STUDY GUIDE - *Ch.1.3 - In Studying Nature, Scientists Form & Test Hypotheses* **NAME:** _____
- Ch.1.4 - Science Benefits From a Cooperative Approach and Diverse Viewpoints

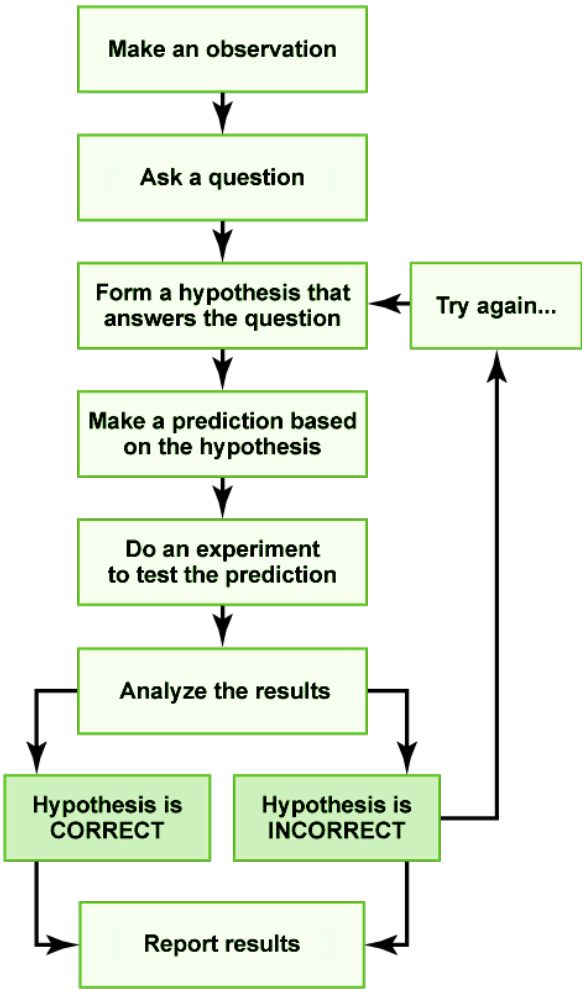
- **PHYSICALLY PRINT OUT this PDF and HANDWRITE (with a black or blue pen) your answers directly on this PDF.** *Typed or digitally-written work is **not** be accepted. Do **not** answer questions on separate paper.*
- **Importantly, study guides are NOT GROUP PROJECTS!!!** *You, and you alone, are to answer the questions as you **read** your assigned textbook. You are **not** to share answers with other students. You are **not** to copy any answers from any other source, including the internet.*
- **Get in the habit of writing LEGIBLY, neatly, and in a medium-sized font.** *AP essay readers and I will skip grading anything that cannot be easily read so start perfect your handwriting, and don't write so large you can't add all the relevant details and key elaborations in the space provided.*
- **SCAN physical documents in color and with good resolution. Then, upload your final work as PDFs to Archie.** *Avoid uploading dark, shaded, washed out, side ways, or upside down scans of homework. Keep completed physical study guides organized in your biology binder to use as future study and review tools.*
- **READ FOR UNDERSTANDING and not merely to complete an assignment.** ***First**, read a section quickly to get an overview of the topic covered. Then, read it a **second** time slowly, paraphrasing each paragraph **out loud** and analyzing every figure. Finally, read it a **third** time as you answer the study guide questions if assigned and to start building your memory. Try to write answers out in your own words when possible and to purposefully and accurately use all new terminology introduced.*

1. Science is an approach taken to come to understand the natural world. **Inquiry** in science refers to the search for information and explanations of natural phenomena. Scientists use **a process of inquiry**, one we often call the

   Scientific Method, which includes _____, _____

   _____ (also called ***hypotheses***), and _____.

2. Be sure to study the steps of the **Scientific Method** below.



3. Why is it important that the process of inquiry and the scientific method be **repetitive**?

4. a. What is **data**?

   b. What is the difference between **quantitative vs qualitative data**?

   Qualitative Data =

   Quantitative Data =

   c. Why do scientists use the field of mathematics known as **statistics** when analyzing quantitative data?

5. a. Explain the process of logic known as **inductive reasoning**.

   b. Your book shares two **generalizations based on inductive reasoning**, one of which is that **"All organisms are made of cells."** How is this an example of inductive reasoning?

6. a. What is a **hypothesis** exactly?

   b. Scientific hypothesis lead to _____ (***if...then*** statements), which can be **tested in which two ways**?

   1.

   2.

