25 LOW-COST Biology Investigations

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Introduction

This book has its origins in the recent economic recession and the resulting budget crunch that was imposed upon almost every school district in the United States. Paramount, and particularly vexing to me, was the issue of providing meaningful laboratory experiences for 30 biology classes, given a supply budget of $200 for the school year. I had to either deny the students the opportunity to participate in hands-on biological experiences or find and/or devise biological investigations that cost little or no money. The latter option was the only viable one. And that is what this book is about.

Some of the investigations in this book involve organisms that are free for the taking, organisms you see almost constantly but ignore. For example, dandelions, which are used in eight investigations, can be found during their growing seasons in both vacant lots and lawns, in cities as well as rural and suburban areas. Spider webs are also free and easily found in many locales. Furthermore, the webs can be investigated without destroying them. Land crustaceans inhabit moist environments and can be released after the investigation into their oxygen consumption. This highlights another positive aspect of these investigations: In most cases the examined organism is returned to its natural environment unharmed. Good use is made of students, their families, and their friends as experimental organisms. These, too, are returned to their environments unharmed. A few inexpensive organisms will have to be purchased from a scientific supply company; two of these are vinegar eels and preserved spiders.

With the exception of microscopes (needed for a few of the investigations), all equipment can be found either at home or in the science storeroom. Supplies are inexpensive and most are universally found in school science supply rooms throughout the nation. Lugol's iodine, salt, and vegetable oil are typical of the expendable materials that will be required.

The types of investigations in this book are a mix of cookbook recipe and open-ended inquiry. For each investigation, Teacher Resource Notes are provided to ensure that the activity will be successful, rewarding, and educationally profitable.

All investigations have been tested using biology and life science students in a number of New York City high schools and middle schools. The youngsters were able to carry out these investigations and found them exciting and worthwhile. I am sure your students will have similar experiences.

—Joel Beller

Teacher Resource Notes

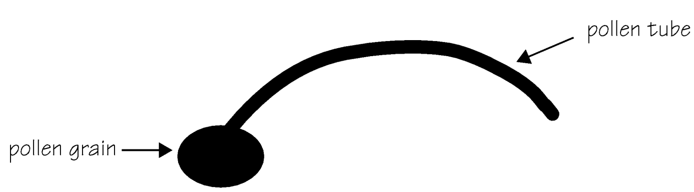
Dandelion Lab #1: Inducing and Observing the Growth of Pollen Tubes from Dandelion Pollen Grains

SUMMARY. In this lab students observe, record, and draw the growth of pollen tubes in a sugar solution. While carrying out this investigation, students will have a lot of free time between half-hour observations. Therefore, it would be wise to presoak the pollen grains for 20 to 25 minutes prior to the time the students enter the laboratory.

Because the pollen tube growth can be seen with magnifying lenses and hand-held illuminated field microscopes that magnify 30X or less, this laboratory research could be assigned as a home activity. Each student could be given an optical instrument, a small medicinal dropper bottle of sucrose solution, a slide, and lens paper to take home. Some schools require a monetary deposit from the parent to cover any lost or damaged equipment.

A good suggestion for your students is that they set a timer between observations in order to remember when the next one is due.

The answers to question 7 will vary. Some of the factors related to success will include composition of sucrose solution, temperature, and health and age of the flower head. For question 8, some variability should be noted in terms of pollen tube length. In response to question 9, most pollen tubes will appear similar to an arc of a large circle, as illustrated below.



Shape of typical pollen tube

Human Behavior Lab #6: How Is Your Muscle Strength Affected by Temperature?

SUMMARY. This lab requires students to test the effect of cold temperatures on muscle strength and flexibility. The students immerse their hands in ice water and count the number of fists they can make. It is suggested that this experiment be done in pairs—each student can take a turn testing his or her hand while the other assists with counting, etc.

The only piece of scientific equipment needed for this investigation is a thermometer. The rest of the equipment should be available in every school and home.

The main concern is indicated clearly in steps 7 and 8. Although this investigation was field-tested with approximately 100 students in grades seven, eight, and ten, and no students found the cold water to be painful to the point of removal, the caution is included just in case a child does find the cold water painful.

Stress the need for allowing the hand immersed in ice water to return to a near-normal temperature before going on to the next water trial. Also emphasize the importance of having ice floating in the pail of water at all times during the investigation.

Analysis

1. The conclusion of this investigation should be that cold water decreases the ability of the muscles to function.

2. The results for both hands should be similar but not identical.

Human Perspiration Lab: How Much Perspiration Is Excreted from One Hand?

