Lab 2, Biol-1, C. Briggs, revised Spring 2018

Name: _____
Lab day of week: _____

Hypotheses

Objectives
Learn to write scientific hypotheses.

Instructions
1. Read the section below, titled "What is a Hypothesis?"
2. Consider the questions that follow.
3. Complete the section, "Can science answer these questions?" as a group.

What is a Hypothesis?

Adapted from http://www.batesville.k12.in.us/physics/PhyNet/AboutScience/Hypotheses.html

A hypothesis is an "educated guess." It can be an educated guess about what nature is going to do, or about why nature does what it does.

A scientific hypothesis must meet two requirements:

1. A scientific hypothesis must be *testable*, and;
2. A scientific hypothesis must be *falsifiable*.

A Scientific Hypothesis Must Be "Testable".

Science proceeds by making observations of nature. (These are often in the form of experiments). If a hypothesis does not generate any possible tests, there is nothing that a scientist can do with it. Arguing back-and-forth about what should happen, or what ought to happen, is not the way science makes progress.

Consider this, Hypothesis A:
"Our universe is surrounded by another, larger universe, with which we can have absolutely no contact."

This statement may or may not be true, but it is not a scientific hypothesis. By its very nature it is not testable. There are no observations that a scientist could make to tell whether or not the hypothesis is correct. Ideas such as Hypothesis A are interesting to think about, but science has nothing to say about them. Hypothesis A is a speculation, not a hypothesis.

A Scientific Hypothesis Must Be "Falsifiable".

Consider this, Hypothesis B:
"There are other inhabited planets in the universe."

This hypothesis is testable, but it is not a scientific hypothesis. Here's why. Hypothesis B may be either correct or wrong. If it is correct, there are several ways that its correctness can be proven, including:

1. A space probe sent from earth to explore the universe sends back the news that it has discovered an inhabited planet. (This news is later confirmed by other space probes.)
2. Knock, Knock. "Greetings, earthling! I am Telek from the planet Zoron in the Andromeda Galaxy. I have just landed in your backyard. Take me to your leader."

So, if Hypothesis B is true, there are observations that scientists could make that would prove its correctness. But, the hypothesis may be wrong. (Most hypotheses are.) If Hypothesis B is wrong, there is no test that will prove it. If one of our space probes never finds an inhabited planet, it doesn't mean that one doesn't exist. If we never receive signals from space, or Telek never lands in your back yard, that does not prove that the hypothesis is wrong, either. Hypothesis B is not falsifiable.

What about this, Hypothesis C:
"All living things require energy inputs."

Hypothesis C is a scientific hypothesis because:

1. It is testable: Find any living thing, and measure what it absorbs from its environment. Of course, some living things will require very careful observation.
2. It is falsifiable: If anyone finds a living thing that doesn't require energy inputs, then she has proven the hypothesis wrong. This hypothesis "sticks its neck out" for every test. In theory and in practice, if Hypothesis C were wrong, it would be very easy and straightforward to show it.

Most Scientific Hypotheses Can't Be Proven Correct!

Note that it is very easy to prove Hypothesis C wrong (if it were), but it is impossible to prove it correct! Since Hypothesis C states that any living thing behaves in a certain way, in order to prove it correct, all possible living

things that exist (or have ever, or will ever exist) must be tested. This is clearly not possible. As we test Hypothesis C more and more, we can get more and more confident in its truth, but we can ***never be absolutely sure***. Someone could always come up with a living thing tomorrow which doesn't behave exactly as Hypothesis C says it should, and this would make Hypothesis C incorrect.

What if the Hypothesis Fails a Test?

If a hypothesis fails a test, it cannot be true, and it must be modified or discarded. In science, if there is a conflict between observation and hypothesis, the hypothesis loses. It doesn't matter whose hypothesis it is or how famous they are - if the hypothesis does not conform to reality it must be rejected.

For each of the example hypotheses below, we consider these two questions:

(i) Does this hypothesis lead to a test we could perform? (Is it testable?)
(ii) If so, is there an observation we could make that would show that the hypothesis is false? (Is it falsifiable?)

Some people live forever.
Test: Watch to see whether some people do not die.
Falsifying observation: None. There could always be some person who was just born who will never die.

More scientific version: *All people live forever.*
Test: Watch to see whether people die.
Falsifying observation: One person dies.

Some animals can predict the future.
Test: Test whether animals can accurately predict future events.
Falsifying observation: Hmm... none, unless we test every animal. Otherwise, we may be missing the one animal that can do it. Not falsifiable.

More scientific version: *All dogs can predict the future.*
Test: Test whether dogs can accurately predict future events.
Falsifying observation: Find a single dog that cannot predict the future.

Practice: *Increased levels of stress in mockingbirds will always lead to their decreased health.*
Test:

Falsifying observation:

Bacterial growth is not affected by temperature.
Test:

Falsifying observation:

Plants like ladybugs.
Test:

Falsifying observation:

More scientific version:

Chlorine is toxic and causes disease in people.
Test:

Falsifying observation:

More scientific version:

CAN SCIENCE ANSWER THESE QUESTIONS?

Read each of the questions below. If you think the scientific process could be used to answer the question, put Y (for yes) in the blank. If you think it's the wrong kind of question for science to work on, put N (no) in the blank, and write an alternative question about the same idea, that ***could*** be answered using scientific methods.