7. What is an **experiment**?

8. a. Though explaining the natural world makes use of inductive logic. Scientists also readily **use deductive logic**, especially **when designing experiments to test hypotheses**. What is **deductive reasoning**?

b. What **form does deductive reasoning take in the scientific process** (the scientific method)?

9. In the example given of the broken desk lamp, the authors highlight that **two possible logical and informed explanations (hypotheses)** for why your desk lamp does not work are that 1. the bulb is improperly screwed in or 2. the bulb is burnt out.

   Each **hypothesis leads to a prediction**: 1. **If** the bulb is improperly screwed in, **then** re-screwing in the bulb correctly will fix the problem or 2. **If** the bulb is burnt out, **then** replacing the bulb will fix the problem.

   The **prediction will help guide the creation of an experiment or a scientific test** to help **determine whether the explanation you came up with is valid or not**.

   Of course, your book says that these two hypothesis are not the only explanations that can be used to explain the reason for the nonworking desk lamp. As a matter of fact, **there are always additional explanations for a phenomenon we see**. For example, the electrical socket could be broken and that may be the real reason the desk lamp is failing to turn on, not the hypothesis (explanation) you proposed. Can you come up with your own, new hypothesis for why the desk lamp doesn't work *not* mentioned in your textbook?

10. a. Besides the fact that many hypothesis (explanations) may exist for a phenomenon observed in nature, we also say that a **hypothesis can never be "proved."** Why is that?

    b. Why is hypothesis testing still a very useful endeavor then even if we cannot prove that particular explanation to be true beyond a shadow of doubt?

    c. Hypothesis that are validated by well-collected data may come to have the backing of scientific consensus. What is **scientific consensus**?

11. In order for it to be considered a **scientific hypothesis, the hypothesis (educated explanation for a phenomenon we observe in nature) must TESTABLE**. What does this mean?

12. Let's understand the process of experimental design a little better. It is important to designed a Controlled Experiment when testing hypotheses. What is a **Controlled Experiment**?

13. a What are **Variables**?

    b. What is the **Independent Variable** in scientific investigations?

FYI: The **Independent Variable** in the environment your subjects are kept in in an experiment is often called the **Treatment**. The **"amount"** of the Independent Variable administered to the subjects in the experimental and control groups of subjects in an experiment often called the **Treatment Level**.

- ➡ Subjects in the **Control Group** do **NOT** receive a manipulated Independent Variable: they receive either **NO** Treatment (no Independent Variable) ***or*** a standard, **unmanipulated** Treatment (unmanipulated Independent Variable).
- ➡ On the other hand, those subjects in the **Experimental (also called the Treatment) Group(s)** **DO** receive a **manipulated** Level of Treatment (Independent Variable).

c. What is the **dependent variable** in scientific investigations?

d. When designing a controlled scientific experiment, **how many variables should be allowed to vary between the control group of subjects and the experimental group of subjects**?

e. Why is your answer to 13.d. so important when it comes to determining if your independent variable influences your dependent variable?

14. **Other variables (besides the Independent Variable) could influence the Dependent Variable.** Unfortunately if these other variables are allowed to **fluctuate among the different groups** of subjects in your experiment, you may reach the wrong conclusion about whether or not your Independent Variable influences the Dependent Variable, leading to you failing to reject or rejecting your hypothesis **incorrectly**. Additionally, if these other variables fluctuate differently among your groups of subjects, **you cannot validly conclude that your Independent Variable does or does not influence the Dependent Variable** **since differences in the Dependent Variable data collected from each group could now be due to the differences in Independent Variable each group was exposed to *OR* due to the influence of these other extraneous variables instead that also varied from one group to the next in your experiment.**

- ➡ **We want to control these other variables that could influence our Dependent Variable in an experiment to eliminate alternative explanations for any differences in the Dependent Variable seen between the groups in an experiment.**

What does it mean **to "control" these unwanted variables** in an experiment?

15. a. In the study on the coat coloration seen in Florida mice populations, what was the **observation** made that initially intrigued scientists and made them want to investigate these mice further?

b. Was this observation **qualitative or quantitative**?

c. **Hypothesis explain the effect of the Independent Variable on the Dependent Variable.** What was the **hypothesis** they designed **to explain the reason for what they observed in the mouse population**?

d. What was the **prediction** scientists had based on the hypothesis above?

