Names: _____ Class: _____ Date: _____

Level I Biology
Mr. Croft

Scientific Method Laboratory

100 Points

Part I: Questions & Hypotheses (3 Points Each)

Lab Study A: Asking Questions

1. Place a checkmark next to the questions that you think can be answered scientifically:
   - ____ a. Do humans communicate by chemical signals called pheromones?
   - ____ b. Is the use of antibacterial soap and cleansers selecting for resistant strains of bacteria?
   - ____ c. Should farmers grow genetically resistant crops?
   - ____ d. Is walking under a ladder bad luck?
   - ____ e. Did the 50-ear-old architect have a heart attack because he was extremely overweight?
   - ____ f. Do cactus spines reduce herbivory (animals eating plants)?

2. How did you decide which questions can be answered scientifically?

Lab Study B: Developing Hypotheses

3. Write an explanatory hypothesis for each of the following questions (If…, then…):
   a. Why are people today on average more likely to be overweight than they were a century ago?

   b. Why do ants, when given a choice, prefer peanut butter?

   c. Do bison grazing on the prairie decrease the diversity of plant species?

4. Place a checkmark next to the statements that would be useful as scientific hypotheses and could be investigated using scientific procedures:
   - ____ a. If there is increased environmental pollution, then there will be a reduction in the percentage of male births in developed countries.
   - ____ b. If students bring their books to class, then they will achieve better grades.
   - ____ c. If the flowers of skunk cabbage produce an odor, then it will attract flies for pollination.
   - ____ d. Plants first colonized the land environment 450 million years ago.
   - ____ e. Zombies are the victims of voodoo spells.

Part II: Designing Experiments to Test Hypotheses (1 Point Each)

Read the following description of a scientific investigation of the effects of sulfur dioxide on soybean reproduction. A figure is also provided to help you understand the experiment.

Investigation of the Effect of Sulfur Dioxide on Soybean Reproduction

Agricultural scientists were concerned about the effect of air pollution, sulfur dioxide in particular, on soybean production in fields adjacent to coal-powered power plants. Based on initial investigations, they proposed that sulfur dioxide in high concentrations would reduce reproduction in soybeans. They designed an experiment to test this hypothesis (Figure 1.1). In this experiment, 48 soybean plants, just beginning to produce flowers, were divided into two groups, treatment and no treatment. The 24 treated plants were divided into four groups of 6. One group of 6 treated plants was placed in a fumigation chamber and exposed to 0.6 ppm (parts per million) of sulfur dioxide for 4 hours to simulate sulfur dioxide emissions from a power plant. The experiment was repeated on the remaining three treated groups. The no-treatment plants were placed similarly in groups of 6 in a second fumigation chamber and simultaneously exposed to filtered air for 4 hours. Following the experiment, all plants were returned to the greenhouse. When the beans matured, the number of bean pods, the number of seeds per pod, and the weight of the pods were determined for each plant.

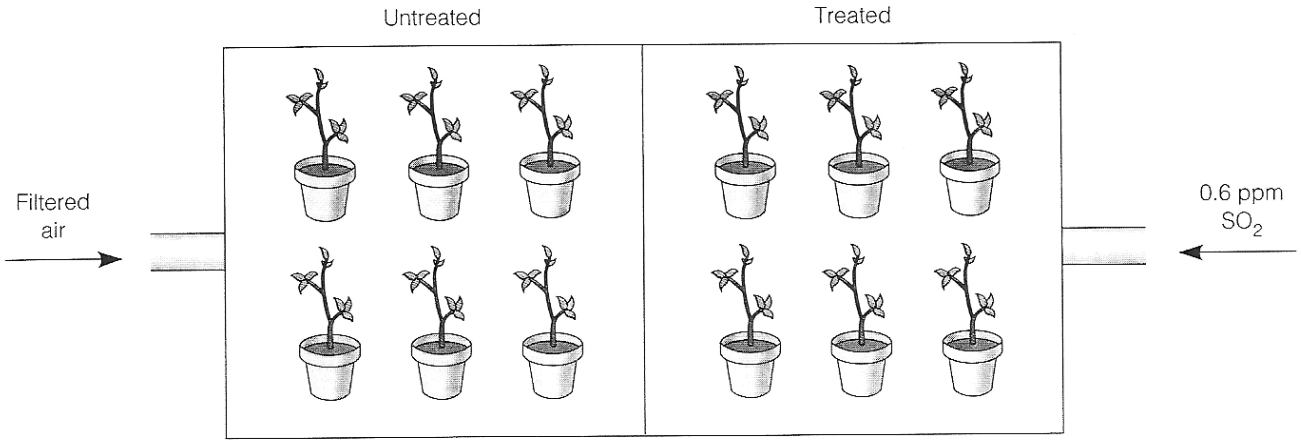


Figure 1.1.
Experimental design for soybean experiment. The experiment was repeated four times. Soybeans were fumigated for 4 hours.

Lab Study A: Determining Variables

5. For the soybeans, several dependent variables are measured, all of which provide information about reproduction. What are they?

6. What was the independent variable in the investigation of the effect of sulfur dioxide on soybean reproduction?

7. Can you suggest other variables that the investigator might have changed that would have had an effect on the dependent variables?

8. Why is it important to have only one independent variable?

9. Why is it acceptable to have more than one dependent variable?

10. What are the controlled variables in this experiment?

Lab Study B: Choosing or Designing the Procedure

11. What was the level of treatment in the soybean experiment?

12. Describe the method of replication in the soybean experiment.

13. What was the control group?

14. What is the difference between the control group and the controlled variables discussed previously?

Lab Study C: Making Predictions

15. For the soybean experiment, the hypothesis was: Exposure to sulfur dioxide reduces reproduction. What should the prediction be?

