

Workshop - Carbon, nutrients, and life

OKD Fall 09

Introduction: This workshop will look at factors that influence plant seedling growth, using an experiment similar to ones used by NASA when they were trying to determine how to grow food in space. You will learn about nutrients, their role in plant growth.

Key concepts:

- The scientific method
- Nutrients and other requirements for life

WHAT'S DUE

First workshop (10 points, paper & pencil for lecture, D2L multiple-choice)

During the in-class discussion of Workshop 1, define "hypothesis." Your definition must include seven words: control, experiment, hypothesis, measurement, methods, prediction, test ([wk1 lect.html](#)). You will *not* hand it in. Use it to answer the D2L workshop. The workshop will ask you questions about writing, and how these seven words are used to define "hypothesis." **At home**, begin your seedling experiment. See instructions beginning on page 2

Second workshop (10 pts, 5 pts multiple choice, 5 pts hypothesis, p. 5)

D2L workshop 2 includes 5 multiple-choice questions on your seedling-growth hypothesis, and you will submit your hypothesis, which will be grade by your GTA. You must show your seedlings to your GTA (beginning of Wk 2) in order to be eligible for workshop 3. See also:

http://www.geo.arizona.edu/Antevs/nats104/wk1_lect.html

Third workshop (10 points, see p. 6)

Type your experimental results using p. 6 as a template and save it in a file format your GTA can read. **Check with your GTA on file formats.** Submit your experimental results in the "Workshop 3 Dropbox." The "Dropbox" tab is in the same toolbar as "Workshops and Quizzes" in D2L. Click on "Dropbox," then on "Workshop 3." Then, click on the "Add a file", and browse your hard drive for the report you have saved. Your write-up should include a data table and your conclusions as to whether the experiment supported your hypothesis.

INTRODUCTION: What influences plant growth?

Water and nutrients: All life needs water and nutrients to survive. Nutrients that exist in such low levels, relative to their need, are often called “**limiting nutrients**” because these nutrients is what control plant growth. For plants, nitrogen and phosphorus are often limiting nutrients.

Light: Plants are primary producers, which means they use an energy source, the sun, to make their own food. Like nutrients and water, the amount of available light can control how fast a plant grows.

Temperature: As temperature increases, growth rates increase at first, then decreases. Thus, temperature plays an important role in controlling plant growth. Plants in polar regions of the world tend to grow slowly whereas plants that live in the tropics grow much faster. However, this assumes that the environment provides all the other requirements for growth! Although Tucson is warm, plants grow slowly because the lack of water limits plant growth.

Materials: fertilizer, markers, paper towels, rulers, seeds, tape, aluminum foil, plastic sacks, table, light stand, lights.

1. Wheat seed growth experiment

You are going to conduct an experiment to study the influence of temperature, light, and nutrients on plant growth. Basically, you are asking ‘What is the best way to grow wheat seeds?’ The list below provides the possible experimental treatments you can apply. Some of them can be combined, for example, if you want to see whether fertilized seeds grow better in the light or in the dark. Select one of the following parameters for your experiment (or check with TA or Prof.)

1. light (vs. dark)
2. tap water (vs. tap water with fertilizer or other substances mixed in)
3. amount of water in bag
4. heat (vs. room temperature)
5. air in bag (vs. no air in bag)

A. Forming hypotheses

First, think about what you would like to test. Are you interested in the effects of light on seed growth? One of the other factors? Based on the introduction and your personal experience, explain how the factor you choose influences plant growth – this is called a ‘**hypothesis**’. What are the implications of this hypothesis? Predict what the influence of lesser or greater amounts of the physical factors will influence plant growth. Formulate a specific **prediction** about your experimental manipulation of the results. The hypotheses should be stated in complete sentences, describing cause and effect. For example, if you were

interested in the effect of temperature on baking cookies, and you turned the oven up to it's maximum temperature your hypothesis might be "The cookies will burn when the oven is really hot" or "The cookies will bake really fast when the oven is really hot".

Think of how you will test your prediction! You will need to measure something!
Write your hypothesis and prediction on p 6. (Remember, everything must be in your own words. Never copy from someone else.)

B. Methods Measurements and Control

To properly test your hypothesis, you need to be as careful as possible about the conditions and measurements of your experiment. In the cookie example, it makes a big difference how long we leave the cookies in the oven. If we leave them in for a short time, they might not burn, but if we leave them in for as long as the recipe says we are supposed to, they might.

Part of the experiment is eliminating confounding variables – factors that were not intended to influence the results of the experiment. The easiest way to do this is to have two samples that differ only in the amount of the key factors. This is the experimental **control**. For example if your hypothesis involves nutrients, one sack would not contain the nutrients but be the same in all other regards. – for the cookie example, you would have two identical ovens, one turned to maximum, the other not turned on at all.

An important aspect of experimentation is **replication**. To avoid accidents and improve measurements, run two identical trials of your prediction. For the cookie example, have two hot ovens, not just one.

How will you measure the amount / level of the variable you manipulate? If it's temperature; frequently record the temperature where the experiment takes place. For the cookie example, you would record BOTH the temperature of the hot oven AND the temperature of the cold oven (the control).