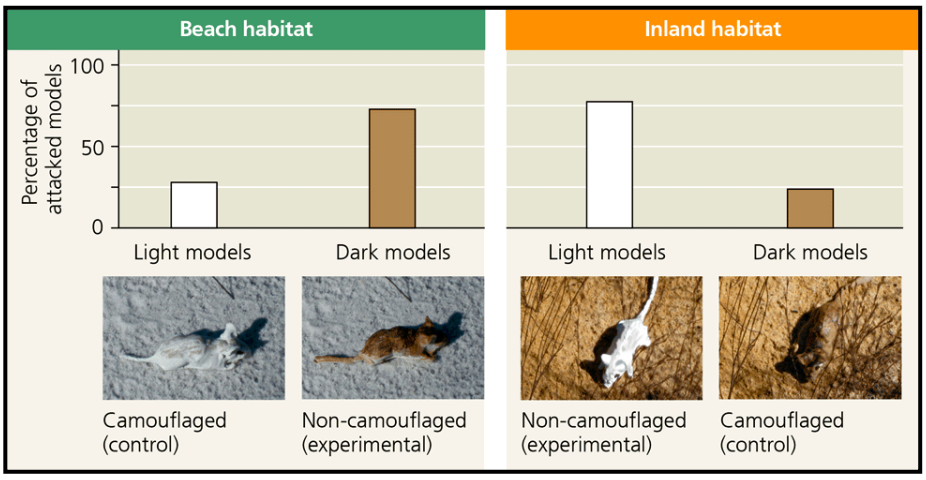
e. Read Figure 1.25 fully and study the two bar graphs carefully. Describe the **experiment** that was conducted **to test the hypothesis (indirectly) and its resulting prediction (directly)**?

f. **The Independent Variable is the variable that scientists manipulate in an experiment.** What is the independent variable in this experiment? **(FYI - the Independent Variable is graphed on the x-axis of graphs)**

g. **The Dependent Variable is the variable that scientists measure and college data on in an experiment.** What is the **data collected** in this experiment, i.e. the dependent variable in this experiment? **(FYI - the Dependent Variable is graphed on the y-axis of graphs).**

TIP: If any variable is quantitative, be sure to always state the units of measurement too when discussing that particular variable!

h. In this mouse experiment, was the data collected (the dependent variable) **qualitative or quantitative**?



i. The bars indicate the percentage of the attacked models that were either light or dark in coloration. Assume 100 mouse models were attached in each habitat. Based on the data graphed, for the beach habitat, how many were light models?

j. For the beach habitat, how many were dark models?

k. Based on the data graphed, for the inland habitat, how many were light models?

l. For the inland habitat, how many were dark models?

(Check your answers to 14.i., j., k., and l. by going to the Ch.1 ***Figure Questions*** *for* ***Figure 1.25*** *in Appendix A of your textbook)*

m. Did the data collected (the **results**) in the experiment **falsify or fail to falsify their hypothesis** and why?

16. What are four ways in which a **Scientific Theory** (such as the theory of natural selection) differs from the unscientific use of the word "theory" (which is merely an every day speculation) or a hypothesis? Remember, a hypothesis is an educated explanation for a particular phenomenon (a specific explanations for the effect an Independent Variable has on a Dependent Variable). **Scientific Theories**, however, ...

    1.

    2.

    3.

    4.

17. Why is Natural Selection (as a mechanism for the evolution of adaptations in populations) a theory? *(Check your answer by going to the Ch.1.3* ***Concept Check Question #3*** *in Appendix A of your textbook)*

18. a. In the deserts of New Mexico, the solids are mostly sandy, with occasional regions of black rock derived from lava flows that occurred about 1000 years ago. Mice are found in both sandy and rocky areas, and owls are known predators. Explain what you might expect about he coat color in these two mouse populations?

b. How would you use this ecosystem to further test the camouflage hypothesis?

(Check your answers to 18.a. and b. by going to the Ch.1.3 ***Concept Check Question #4*** *in Appendix A of your textbook)*

19. Though earlier we said you typically want only one variable (one independent variable) to vary between your control and your experimental group (often also called the treatment group), in certain situations you may be able to use one experiment to test more than one independent variable simultaneously. Carefully read and study the hypothesis, experimental set up, and the results of the experiment described in the Ch.1.4 Scientific Skills Exercise.

