Worksheet for Morgan/Carter Laboratory #1
“Scientific Investigation”

Ex. 1-1: QUESTIONS AND HYPOTHESES

Lab Study A: Asking Questions

Indicate whether or not each question below can be answered scientifically by circling “yes” or “no”:

1. Does playing football cause Lou Gehrig’s disease? (yes or no)
2. Did the consumption of seven cans of “energy drink” cause the heart attack of a motorcyclist in Australia? (yes or no)
3. Will increase the length of allergy seasons? (yes or no)
4. How effective are extracts of marigold and rosemary as insect repellents? (yes or no)
5. Should it be illegal to prolong the life of a terminally ill patient? (yes or no)

How did you decide which questions could be answered scientifically?

Lab Study B: Developing Hypotheses

Write an explanatory hypothesis for each of the following questions:

1. Can human dander cause allergic reactions in cats?

2. Does the proximity of neighborhood parks have an effect on the health of children?

Indicate which of the following statements would be useful as a scientific hypothesis investigated using scientific procedures. Give the reason for each answer by stating whether it could possibly be falsified and what factors are measurable and controllable.

1. “Snake oil” from pythons can be used to build heart muscle.

2. Obese women are more likely to have children who develop autism than normal-weight women.

3. Pierced and tattooed people consume more alcohol when visiting bars than persons without piercings and tattoos.

4. Birds evolved from bipedal dinosaurs called theropods.

5. Women who take aspirin have a lower risk of developing melanoma.
Ex. 1-2: DESIGNING EXPERIMENTS TO TEST HYPOTHESES

Lab Study A: Determining the Variables
For the monarch butterfly experiment as described, one dependent variable was measured. What is the dependent variable for this experiment?

What additional dependent variables might be measured in this experiment?

Why is this acceptable?

What was the independent variable in the investigation of female butterfly preference for milkweed plants?

Can you suggest other variables that the investigators might have changed that would have had an effect on the dependent variable?

Why is it important to have only one independent variable?

What are the controlled variables in this experiment?

Lab Study B: Choosing or Designing the Procedure
In many experimental studies the investigators must choose a level(s), however this is not always an option. Did the investigators choose the level of treatment in the butterfly experiment?

Describe the replication in the butterfly experiment.

What was the control in the butterfly experiment?

What is the difference between the control and the controlled variables discussed previously?
Lab Study C: Making Predictions

State your prediction for the butterfly experiment.

Consider an experiment to test this. How would you measure “healthier” for this experiment?

State a prediction based on the hypothesis you wrote for the question “Does the proximity of neighborhood parks have an effect on the health of children?” on the first page of this worksheet using the if/then format.

List the components of a scientific investigation from asking a question to carrying out an experiment.

List the variables that must be identified when designing an experiment.

What are the components of an experimental procedure?

Ex. 1-3: DESIGNING AN EXPERIMENT

Record the question chosen by the class below.

Record a hypothesis for the question chosen by the class (be sure to consider the characteristics of a testable hypothesis).

List the details of the step test procedure designed by the class:

Number and names of subjects in each test group:

Students designated to measure and record data:

Step rate: Duration of test: Height of step:

When are pulse rates (bpm) measured?

How are pulse rates (bpm) measured?
What is (are) the dependent variable(s) in your experiment?

What is the independent variable in your experiment?

What are the controlled variables?

What is the control?

What are the levels of treatment, if any?

Describe the replication in this experiment.

Predict the results of your experiment based on your hypothesis (if/then).

