

Portfolio Lab 1 – Birds and Beaks Lab Teachers Notes

S. Lenz

Overview:

This lab is a modification of one that I do with upper level (junior and senior) students in my evolution elective. We read some excerpts from Beak of the Finch by Jonathan Weiner (<http://www.amazon.com/Beak-Finch-Story-Evolution-Time/dp/067973337X>). At this point in the course we have discussed the importance of variation in natural selection and used these finches as an example of adaptive radiation. PBS also has an activity I used around the same time, using the data from the Grants' (http://www.pbs.org/wgbh/evolution/library/01/6/l_016_01.html). What I find interesting is that students will often ask how using tweezers or pliers really makes a difference before they do the lab. I remind them that differences in millimeters of a beak can be the difference between eating and not eating for some of the finches.

Objectives:

Through this lab I hope to have students understand how minor differences in the size of the tools correlates to differences picking up the same type of bean, so that they can understand how small differences can make a difference in a bird's success in obtaining food.

Also, I hope that they will be able to use good lab practices (identifying variables, stating a hypothesis, collecting data following a protocol, and then analyzing the data).

Set up:

Divide the class into pairs and collect as many petri dishes (with lids) as there are groups. Also, one large bag of kidney beans from the grocery store (or some other bean) should be enough. Also, a collection of the tools is needed. The lab is written with tweezers, wire cutters, pliers, an adjustable wrench, and needle-nose pliers, but you could substitute other like tools. Also, you will want a timer (a clock with a second hand will suffice).

Execution:

The variables and hypothesis sections can be assigned to students as a pre-lab assignment so that discussion could be had before lab begins. Some students may need help identifying the variables, so an explanation of independent, dependent, and extraneous may be necessary. The most likely answers will be that the independent variables are the tools and the dependent variable is the number of seeds collected. Extraneous variable answers will vary. When reviewing their hypotheses, be sure to point out examples of 1-tailed and 2-tailed.

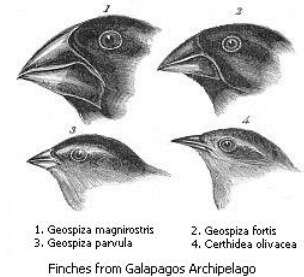
To run the actual lab, make sure each of the groups has the proper set up and then signal the entire class to start at the same time. Keeping track of the 30 seconds yourself will eliminate error on their part. Signal when there are fifteen, then five seconds left and then at the end. Have a copy of the data table on the board so that they can enter their data.

For the data analysis, you could also use the spreadsheet from our course, but not everyone has access to a shared drive to post that for their students to use. Many computers do not have the newest version of Excel and I am not sure if the older version has the data analysis function found in the more recent version. I found this website as an alternative, but if you can use the course spreadsheet it is preferable so the students can see the data more clearly.

Birds and Beaks Lab

Overview:

We've been reading about Darwin's finches on the Galapagos Islands as examples of adaptive radiation and variation. Much of the research there focuses on the beaks of the finches, which are considered to be the "toolboxes" of the finches. And so, we will reach into our own toolbox to simulate their beaks. We will try to simulate how variations in structure can lead to variable success.



Variables:

What are the independent variables?

What is the dependent variable?

What are the extraneous variables?

Hypothesis:

Do certain tools collect seeds more quickly than other tools? State your hypothesis about the effectiveness of the various tools.

Is your hypothesis one-tailed (you are predicting a certain result) or two-tailed (you predict there will be variation but do not know where it will be)?

Experimental Procedure:

How many seeds can you pick up, one by one, in thirty seconds using tweezers? Wire cutters? Pliers? An adjustable wrench? Needle-nose pliers? It may sound simple, but to a seed-eating bird like the finches on the Galapagos Islands, the ability to pick up seeds can mean the difference between survival and death. You will work with a partner in this lab.

1. Collect a petri dish and count out 50 kidney beans.
2. Place the top of your petri dish 10 cm away from the seed containing dish.
3. Collect your first tool (tweezers) from the stock pile of tools.

Analysis:

To see if there is a statistical difference in the number of seeds picked up by each tool you will analyze your data using one-way analysis of variance. It is used to compare the means of three or more independent sets of measurement data and since we have five sets of data this is a good choice of a test to use.

To do this calculation you can use Excel or the following website:

Microsoft Excel directions:

Enter your data into a new spreadsheet in Excel. Select the Data tab in the top menu and then select the data analysis button. Scroll to the top and select ANOVA: Single factor. Where it says input range, select the button to the right of the empty box and then highlight your set of data. Make sure grouped by columns is selected. If your P-value is >0.05 , then the null hypothesis is accepted and your experimental hypothesis is rejected. If your P value is < 0.05 further analysis is needed using the Tukey-Kramer test. If you need to do this step please see your teacher.

Website directions:

http://www.physics.csbsju.edu/stats/anova_NGROUP_NMAX_form.html. The first box is asking for how many groups you have (5) and the second is asking how many values you have for each tool (the number should be the number of members of the class).

Next you enter your value for tweezers into the area for data group A. Do this for each of your columns of data.

Click calculate at the top of the page.

You will then get a statement that says "The probability of this result, assuming the null hypothesis, is ____." Record that value on the line.