SUMMARY. In this lab students observe and record the amount of perspiration secreted from their hands. They then calculate the rate of perspiration per square centimeter of skin on the hand.

Name ______________________________ Date ____________________

Dandelion Lab #1

Inducing and Observing the Growth of Pollen Tubes from Dandelion Pollen Grains

Introduction

Pollen tubes are found in flowering (*angiosperm*) plants, and their function is to deliver the *sperm nuclei* to the *ovules*. In this lab you are going to stimulate the pollen grains of the dandelion to grow pollen tubes by placing the grains in a 5% sugar solution. Growth may begin as early as 30 minutes after the pollen grains are put in the growth medium, or it may not start until 90 minutes or longer have passed. To save time, your teacher may have started stimulating pollen grain growth before you entered the laboratory.

Materials

- Several dandelions with healthy, young, yellow flower heads
- Microscope slides
- Microscope or 2 hand lenses (6X)
- Sucrose (white table sugar)
- Graduated cylinder
- Lens tissue
- Water
- Weighing paper
- Watch or clock
- Medicine dropper
- Balance scale
- Spatula
- Transparent metric ruler

Procedure

1. Use the spatula to transfer sugar from container to balance scale. Prepare a 5% solution of sucrose (white table sugar) by dissolving 2.5g of sugar in 43mL of water. The percentage is not critical and the solution will work in a range between 4% and 8%. You can even estimate the amounts if you don't have a balance scale and a graduated cylinder.
2. Hold a dandelion *scape* (stalk) with your thumb and first two fingers so that the flower head is firmly secured. Tap the flower head gently over the center of a microscope slide that has been cleaned. You should be able to see a fine dust of yellow pollen. If you don't, repeat the tapping using different flower heads. Continue using different flower heads until you do see some pollen grains on the slide.

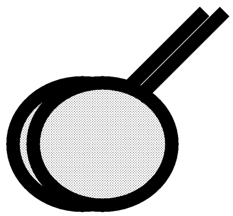
(continued)

Name ____ Date __________________________

Dandelion Lab #1

Inducing and Observing the Growth of Pollen Tubes from Dandelion Pollen Grains (*continued*)

3. When pollen grains become visible, place a drop of the sugar solution on top of them. Using the low-power objective of the microscope, check to be sure that the pollen grains are in the drop of sugar solution. If a microscope is not available, you can use two similar hand lenses held on top of each other, as in the diagram that follows. Looking through the pair will approximately double the magnification.



Two magnifying lenses held together

In the space provided below, draw several dandelion pollen grains as you see them under magnification.

Fill in the data table below.

Time began ____________ Time pollen tube growth was first noted ________________________

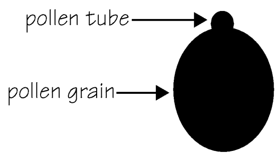
(continued)

Name ______________________________ Date ________________

Dandelion Lab #1

Inducing and Observing the Growth of Pollen Tubes from Dandelion Pollen Grains
(*continued*)

4. When the pollen tubes first start to grow, they look like little bumps on the pollen grains. This diagram gives you a good idea of what to look for.



5. Scan your slide every 30 minutes to look for pollen tubes growing. When you find one or more growing, keep your microscope focused over them. **Don't let the pollen grains dry up.** Replenish the sugar solution from time to time by adding a drop or two of the sugar solution.

6. After growth has begun, make observations every 30 minutes. Record these observations by making detailed drawings in the spaces below.

30 minutes after initial growth	60 minutes after initial growth	90 minutes after initial growth

(continued)

Name ______________________________ Date ______________________

Dandelion Lab #1

Inducing and Observing the Growth of Pollen Tubes from Dandelion Pollen Grains (*continued*)

7. Make a rough estimate of the number of pollen grains that germinated: ________ What is the approximate number of pollen grains on the slide? ________ What is the approximate percentage of pollen grains that grew pollen tubes? _________% What is a possible explanation for this percentage? ________________________

____

____

8. Are all the pollen tubes identical in length? ______________________________ By mounting a transparent metric ruler on the microscope stage parallel to the slide, you can make a rough estimate of the length of the pollen tubes in *micrometers* (1,000 micrometers = 1 millimeter). What is the length, in micrometers, of the shortest pollen tube? __________ the longest pollen tube? __________________

9. Are all the pollen tubes the same shape, or do the shapes vary? ______________ In the space below, draw a typical pollen tube and then draw the one you think is the most unusual.

Typical	**Unusual**