**TABLE 1.2: Results of step tests (you may modify the table as necessary):**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Test Group 1:</th>
<th>Test Group 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before step test pulse rate (bpm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 minute after step test pulse rate (bpm) = $t_1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 minutes after step test pulse rate (bpm) = $t_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 minutes after step test pulse rate (bpm) = $t_3$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fitness Index (FI) = test duration (sec)/($t_1 + t_2 + t_3$) x 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 1.3A – Results for Test Group 1:**

<table>
<thead>
<tr>
<th>Subject</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Avg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before step test pulse rate (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 minute after step test pulse rate (bpm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 minutes after step test pulse rate (bpm)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3 minutes after step test pulse rate (bpm)</td>
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<td></td>
</tr>
<tr>
<td>Fitness Index (FI)</td>
<td></td>
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</tr>
</tbody>
</table>
TABLE 1.3B – Results for Test Group 2:

<table>
<thead>
<tr>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before step test pulse rate (bpm)</td>
</tr>
<tr>
<td>1 minute after step test pulse rate (bpm)</td>
</tr>
<tr>
<td>2 minutes after step test pulse rate (bpm)</td>
</tr>
<tr>
<td>3 minutes after step test pulse rate (bpm)</td>
</tr>
<tr>
<td>Fitness Index (FI)</td>
</tr>
</tbody>
</table>

Ex. 1-4: PRESENTING AND ANALYZING RESULTS

Lab Study A: Tables
Using the data from your experiment, design a summary table to present the results for one of your dependent variables. Label this table 1.5 and compose a title for your table.

Lab Study B: Figures
Using the data from your experiment, design a bar graph in the grid below that shows the relationship between the dependent and independent variables in your experiment.

   a) What is the independent variable for your experiment, and on which axis would you graph this?

   b) What is the dependent variable, and on which axis would this variable go?

Label the axes of your graph and indicate the units if applicable. Add a legend to your figure to distinguish the two test groups and include a title for your graph.
Ex. 1-5: INTERPRETING AND COMMUNICATING RESULTS

Using your tables and figures, analyze your results looking for relationships between the variables and for general trends. Write a summary statement for your results being sure to also address whether the data support or falsify each hypothesis.

Critique your experiment using the table below to indicate weaknesses and suggest improvements.

<table>
<thead>
<tr>
<th>Weaknesses in Experiment</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>

Suggest additional and modified hypotheses that might be addressed in the future.
REVIEWING YOUR KNOWLEDGE

1. Match each description on the right with the corresponding term on the left:

___ control  
___ controlled variables  
___ level of treatment  
___ dependent variable  
___ replication  
___ procedure  
___ prediction  
___ hypothesis  
___ independent variable

A. variables kept constant during experiment (not manipulated)  
B. tentative explanation for an observation  
C. what the investigator varies in the experiment  
D. process used to measure the dependent variable  
E. appropriate values to use for the independent variable  
F. treatment eliminating or standardizing independent variable  
G. what investigator measures or records, i.e. what is affected  
H. number of times the experiment is repeated  
I. statement of expected results based on the hypothesis

2. Circle the dependent variable and underline the independent variable for each experiment below:

Scientists investigating the effects of increased temperatures on the occurrence of allergens in urban environments measured the number of days that ragweed pollen was present in Baltimore city lots and rural fields.

Coral reefs compete for light and space with seaweeds that may cover the coral like a lawn. Scientists measure the percent of coral covered with seaweed and the rate of coral growth in test plots with and without goby fish present.

Scientists compare the preference for sweets in hamsters kept in chronic dim light throughout the night, compared with hamsters kept on normal light/dark cycles.

3. Suggest a control treatment for each of the following experiments:

Scientists record the onset of increased levels of testosterone in male blackbirds kept in an environment with city lighting.

To investigate if night lights foster depression, a group of hamsters is kept in chronic dim light throughout the night.

4. Propose an experiment and suggest a control treatment for the following questions:

Is the mineral zinc effective as a possible emergency treatment for deadly Australian box jellyfish stings?

Experiment:

Control:
Does the fear of being attacked by predators have a negative impact on reproduction in nesting birds?

Experiment:

Control:

5. A recent study of 59,806 Caucasian women reports that women who take aspirin for 5 or more years are 30% less likely to develop melanoma than women who do not use aspirin. List other variables that would be important to control in this study (i.e., controlled variables).

6. A study of the effects of vitamin D in the body has shown that persons with lower levels of vitamin D are more likely to have chronic diseases such as cardiovascular disease, breast cancer, colds and flu. Can you conclude that vitamin D prevents these chronic diseases? What other possible explanations for this correlation can you suggest?

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