Name: _____ Date: _____

Guided Learning: Hypotheses and Theories

Learning goals
After completing this activity, you will be able to …

- Understand that hypotheses must be testable.
- Distinguish between scientific hypotheses and theories
- Understand that scientific theories are based on observational evidence.
- Explain how scientific theories can change due to new scientific knowledge.

Vocabulary: hypothesis, theory

Warm-up question:
Pedro likes to run every evening. Suppose he is running at a speed of 5 mph. If he increases his speed to 8 mph, how do you think this will affect his breathing rate?

_____

_____

Scientific Hypotheses
Guess what? You've just formed a **hypothesis**. In science, a hypothesis is a proposed answer to a question. Hypotheses are not necessarily true, but they must be testable. In other words, a hypothesis must be stated in such a way that a scientific experiment could be performed to support or refute the hypothesis.

1. Suppose you hypothesized that increasing a person's running speed would cause an increase in his or her breathing rate.

   A. How could you test this hypothesis? _____

   _____

   B. What results would prove your hypothesis is false? _____

   _____

   C. What results would support your hypothesis? _____

   _____

Other factors that are not tested during your experiment may cause the runners' breathing rates to increase. Because this uncertainty will always exist in any experiment, hypotheses can never be proven beyond a doubt. This is why experiments can only support or refute hypotheses.

Quick Check: Are hypotheses better described as "tentative statements" or "provable ideas"?

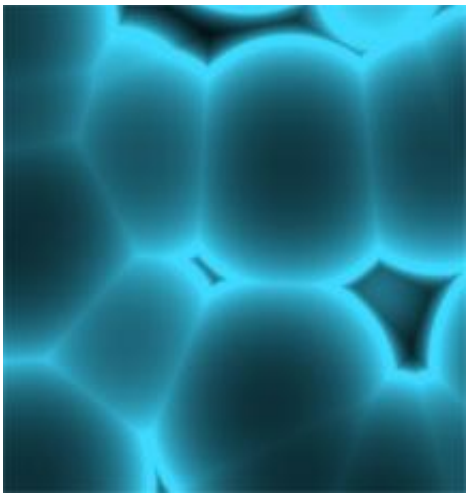
Explain: _____

_____

Scientific theories

Once a hypothesis has been thoroughly tested by many different experiments over a wide variety of conditions, the hypothesis may become a scientific **theory** or be incorporated into an existing theory. A scientific theory is a generally accepted set of ideas that tie together many different observations of natural and physical phenomena. For example, the cell theory, which states that cells are the basic unit of structure and function in all living things and all cells come from other cells, is supported by the following observations:

- Cells can be viewed using a microscope.
- All organisms displaying the major characteristics of life (such as the ability to grow and develop) are composed of cells.
    - The smallest organisms, bacteria, are composed of single cells.
    - The largest organisms are composed of billions of cells.
- No cell has ever been observed arising from anything but another cell.
- Cellular division has been observed by multiple researchers at many different times under many different conditions.



A colony of cells

Unlike hypotheses, theories are very well-established and have been tested by multiple independent researchers. In addition, theories are widely accepted by the majority of scientists within a field. Because of this, theories are highly-reliable explanations of phenomena, so they can accurately predict events in the natural world. However, this does not mean that theories cannot be revised or replaced my more accurate theories.

As scientific and technological knowledge grows, scientific theories are refined, improved upon, or replaced. For example, many scientists once believe that life could arise spontaneously from nonliving substances. This idea was called the theory of spontaneous generation. Experiments showing that maggots would not appear on meat kept in sealed containers along with the development of powerful microscopes that allowed scientists to see cells for the first time led to the replacement of the theory of spontaneous generation by the cell theory.

2. How does a theory differ from a hypothesis? _____

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_____

3. The theory of plate tectonics states that Earth's crust is made up of large plates that are constantly moving. What types of observations do you think might support this theory?

_____

_____

_____

Scientific laws

Like scientific theories, scientific *laws* are based on a large number of observations. Scientific laws differ from scientific theories in that scientific laws describe how the natural world will work under certain conditions while scientific theories explain how nature works.

Scientific laws often include or are stated as mathematical formulas. These formulas can be used to make predictions about how objects will behave under given conditions. Examples of scientific laws include:

- Law of universal gravitation
- Law of conservation of energy
- Kepler's laws of planetary motion
- Newton's laws of motion

Think about it: Look up one of the laws listed above and describe what kind of predictions can be made using the law. _____

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