Review Questions

16. From this exercise, list the components of scientific investigations from asking a question to carrying out an experiment.

17. From this exercise, list the variables that must be identified in designing an experiment.

_____, _____, _____

18. What are the components of an experimental procedure?

_____, _____, _____

Part III: Designing an Experiment (3 Points Each)

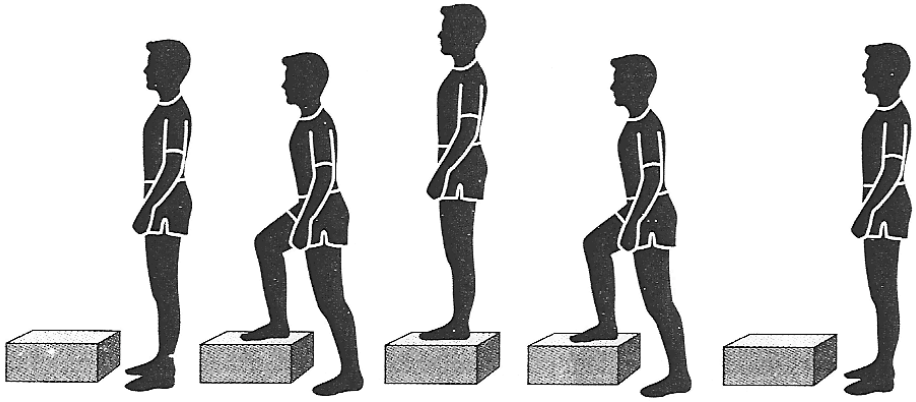
Problem: Does athletic ability have an effect on cardiovascular fitness?

19. Hypothesis:

The Experiment

If you were performing an independent investigation, at this time you would go to the library and read relevant scientific articles or texts to determine an accepted procedure used by scientists to test cardiovascular fitness. You might discover that there is a test, called the *step test,* that is used for this purpose (Kusinitz and Fine, 1987). Here are the basic elements of this test:

1. The subject steps up and down on a low platform, approximately 8 in. from the ground, for 3 minutes at a rate of 30 steps per minute. (Using a metronome to count steps ensures that all subjects maintain a constant step rate.) The subject should step up and then step down again, keeping the rate constant (Figure 1.2).
2. The subject's pulse rate is measured before the test and immediately after the test. The subject should be sitting quietly when the pulse is counted. Use three fingers to find the pulse in the radial artery (the artery in the wrist, above the thumb). Count the number of beats per minute. (Count the beats for 30 seconds and multiply by 2.)
3. Additionally, the pulse rate is measured at 1-minute intervals after the test until the pulse rate returns to normal (recovery time). Count the pulse for 30 seconds, rest 30 seconds, count 30 seconds, and rest 30 seconds. Repeat this procedure until the pulse returns to normal. Record the number of minutes to return to the normal pulse rate. (Do not record the pulse rate.)



As a class, design the experiment. Record the components of your experiment by completing the information below.

20. Dependent Variable(s):

21. Independent Variable:

22. Controlled Variables (at least 5):

23. Control Group:

24. Level of Treatment:

25. Method of Replication:

26. Predict the results of the experiment based on your hypothesis.

27. List in numerical order each step of the class procedure.

Results:

	Athletes				Non-Athletes			
Subject	1	2	3	4	5	6	7	8
Pulse Rate (bpm) Before Step Test								
Pulse Rate (bpm) After Step Test								
Recovery Time (min)								

Part IV: Presenting and Analyzing Results (5 Points)

28. Using data from your experiment, design a bar graph that shows the relationship between the dependent and independent variables in the experiment. Be sure that your graph has axis labels (with appropriate units) and a title.

Part V: Discussing and Communicating Results (5 Points Each)

29. Critique your experiment by filling in the table below. Suggest five weaknesses in the experiment and how you could improve them.

	Weaknesses in Experiment	Improvement
1		
2		
3		
4		
5		

30. Conclusion:

Part VI: Questions for Review (8 Points Each)

31. Match the following definitions to the correct term:

A.	Control
B.	Controlled Variables
C.	Dependent Variable
D.	Hypothesis
E.	Independent Variable
F.	Level of Treatment
G.	Prediction
H.	Procedure
I.	Replication

_____ 1. Variables that are kept constant during an experiment (variables not being manipulated)

_____ 2. Tentative explanation for an observation

_____ 3. What the investigator varies in the experiment (for example, time, pH, temperature, concentration, etc.)

_____ 4. Process used to measure the dependent variable

_____ 5. Appropriate values to use for the independent variable

_____ 6. Treatment that eliminates the independent variable or sets it at a standard value

_____ 7. What the investigator measures, counts, or records; what is being affected in the experiment

_____ 8. Number of times the experiment is repeated

_____ 9. Statement of the expected results of an experiment based on the hypothesis

32. Identify the dependent and independent variables in the following experiments:

a. The number of holes produced by herbivores in cactus pads with different densities of cactus spines.

Dependent Variable: _____

Independent Variable: _____

b. Tadpole length measured for 4 weeks.

Dependent Variable: _____

Independent Variable: _____

c. Number of AIDS-related illnesses for patients taking three different doses of a new drug.

Dependent Variable: _____

Independent Variable: _____

33. Suggest a control group for each of the following experiments:
    a. Plants are exposed to red, blue, and yellow wavelengths of light and the amount of oxygen produced during photosynthesis.

    b. Frogs are captured from polluted ponds. The investigator records the number of limb deformities.

    c. Cactus plants with different densities of cactus spines are observed for the number of holes made by herbivores.

34. What is the essential feature of science that makes it different from other ways of understanding the natural world?