Enter your methods and measurements, and describe the control on p.5, to be submitted on D2L <http://d2l.arizona.edu/>

Instructions (see illustrations at http://www.geo.arizona.edu/Antevs/nats104/wk1_lect.html)

These are examples of how to conduct an experiment. You can obtain the **materials** from the Professor or buy your own. Either way, you'll need to describe your materials. For example if you don't use wheat seedlings and ziplock bags, you'll need to write down the names of the seeds, containers, etc.

These are examples of **methods**: Label the ziplock bags (example: two controls and 2 replicates) with your name, the date, and the treatment it will receive. Fold

a paper towel in four and place it inside the ziplock bag, lying it on its side. Moisten the towel (less than 25 ml of the appropriate liquid [record the amount]) – the entire paper towel will absorb the water in a few seconds. Carefully place 10 seeds on the paper towel. Put the towels containing the seeds in the labeled ziplock bags and place them in the experimental locations.

Results (final report due in the third workshop, 10 points)

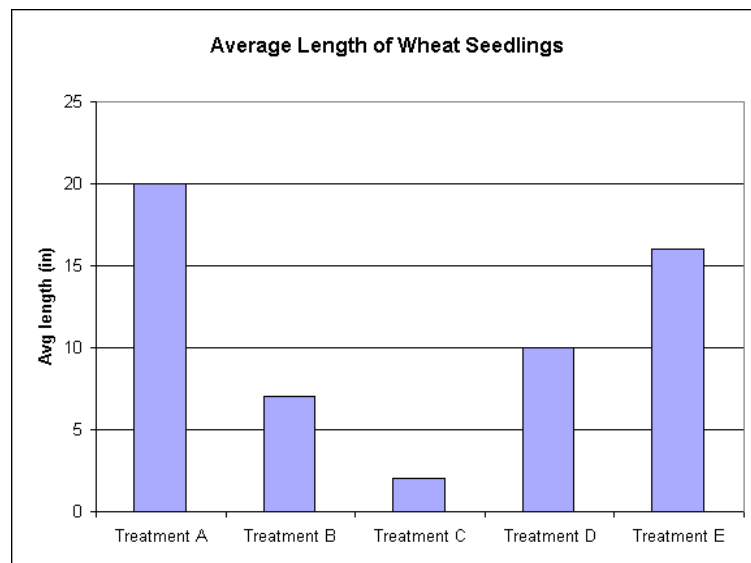
Collect your samples. **How might you determine which wheat seedlings are the ‘biggest’?** (i.e. How do you define ‘biggest’?) How will you measure the length of the seedling? Since the seed will not change in length, will you include the seed length in your measurement?

Seven days after the beginning of the experiment (record date and time of beginning and end) measure the full length of **each** of the seedlings, including the root. Create a table on a separate sheet of paper to display your measurements. To better compare the effect of different treatments, scientists often compare the *average* value for a treatment. **Calculate the average length for each treatment as follows:**

$$\text{average length} = \frac{\text{length}_1 + \text{length}_2 + \dots + \text{length}_{10}}{\text{total number of seedlings}}$$

Include the averages with the other measurements, in your table.

A bar graph (like the figure below) may help you to interpret and explain your results. **If you plot a figure, it needs to be part of your report.**



SECOND WORKSHOP REPORT Answer these questions (write out your hypothesis) in preparation for D2L workshop 2

NOTICE: Up to 10 points will be taken off of your score for poor spelling or poor grammar.

Experimental Design (see page 2 and following)

Date Experiment Begins _____

Hypothesis Explain how the factor you choose influences seedling growth.

Prediction Predict what influence the active factor will have on seedling growth.

Experiment Methods and Measurements. Include enough information about your materials and procedures that someone else could repeat your experiment.

Control How was the active factor eliminated in the control part of the experiment?

THIRD (final) part of seedling experiment.

EXPERIMENTAL REPORT (Submit the information below in D2L DROPBOX <http://d2l.arizona.edu/> [10 points])

Fill out each topic below, with up to one paragraph for each topic, to make sure you've included the required items. **Then add each topic to your report** with the data table and figure (optional). **Remember this report must be entirely your own words**, it is plagiarism for two students to submit cut-and-pasted data tables or figures.

Up to 5 points off for sloppiness, spelling, grammar.
Up to 5 points off for poor scientific approach.

Copy and paste this information into your report, revise the report, save it on your hard drive and deposit it in "Workshop 3 (dropbox)" under the "Dropbox" tab on D2L <http://d2l.arizona.edu/>

Date Experiment Began _____

Hypothesis Explain how the factor you choose influences seedling growth. (2 pts) (revised from workshop 2!)

Prediction Predict what influence the active factor will have on seedling growth. (2 pts) (revised from workshop 2!)

Experiment Methods and Measurements. Include enough information about your materials and procedures that someone else could repeat your experiment. (2 pts) (revised from workshop 2!)

Results (include table) Summarize and discuss your measurements as shown in the table and optional graph. You should state the average growth for each bag's seedlings in your written explanation and compare the treatment with the control. (2 pts)

Conclusions: What did you learn from your experiment? Do the results support your hypothesis? What would you do differently if you did it over again, and what factor would you like to test next? (2 pts)

Your report must be in a file format your GTA can read like **.rtf** or **.doc** or you will receive **no** credit. **Check with your GTA!**