CB 14 Measuring Biomass

Biomass is the total weight of a defined group of organisms in an ecosystem. From where does the biomass of an organism such as plant come? Under what conditions is biomass more quickly produced? How does soil type affect plant growth and biomass production?

In this activity, you will compare the biomass of two types of plants grown in three different types of soil. Because your goal is to study the effects of soil characteristics on growth, you must keep other variables, such as light and water, the same. Do not fertilize these plants. Observe the effects of growth in the existing soil conditions, with nothing added.

Materials (per student or group)
- 3 corn and 3 lima bean seeds per student or group, soaked for at least 24 hours
- Small containers (such as 4-ounce paper or plastic cups) for growing the seeds
- Soil from four different places such as local soil, compost and pond scum
- Balance which will mass to ±0.01 grams
- Casio fx2 Graphing Calculator
- Casio QV2800 Digital Camera

Procedure
1. Gather your soil samples. Predict what you think will happen when you plant the seeds in the three different soils.
2. Determine what the plants may need to grow (light, water, temperature) and how often you will take care of these needs.
3. Record the mass each of your soaked seeds and record your data in a table such as that below. You can compute class averages and complete the second table later.

Seed Masses (grams) in Each Type of Soil

Day	Seed Type	Local Soil	Compost	Other Soil
0	Corn			
0	Bean			
20	Corn			
20	Bean			

Class Data for Mean Plant Mass after 20 Days of Growth

---------	Local Soil	Compost	Other Soil
Corn			
Bean			

4. Fill your containers with soil--a different soil type in each container. Punch holes in the bottom of each container to drain water. Plant one seed in each container, so that there is a corn seed in each type of soil and a lima bean seed in each type of soil. Plant seeds about one inch deep. Moisten the soil, and keep it moist but don't soak it.
5. Try to choose environmental conditions (light and temperature) which you think will

produce plants with the greatest mass possible in tow to three weeks. All of your plants must experience the same environmental conditions.

6. Record a description and a digital image of the environment in which you will grow your plants. Be sure to include amount of light, air temperature, exposure, location, and watering schedule.
7. Identify your independent variables in this experiment. Remember that the independent variables are the causes of change in your experiment.
8. Identify other variables which should be kept constant (controlled). Why do you have to keep these variables constant?
9. Identify the dependent variable in your study. Remember that the dependent variable is the effect or result of the experiment. How will you measure the dependent variable? How often will you measure the dependent variable?
10. Based on your responses to 7, 8 and 9 above, write a hypothesis for this experiment. This should be an "If..., then..." sentence, with the "if" representing your independent variable(s) and the "then" representing your dependent variable(s).
11. Each day for 20 days, note any differences you can see between the plants. Take digital images when you notice any significant growth (or death) of the plants. Each day, also measure the height of each plant. Record this data in your *Log*.
12. After 20 days gently pull the six plants out of the soil, keeping the roots intact. Wash off soil particles. Gently pat the roots dry with a paper towel.
13. Mass each plant to determine the wet biomass. Record these biomass values in a table in your *Log*.
14. As a class, record all of your collected biomass data in a single table.
15. From this class table, calculate the mean value for the biomass of the corn and of the bean plants grown in each of the three types of soil.
16. Construct a histogram of class data in your Log.

Interpretations

Discuss these questions in small groups and complete them at home.

1. Compare your histograms. What trends are evident?
2. What is the origin of the new mass accumulated by the plants? What is being added to the plants that is not readily visible?
3. What is being taken into and what is being given off by the plants as they grow?
4. Discuss your experimental design with your group. Review all of the variables, independent, dependent, and controlled.
5. What variables could you not control, even though you may have tried?
6. Write a definition of a "controlled experiment."
7. Describe an experiment that would test one idea you generated during this inquiry.

Applications

1. Most of the mass of an organism is, of course, water. If you assume that 90% of your seeds and resulting plants are water, what are their dry masses? To calculate, multiply the wet mass times 0.10. Use a table like for your final dry mass estimations.
2. What forms of life would you expect to find in a compost pile in your yard?

