

Topic 1: Scientific Method – 1e. Bess Bug Lab

Resources: Information about bess bugs (also known as patent leather beetles) can be found on Foss website:
<http://lhsfoss.org/fossweb/teachers/materials/plantanimal/bessbeetle.html>

Bess bugs can be ordered from Carolina Biological Supply:
<http://www.carolina.com/>; they are ordered by the dozen and, if cared for properly, will live for months.

Campbell, N., Williamson, B., Heyden, R. (2006). *Biology: Exploring Life*. Boston, MA: Pearson Prentice Hall.

Graphing website: Create a Graph [Internet]. Washington, DC: National Center for Education Statistics, U.S. Department of Education. Available from: <http://nces.ed.gov/nceskids/createagraph/default.aspx>

1989 World's Strongest Man – Truck Pull (Part 5) [Internet]. Available from: <http://www.youtube.com/watch?v=2iAARZn41Ik>

Building on: This lab is very open-ended. It can be used to introduce the concept of *scientific method* and *experimental design*. It can also be used to reinforce the *characteristics of living things* and has application for an anatomy and physiology unit dealing with the *skeletal and muscle systems*.

When used for experimental design, it should be noted that the students are given a variety of things to work with, but very little instruction about how to complete the objective. Students do need to be shown how to make a lasso of dental floss and how to attach it to the bug; however beyond that they are given the freedom to choose how to proceed. As a result of the variations in procedure it is hoped that students will find it difficult to exchange data that is truly comparable. They will see the need to define procedures such as, the type of surface the bug moves on, the method used to attach the weights to the dental floss, the amount of movement needed to consider the bug successful, etc. All of these points should be brought up in a post-lab discussion.

This lab provides a good opportunity to discuss the descriptive list. The students will usually recognize the dependent variable as the maximum mass the bug can pull, but there is a lot of confusion over the independent variable. Some will say it is the different bugs, or the mass of each individual bug and some will say it is the amount of weights attached to the bug. This is a good time to discuss graphing and look to see if the graph the student constructed matches their identification of the dependant (y-axis) variable and the independent (x-axis) variable. Is everyone measuring the same thing (max. mass pulled, % of body mass pulled, # times body mass pulled, how far a

mass was pulled)? Is there a best way to solve the question of bug strength?

This lab also provides the opportunity to discuss the concept of a control and constants. Was there a control in this experiment? Do all biology experiments have controls? There is an excellent discussion of discovery science vs. hypothesis-based science in Chapter 2 of *Biology: Exploring Life*, Campbell, Williamson, and Hayden (see resource above). In discussing the factors that should have been kept constant (gender of the bugs, age of the bugs, health of the bugs, etc.), it becomes clear that when working with living organisms, it is very difficult to keep all of these factors constant (maybe a bug is just having a bad day). This reinforces the need to have lots of data using many bugs.

Graphing is an important part of this lab and graphs will vary greatly depending on the type of data the student collected. It is a good opportunity to introduce the students to the graphing website established by the U.S. Dept. of Education (see the resources above for the URL). It is easy to use and is accessible from any computer with Internet availability.

Links to Physics: Newton's Law of Inertia
Net Force
Work
Efficiency
Energy for Life
Linear Motion

Stories: There are clips on YouTube (see resources above) and on television of the "World's Strongest Man Competition" that can be shown to the class at some point in this lab. The students may notice that just as the man starts low to the ground and as he applies more and more energy he begins to rise, so does the bug. The comparison is startling and it feeds into the question, "If you were a bug, how much could you pull?" The students can then compare their body mass to that of the bug and figure out how much they could pull. You could also set up a large, strong box and rope along with some free weights and get a volunteer student to determine how much he/she can pull. That information can then be used to compare the strength of the bug with the strength of a human.

Materials and Teacher Instructions for the Lab:

- One bug for each lab group (preferably groups of 2 students)
- Dental floss
- Paper clips
- Plastic petri dishes
- Many small weights, some of which need to be washers and bolts
- Various squares of surface material such as felt squares, carpet samples, spongy shelf liners, old towels, etc.

- Digital balance

Note that the dental floss should be cut about 10-12 inches long. A large loop should be tied in one end of the dental floss. The student should be able to stick two fingers through the loop in the dental floss and pull some of the dental floss up through the loop. This makes something that resembles a lasso and you can now adjust the size of the lasso. The student needs to slip the lasso over the head and thorax of the bug, letting it settle in the indentation that separates the thorax from the abdomen. Gently tighten the lasso. This much you should demo for the students and help them, as many have a hard time getting the lasso around the bug. They have even more trouble getting the lasso off at the end of the lab and it is often easiest to just cut the dental floss close to the bug and allow it to loosen up.

After the lasso is attached to the bug the student has to decide how to attach weights. Some will just tie washers and bolts directly to the dental floss, others may make a hook out of a paperclip that can have the washers and nuts slipped on, and others will tape the dental floss to a plastic petri dish and start loading the dish with weights. All of these methods will work, but you may notice that after one student comes up with the petri dish idea, most of the others follow suit-collaboration among scientist.

Bess Bug Lab

Introduction:

Bess bugs are members of the phylum Arthropoda and the class Insecta. As you have already seen, they are large compared to many insects, but are they also strong?



Purpose: Read this whole lab first and then write your purpose. Tell what problem you are trying to solve and how you are going to solve it. (Include the words “to determine” in your sentence.)

Procedure: Draw a picture procedure showing the steps you are planning to take in this lab. This is a summary of what you need to do to complete the lab.

Descriptive List: List the dependent variable in this lab.
List the independent variable in this lab.

Hypothesis: Predict the results based on your prior experiences. What do you think is going to be the outcome of the experiment and why do you think so?

Evidence: Construct a table on which you can record your results and the results of two other lab groups. You should also construct a bar graph comparing your results with those of the two other lab groups. (Remember that graphs must be on graph paper or computer generated.) The following website is very useful for making most types of graphs: <http://www.nces.ed.gov/nceskids/graphing/>

Questions:

1. According to the text, the scientific method consists of four operations. List them.
2. Complete this sentence:
Results may either _____ or _____ the hypothesis.
3. Controlled experiments have only a single independent variable. What was the independent variable in this lab?
4. “The bess bug is alive.” Defend this statement using characteristics of living things and support it by *actual observations* that were witnessed during the lab.
5. Into what domain and kingdom are bess bugs included?

Conclusion: Write two paragraphs. Paragraph #1 should restate the purpose, summarized data, and must tell if the hypothesis was supported or refuted. This paragraph must cite evidence from the lab. Paragraph #2 should be an error analysis. Write a paragraph describing the *cause and effect* of a specific error in this lab.

NLQ: What could be done to improve this lab and further explore the strength of bess bugs?