Discussion: The following questions should be addressed in your discussion:

Did your results confirm your hypothesis?

What tool seemed to do the best? The worst? Why might that be?

How does this relate to the variation in the beaks of the finches?

Why did you pool data with your classmates instead of only using your own data?

What sources of error did you have in this lab?

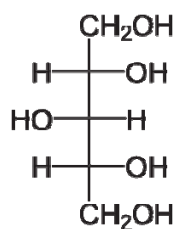
How could you expand upon this lab? What would you change? How could you design a lab using five different types of seeds in your initial seed dish? What would that experiment demonstrate?

Portfolio Lab 2 – Xylitol gum and Mouth pH Lab Teachers Notes

S. Lenz

Overview:

This lab is meant to be conducted with an introductory biology class for sophomores. It can be done in one class period if the stations are set up ahead of time. It could be conducted during the biochemistry unit as a follow-up to lectures on pH or it could be done during the systems of the body unit when learning about the mouth as part of the digestive system. You can also tie it back to the organic chemistry section by reviewing its structure.



If you are unfamiliar with xylitol you can simply enter “xylitol” into Google and get a variety of websites all claiming different things about this compound. For more information on acid and tooth decay you can also find a variety of sites including:

<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mmed.chapter.5326> and

http://www.ada.org/public/topics/decay_faq.asp.

Objectives:

This lab aims to get students interested in biochemistry, organic chemistry, and physiology by using a model that interests many teenagers: gum chewing.

They will also implement good lab practices (identifying variables, stating a hypothesis, collecting data following a protocol, and then analyzing the data) while investigating claims in the popular media.

Set up:

You will need a setup for each student in the class. Disposable medicine cups work well but any other small disposable container that has a large enough opening to allow the students to spit and not get it everywhere will suffice. Each student will need two containers, a marker to label the containers, and two pieces of pH paper. More than one color chart for the pH paper is recommended as to not create a bottleneck when trying to read their papers. Also, students should all wear gloves during the experiment and it is recommended that a biohazard bag is available to collect the containers after they have spit into them. If that is not available, make them wash their cups out thoroughly in the sink and then dispose of them in the garbage.

Execution:

Students should not have difficulty identifying the independent variable (presence of gum) and dependent variable (saliva pH), but they may have some difficulties with the extraneous variables. This could be an activity for class brainstorming. When they are creating their hypotheses, make sure they are one-tailed by clearly explaining the difference between 1-tailed and 2-tailed.

After the lab is set up there is not much to do for the procedure. Students may need help deciding what color their pH paper is, but that aside, there should be minimal need for teacher intervention. While they are chewing the gum you could continue with another lecture or you could have them read articles you have printed ahead of time about xylitol and tooth decay.

Even math challenged students should be able to do the data analysis on their own. The only part that may be challenging is interpreting the lookup table in the event the students confuse their axes.

Does chewing gum with xylitol affect the pH of your mouth?

Overview:

In recent years there have been reports that chewing sugar containing gum promotes cavities and dental decay. Just when some Americans thought they would have to give up their habit of chewing gum, reports that xylitol-sweetened sugarless gum could actually help our teeth arose. There are many claims that products containing xylitol can help prevent cavities, reduce plaque, and stop decay in our mouths. Chewing gum triggers a salivary response and in turn an increase in saliva can wash out bacteria that produce acids that remove certain minerals that can help prevent cavities.

Hypothesis and variables:

State a 1-tailed hypothesis about chewing xylitol gum and mouth pH levels.

What is the independent variable?

What is the dependent variable?

What are the extraneous variables?

Experimental Procedure:

It is important to note that you should not consume any beverages (including water), food (including water), or use any toothpaste or mouthwash for two hours before this investigation. Also, it is important you do not touch anyone else's samples or lab stations during this lab to help prevent contamination. Gloves should be worn before touching any of the supplies at your station as to not contaminate your sampling devices.

1. Obtain a disposable medicine cup and label it with your name and the word "before" with a marker.
2. Collect your saliva in the medicine cup from step one, trying to get a noticeable sample size (1/4 of the container is enough).
3. Place a strip of pH paper into your sample and then compare the number to the color chart included with the paper. Record this number here_____.
4. Obtain one piece of Original Trident with Xylitol and chew for thirty minutes. (Yes you can chew gum in class today) Do NOT consume any other products during this time.
5. Obtain a second disposable medicine cup and label it with your name and the word "after" with a marker.
6. At the end of thirty minutes dispose the gum in the garbage.
7. Collect your saliva in the medicine cup from step five, trying to get a noticeable sample (chances are you will have more in this sample than the first, but that is irrelevant).
8. Place a strip of pH paper into your sample and then compare the number to the color chart included with the paper. Record this number here_____.
9. Rinse out your medicine cups and then dispose of in a biohazard bag if provided.
10. Compile your data with the rest of the class in the saliva pH table.

Discussion: The following questions should be addressed in your discussion:

Were your results statistically significant? Did they support your hypothesis?

What sources of error could be identified during this lab?

Research more about the effects of xylitol and explain how your data relates to your findings.

How could you expand this experiment? How could you incorporate a control?