Note: These are not hypotheses, so they are not explicitly testable or falsifiable. These questions may ***lead*** to hypotheses.

_____1. How far away is the planet Venus?

_____2. Why are the head feathers of the golden eagle golden?

_____3. What is the best way for me to use the adult years of my life?

_____4. How did the solar system form?

_____5. Is there a God?

_____6. Is it right for a couple to continue a pregnancy even when they know the baby will likely be born with a serious health defect?

_____7. Was *Tyrannosaurus rex* a fast- or slow-moving dinosaur?

_____8. Why do leaves turn colors in the fall?

_____9. Does the sex drive in human males decrease with age?

_____10. Do people who pray about their illnesses get better because a divine power healed them?

_____11. How old is the earth?

Strategies for making quality observations

Objectives
Discuss strategies for making quality observations.

Instructions
Search for words within the grid.
When you find a word, tell your group, and point out why it might be a useful habit or behavior.
Ask your group members to define any words with which you are unfamiliar.

Challenge: See if you can find 22 words.

W	S	B	Y	H	Z	P	A	T	I	E	N	T	E	F
X	T	A	C	Q	U	E	S	T	I	O	N	I	N	G
L	R	A	U	F	A	P	R	E	C	I	S	E	N	B
Q	A	D	T	D	M	D	E	D	I	C	A	T	E	D
E	N	I	I	N	Q	U	I	S	I	T	I	V	E	A
X	S	L	L	O	T	E	N	A	C	I	O	U	S	U
P	P	I	I	F	I	C	A	W	C	U	P	T	E	C
E	A	G	T	H	O	U	C	S	O	N	E	H	F	R
R	R	E	A	Q	L	R	C	Y	M	B	N	O	F	E
I	E	N	R	U	C	I	U	G	P	I	M	R	I	L
E	N	T	I	I	A	O	R	Z	L	A	I	O	C	I
N	T	Y	A	E	L	U	A	U	E	S	N	U	I	A
C	G	L	N	T	M	S	T	F	T	E	D	G	E	B
E	P	R	E	P	A	R	E	D	E	D	E	H	N	L
D	S	F	X	E	Q	U	I	P	P	E	D	P	T	E

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Enzymes

Objectives: Learn to detect invisible objects.
Observe results of enzyme activity.
Determine whether particular environments will stop enzymes from working.

Background (complete this first):
Sizes from small to large ----->

	atom	**molecule**	**macromolecule**	**organelle**	**cell**	**organism**
Examples			*polysaccharides* *polypeptides* *fats*			

Ingredients	**Original colors**	**Reaction**
Starch + Iodine		
Starch + Benedict's + Heat		
Glucose + Benedict's + Heat		
Acid + Litmus		
Base + Litmus		

Other known reactions: $2\ H_2O_2 \longleftrightarrow 2\ H_2O + O_2$
hydrogen peroxide water oxygen

lipid (fat) <----------> glycerol + fatty acid

starch <----------> glucose

Starting materials: Hydrogen peroxide, Potato (starch)
Enzymes: Catalase (in each potato cell), Amylase, Lipase
Potential end products: Acid, Oxygen, Glucose

Instructions
First, determine which enzyme reacts with hydrogen peroxide, and what is produced. (Tip: Use only a few mL of lipase, amylase, or hydrogen peroxide at a time.)

Results:

Next, determine how these each alter enzyme activity, in three separate tests. (Tip: Use only a few mL of hydrogen peroxide or HCl at a time.) (1) Heat catalase. (2) Change surface area of potato. (3) Add acid to catalase.

Results:

Optional challenge: What does amylase do?

Food energy content

Objectives: Determine the calorie density of two different foods.

Suggestions:
Measure the mass of the food before and after burning.
Use 20 mL of water in the test tube.
Measure the initial and final water temperatures.

Lab 2 Assignment

Grading scheme: Same as before. Objectives: Same as before.

Expectations for assignments

- Respond meaningfully to every part of the assignment.
- Respect your own ideas enough to present them professionally and clearly. Consider grammar, spelling, appropriate terminology, and appearance. Complete sentences, however, are not always necessary.
- Type or write clearly. Double-sided printing is encouraged.
- If you generate multiple pages, simply staple them together rather than using a cover.
- If you consult outside resources, cite them in your answer. For example, give the name of websites, of books, or of people granting interviews.

Materials needed

- Lab 2 work
- One to two hours of your time

Assignment prompts

Regarding Lab 2:

1. Turn in this completed lab, and attach your responses to the items below.
2. Among the qualities and habits necessary to make good observations, which is hardest for you? What might be a strategy to help you improve?
3. What chemical reaction did catalase accelerate?
4. Why do you think catalase might be important for a living thing to have? (Look it up!)
5. What do your observations suggest about the relationship between:
   (a) enzyme activity and surface area?
   (b) enzyme activity and pH?
   (c) enzyme activity and heat?
6. What were the final calorie densities you determined for the two food types?
7. How do you explain these differences between the calorie densities?
8. What were some potential sources of error in your calorie experiment?

Preparing for Lab 3: If you use outside sources, cite them in your answer.

9. Find a diagram of a compound light microscope, and use it to respond to the parts below.
   a. Describe the stage.
   b. What are the two major kinds of microscope lenses? (Hint: They both start with the letter "o.")
   c. What part moves the stage just a tiny bit up and down?
10. What is the nucleus of a cell? What is a nucleolus?