Casio FX2.0 Calculator Procedures for CB 14

Rates of Growth

It will be helpful if a separate table is created for each plant type in each soil type. Since there are two plant types and three soil types, you will need to construct six different tables. The day you begin the data collection should be entered at Day 0 in the table. Enter as many numbers in the day column as you will need for this experiment. See sample below.

CORN IN SOIL TYPE #1

DAY	HEIGHT
0 1 2 3 . . .	
BIOMASS ON FIRST DAY: BIOMASS ON LAST DAY:	

The rate of growth for the plant can be determined in two different ways, either by using height or by using the biomass. Since the biomass is the focus of this study, we will find the rate of growth based on biomass, but the same process could also be applied to finding the rate of growth based on height. First subtract the smaller first day biomass from the larger last day biomass. Then divide that amount by the number of days the plant was allowed to grow. This can be done using the FX2.0 from the RUN-MAT menu. Press the left parenthesis [(], the last day biomass, the subtract sign [-], the first day biomass, the right parenthesis [)], the divide [÷], then the number of days (which is the last day listed in your list). This is the average biomass gained per day for the plant.

Histogram of the Six Different Biomasses

- ☞ Choose the STAT menu from the main screen (activated by pressing the grey [MENU] button). STAT can be chosen either by highlighting it and pressing [EXE] or by simply pressing [2]. Press [CTRL] [F3] and be sure that Stat Wind is set to Auto. If it is not press [F1] while Stat Wind is highlighted. Then press [ESC].
- ☞ You will need two lists for the average daily biomass rates of growth. Either clear out the lists you want to use, or cursor over until you find two empty lists on the screen. (Recall, to clear a list, simply highlight any entry, press [F4] for DEL-A, then [EXE] for yes.)
- ☞ In the first list enter 1 through 6, indicating the six different plant/soil combinations you might use. Following is a suggested ordering:

1. Corn, Soil 1
2. Corn, Soil 2
3. Corn, Soil 3
4. Lima, Soil 1
5. Lima, Soil 2
6. Lima, Soil 3

Be sure to press [EXE] after each entry.

- ☞ In the second list you will enter the rates of growth you found in the previous calculator section. Enter these in the order that corresponds to the type number indicated above. Again be sure to press [EXE] after each entry.
- ☞ Press [F1] for GRPH and [5] for Set. This allows us to set up the calculator for the histogram information.
- ☞ At the top of the screen StatGraph followed by some number will be highlighted. For this example we will use StatGraph1, but any of the three choices would be fine. If it does not say StatGraph1 at the top of your screen, you may press [F1] to change to the first graph.
- ☞ Cursor down to the Graph Type. We want a histogram, so press [F6] for more options. You should see Hist at the bottom of the screen above the [F1] button. Press [F1].
- ☞ Cursor down again to XList. Press [F1] for LIST, then [1] for List 1, then [EXE].
- ☞ The Frequency should contain the rates of growth so press [F2] followed by [2] then [EXE].
- ☞ This will return you to the main list screen. Press [F1], then [1] for S-Gph1 (stat graph 1). A small window will pop which says Set Interval. With Start: highlighted press [1] followed by [EXE]. Then with pitch: highlighted press [1] followed by [EXE] again. Finally press [EXE] again to Draw. You can press the [F1] button and use the left and right disk arrows to trace along the histogram.

Histogram of Class Data

Setting up a histogram of class data is done in the same way as the histogram for individual data. However you need to enter the class average for rate of growth for each sample. To determine the class average for a particular sample, say Corn grown in Soil #1, first find the average first day biomass. To do this, add together each group's first day biomass (be sure that you are using the biomass for the corn grown in the same kind of soil), then divide that total by the number of groups. Do the same thing for last day biomass. Find the average rate of growth for the corn grown in soil #1, for the class, using the Rate of Growth instructions. Graph the histogram for the class rates, using the Histogram instructions.