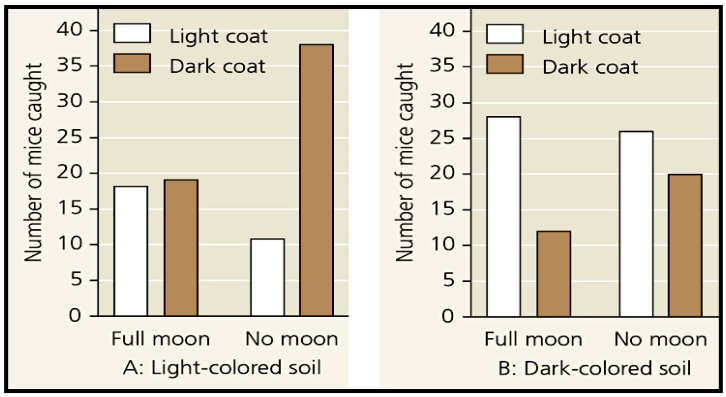
a. This is an example where you see more than one independent variable in the graphs. **Independent variables are always plotted along the x-axis in a graph.** What are these <u>two independent variables</u> that were manipulated (tested) by the researcher in the experiment?

I.V. #1 =

I.V. #2 =

b. **Dependent variables are always plotted along the y-axis in a graph.** What is the dependent variable, the variable being measured (the data collected), as a result of varying the independent variables?

(Check your answers to 19.a. & b. by going to the Ch.1.4 ***Scientific Skills Exercise #1.a & 1.b.*** *in Appendix A of your textbook)*



c. How many dark brown mice were caught in the light-colored soil on a moonlit night?

d. How many dark brown mice were caught in the dark-colored solid on a moonlit night?

e. On a moonlight night, would a dark brown be more likely to escape predation by owls on dark or light-colored soil? **ALWAYS - <u>throughout this course</u> - BACK UP YOUR STATEMENT USING THE DATA GIVEN.** ***ALWAYS QUOTE THE DATA TO BACK UP YOUR CLAIMS & SHOW THE READER WHY YOU SAY WHAT YOU SAY.***

(Check your answers to 19.c., d., & e. by going to the Ch.1.4 ***Scientific Skills Exercise #2.a, 2.b., & 2.c.*** *in Appendix A of your textbook)*

f. Is a dark brown mouse more likely to escape predation in moonlight or when there is no moonlight when the mouse is living on the dark-colored soil? **(Again, explain by using the data in your answer)**

g. Is a light brown mouse more likely to escape predation in moonlight or when there is no moonlight when the mouse is living on the light-colored soil? **(Again, explain using the data in your answer)**

(Check your answers to 19.f. & g.. by going to the Ch.1.4 ***Scientific Skills Exercise #3.a & 3.b.*** *in Appendix A of your textbook)*

h. When studying both graphs and so both soil-color and moonlight conditions, under which condition**S** would a dark brown mouse be more successful in escaping predation at night? **(Again, explain)**

i. When studying both graphs and so both soil-color and moonlight conditions, under which condition**S** would a light brown mouse be more successful in escaping predation at night? **(Again, explain)**

(Check your answers to 19.h. & i.. by going to the Ch.1.4 ***Scientific Skills Exercise #4.a & 4.b.*** *in Appendix A of your textbook)*

j. What combination of independent variables led to the highest predation in environments with light-colored soil? **(Again, explain)**

k. What combination of independent variables led to the highest predation in environments with dark-colored soil? **(Again, explain)**

(Check your answers to 19.j. & k.. by going to the Ch.1.4 ***Scientific Skills Exercise #5.a & 5.b.*** *in Appendix A of your textbook)*

l. What combination of conditions are especially deadly to dark-colored mice? **(Again, explain)**

m. What combination of conditions are especially deadly to light-colored mice? **(Again, explain)**

(Check your answers to 19.l. & m. by going to the Ch.1.4 ***Scientific Skills Exercise #6*** *in Appendix A of your textbook)*

n. Combining the data from both graphs estimate the number of mice caught in moonlight versus no-moonlight conditions.

# of Mice caught in moonlight =

# of Mice caught in no moonlight =

o. Which conditions is optimal for sedation by the owl? **(Again, explain)**

(Check your answers to 19.n. and o. by going to the Ch.1.4 ***Scientific Skills Exercise #7*** *in Appendix A of your textbook)*

20. How does **science police itself**?

21. How does **science** differ from **technology**?

Science =

Technology =

22. Proceed to the TEST YOUR UNDERSTANDING section at the end of the chapter. **Study your chapter sections and all Ch.1 study guides first!** Then, do your best to try to answer these from memory first in order to test how well you grasped the material before. If you are unsure, return to the relevant section of your chapter and restudy any pertinent material to refresh your memory. *(Check some of your answers by going to the Ch.1 Test Your Understanding answers in Appendix A)*

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____

8.