0.4 Lesson Guide

Scientific Laws and Theories

Penguin Bay Biology
- Biology Class, Simplified -

Objectives

Today's lesson illustrates the differences between hypotheses, theories, and laws in science.

Students should come away from today's lesson understanding that:

1. A hypothesis is an educated guess that must be tested in order to be proven correct or incorrect.
2. A theory is a well-tested explanation of experimental data.
3. Laws are statements based on repeated experimental observations.
4. Pure science is a field of natural science, such as Biology, Chemistry, or Geology.
5. Applied science uses the knowledge from pure science to solve practical problems, such as Medicine, Engineering, or Forensics.
6. Experimental data must be presented in a clear way, such as in a graph.
7. Y axis: the vertical axis where the dependent variable is placed.
8. X axis: the horizontal axis where the independent variable is placed.

Bell Work

1. As each student enters, pass out the bell work.
2. Give the students about 5-10 minutes to finish these, then discuss their answers.
3. Remind the students to turn in the Scientific Method Lab Sheet.

Lesson

- Pass out the Student Notes.

➢ Go to slide 1 (*Scientific Laws and Theories*) of the 0.4 PowerPoint.

- Using the following lesson, go through and explain Scientific Laws and Theories.

➢ Go to slide 2 (*Hypotheses*) of the 0.4 PowerPoint.

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Hypotheses

A **hypothesis** is an educated guess that must be tested in order to be proven correct or incorrect.

- Example: If I use a toothpaste containing fluoride, then I will develop fewer cavities.

A 'guess' is only a hypothesis if it is testable.

➢ Go to slide 3 (*Theories, 1 of 2*) of the 0.4 PowerPoint.

Theories

A **theory** is a well-tested explanation of experimental data.

Scientific theories are created by repeatedly testing a hypothesis through the formula outlined in the scientific method.

One scientist alone cannot create a theory. In science, a theory implies that something has been confirmed through experimentation.

Tip: *Ask the students to suggest examples of theories, such as evolution.*

➢ Go to slide 4 (*Theories, 2 of 2*) of the 0.4 PowerPoint.

Theories must **always**:

- Be totally supported by data.
- Be verified by repeated testing.
- Be subject to review by peers.

A theory can be modified if additional data is found.

In order for a hypothesis to become a theory, every scientist who tests the hypothesis must come up with exactly the same conclusion.

Tip: *Remind students that scientists must **never** alter the results of an experiment.*

➢ Go to slide 5 (*Laws*) of the 0.4 PowerPoint.

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Laws

Laws are statements based on repeated experimental observations that are:

- Based on proven, reliable evidence.
- Accepted to be true because they are consistently observed to be true.
- Different from theories because they are conclusions based on **observations** of phenomena, rather than explanations of phenomena.

➢ Go to slide 6 (*Pure and Applied Science*) of the 0.4 PowerPoint.

Pure and Applied Science

Pure science is a field of natural science.

- Example: Biology, Chemistry, Geology, etc.

Applied science uses the knowledge from pure science to solve practical problems.

- Example: Engineering, Medicine, Forensics, etc.

Tip: *Ask the students to suggest examples of how applied science has helped solve some practical problems in the world, such as the discovery of insulin by Frederick Sanger in 1953.*

➢ Go to slide 7 (*Experimentation, 1 of 3*) of the 0.4 PowerPoint.

Experimentation

A valid scientific experiment must test only one variable at a time and include a control group to compare the variable with.

- Example: When testing a new drug, the test group is given the medication and the control group is given a placebo (fake drug).

➢ Go to slide 8 (*Experimentation, 2 of 3*) of the 0.4 PowerPoint.

The data obtained by experimentation will be either **quantitative** or **qualitative**.

Quantitative data is obtained by making measurements which result in reproducible sets of numeric information.

- Example: Measuring the height of everyone in class.

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Qualitative data is obtained by observation or approximations.

- Example: Most of the shirts in the room are green.

➢ Go to slide 9 (*Experimentation, 3 of 3*) of the 0.4 PowerPoint.

Quantitative and **qualitative** data are both valid and useful if collected carefully following the scientific method.

Well-planned experimentation is vital for reaching an accurate conclusion. You should be able to use your data to reach a factual conclusion that others can confirm by following your methods.

Representing your data in an understandable way is a critical step in the process of reporting your results.

Graphing is often a good way of accomplishing this.

➢ Go to slide 10 (*Graphing Data*) of the 0.4 PowerPoint.

Graphing Data

Y axis: the vertical axis where the dependent variable is placed.

X axis: the horizontal axis where the independent variable is placed.

- Example: In an experiment measuring the effect of water quality on plant growth, the water quality would be the independent variable and the plant growth would be the dependent variable.

Reinforcement

1. Pass out the Scientific Laws and Theories Student Activity Sheet. This will take about 10 minutes to complete.

Exit Survey

1. Pass out the Scientific Laws and Theories Exit Survey. This will take about 5-10 minutes to complete.

Homework

1. Instruct the students to read over the notes they took in class today.