the time of the actual experiment so as to minimize distraction of the children. A slide show with vocabulary should also be prepared.

Because this activity occurs near the beginning of a genetics unit, and because genetics is very confusing without knowing the vocabulary associated with this subject, we open with a slide show discussion of the first vocabulary terms from the list above ("Genetics" through "Recessive"). This vocabulary should be written in the student's science journals so they have it to refer to for the evaluation at the end of the Chili Pepper Inheritance Lab.

Safety Information

Students are not permitted to touch the insides of any of the chili peppers with their bare hands! Latex gloves and goggles must be worn at all times if the students are allowed to handle the chilies. I recommend that the instructors only do chili handling. Also, have some high-fat yogurt around to apply to skin if any capsaicin gets on the students - this will ease the burning sensation.

Engagement Technique (and beginning of explanation):

Who is whose parent?

- We start class with a conversation about how many brothers and sisters each of the students have, and I explain that a brother or sister is called a sibling. I then ask the students to raise their hand if anyone has told them that their siblings look like them. Of, course many of the students raise their hand. I then ask them why they think that is, and I start the slide show with the vocabulary terms, "genetics", "heredity", "trait", "dominant", "recessive", and "DNA".
- At the end of the PowerPoint presentation we play the genetic inventory game where each student has to check whether others at their lab table possess traits like "widows peak", "mid-digital hair", "hitchhikers thumb", "which thumb is on top when they fold their hands", "tongue rolling".
- After this the teacher holds up a chili pepper and reminds them that plants have DNA too, so there are traits that chili peppers inherit in the same way that people inherit traits. The students are asked to offer traits that can be seen in the chili pepper. Some of these traits are: "big vs. small", "round vs. long and thin", "pointy tip vs. blunt tip", "pepper color", "texture of the pepper's skin", and "spiciness".
- Then I tell the students that each of the chili peppers in the room was separated at birth from their sibling, and I invite a group of students to the front of the room to hold up each type of chili pepper. Then I ask the rest of the class to yell out the person's name that is holding the sibling of each pepper that I hold up (one by one, I hold up a matching chili to each of the student's chilies). The students are told to make their decision based upon whether the peppers share any of the pepper traits that we discussed. After this is done the students are told to return to their seats, and then if there is time left I ask them the following question...

- What makes a chili spicy? Then I show them the slide with the sliced chili pepper with exposed capsaicin blisters. I explain how capsaicin works, and how you tell how hot a chili is based on the amount of capsaicin that you can see in the placental tissue. I explain that we will be dissecting chilies as a class, and we will be ranking the chilies based upon how much capsaicin we see in the peppers.

Exploration

Ranking the capsaicin concentration of chili pepper varieties:

- At the beginning of class I tell the students to copy a small table into their science journal for the purposes of taking notes on the chili pepper observations we will make. The table should look like:

Pepper name	Observations	Rank

- I review the concept of ranking one object relative to another so the students will be prepared to rank chilies according to hotness.
- We then review the concept of concentration. We do this with a demonstration involving two different sized glasses full of water, and adding one drop of food coloring to each glass, and noticing that the smaller glass gets darker in color because its small volume of water makes the relative concentration of food coloring higher. I liken each glass to a chili pepper, and note that all chili peppers have volume just like a glass of water, and that all chili peppers have a certain amount of capsaicin, which is analogous to the amount of food coloring placed in the glass. I explain that the hotness ranking of the chili pepper is based upon its CONCENTRATION of capsaicin.
- At this point we are ready to cut the peppers open and look for the capsaicin, but we first review the safety precautions: NO TOUCHING ANY PEPPERS
- I cut open the peppers and place pieces of each type in front of the students so they can make their observations.
- Once all the observations have been made, we discuss as a class what the 1st, 2nd, and 3rd ranked pepper should be based upon how much capsaicin we saw, and how big each pepper was.

Elaboration

Are some chilies hotter than others? Why are chilies hot at all?

- I open class with a review of the vocabulary that we learned the first day of the lab, and then we start into the last three vocabulary terms.
- Have the students read and copy these terms and definitions into their science journals:
 - "natural occurrence" (I ask the students to come up with an example of something that is naturally occurring, and then something that is not naturally occurring)
 - "selective breeding" (here I give the example of domesticated, pure-breed dogs, and I mention that Chili peppers have been selectively bred for their hotness, and that the gene for hotness is dominant, so if you breed a Jalapeño with a bell pepper, their offspring will be hot even though the bell pepper has no heat at all),
 - "adaptation" (we discuss how the fish in the classroom has various adaptations that help them survive or reproduce, like gills, and scales etc.)
- Then we go into the idea of the "Scoville Heat Unit" - the ratio of water to chili necessary to render the pungency of the chili undetectable to people on a tasting committee. I then mention the Scoville Heat Units of some of the world's hottest chili peppers, and explain that the new one up at NMSU imported from India is a truly HOT! It is probably so hot because the Indians have been "*selective*

breeding" for hot chilies (they breed the hottest with the hottest to get kids that are even hotter). This chili tour is arranged from least hot, to most hot on the PowerPoint Presentation.

- I finish by explaining that chilies, and their capsaicin are "*naturally occurring*" (and native to our region in El Paso), and that it is an "*adaptation*" to avoid being eaten by mammals because mammals destroy the seeds as they consume them. However, because birds do not destroy the seeds, the pepper plants "want" the bird to eat the pepper so that the seeds can be dispersed. Then finish by mentioning that birds are not affected by capsaicin, so they like the peppers as a nutritious food source. Explain that adaptation comes about through "*natural selection*".

Evaluation

- By the end of this lab, students should have vocabulary in their science journals, an observation table for which peppers were ranked according to hotness, and their own question and answer to be shared with other students at their group (see below). They get a grade for turning in three good questions that they wrote, and provided the correct answers to.
- I then assemble a 10-question quiz using the questions collected from the students.