Lesson Overview

1.2 Science in Context
THINK ABOUT IT

**Scientific Methodology** is the heart of science. But that vital “heart” is only part of the full “body” of science.

Science and scientists operate in the **context** of the scientific community and **society** at large.
1.2 Science in Context

1.2.1 Explain how scientific attitudes generate new ideas.

1.2.2 Describe the importance of peer review.

1.2.3 Explain what a scientific theory is.

1.2.4 Explain the relationship between science and society.

Indiana Standards covered: NoS.3, NoS.4, NoS.8, NoS.10, & NoS.11
Exploration and Discovery: Where Ideas Come From

What scientific attitudes help generate new ideas?
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Curiosity, skepticism, open-mindedness, and creativity help scientists generate new ideas.
Exploration and Discovery: Where Ideas Come From

Scientific methodology is closely linked to **exploration** and **discovery**.

Scientific methodology starts with **observations** and questions that may be inspired by scientific attitudes, practical problems, and new technology.

Adapted from Understanding Science, UC Berkeley, Museum of Paleontology
Scientific Attitudes

**Good scientists** share scientific attitudes, or habits of mind, that lead them to exploration and discovery.

Curiosity, skepticism, open-mindedness, and creativity help scientists generate new ideas.
Curiosity

A curious researcher, for example, may look at a salt marsh and immediately ask, “What’s that plant? Why is it growing here?”

Often, results from previous studies also spark curiosity and lead to new questions.
Skepticism

Good scientists are skeptics, which means that they question existing ideas and hypotheses, and they refuse to accept explanations without evidence.

Scientists who disagree with hypotheses design experiments to test them.

Supporters of hypotheses also undertake rigorous testing of their ideas to confirm them and to address any valid questions raised.
Open-Mindedness

Scientists must remain **open minded**, meaning that they are willing to accept different ideas that may **not** agree with their hypothesis.
Creativity

Researchers need to think \textit{creatively} to design experiments that yield \textit{accurate} data.
Practical Problems

Sometimes, ideas for scientific investigations arise from **practical problems**. For example, people living on a strip of land along a coast may face flooding and other problems.

These practical questions and issues **inspire** scientific questions, hypotheses, and experiments.
The Role of Technology

Technology, science, and society are closely linked.
The Role of Technology

Discoveries in one field of science may lead to new technologies, which enable scientists in other fields to ask new questions or to gather data in new ways.

Technological advances can also have big impacts on daily life. In the field of genetics and biotechnology, for instance, it is now possible to mass-produce complex substances—such as vitamins, antibiotics, and hormones—that before were only available naturally.
Communicating Results: Reviewing and Sharing Ideas

Why is peer review important?
Communicating Results: Reviewing and Sharing Ideas

Why is peer review important?

Publishing peer-reviewed articles in scientific journals allows researchers to share ideas and to test and evaluate each other’s work.
Peer Review

Scientists share their findings with the scientific community by publishing articles that have undergone peer review.

In peer review, scientific papers are reviewed by anonymous, independent experts.

Reviewers read them looking for oversights, unfair influences, fraud, or mistakes in techniques or reasoning. They provide expert assessment of the work to ensure that the highest standards of quality are met.
Sharing Knowledge and New Ideas

Once research has been published, it may spark new ___questions____________. Each logical and important question leads to new hypotheses that must be independently confirmed by ____controlled________ experiments.

For example, the findings that growth of salt marsh grasses is limited by available nitrogen suggests that nitrogen might be a ___limiting nutrient________________ for mangroves and other plants in similar habitats.
Scientific Theories

What is a scientific theory?
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In science, the word **theory** applies to a well-tested explanation that unifies a **broad range** of observations and hypotheses and that enables scientists to make accurate predictions about **new situations**.
Scientific Theories

Evidence from many scientific studies may support several related hypotheses in a way that inspires researchers to propose a scientific **theory** that ties those hypotheses together.

In science, the word theory applies to a well-tested explanation that unifies a broad range of observations and **hypotheses** and that enables scientists to make accurate predictions about new situations.

A useful theory that has been thoroughly tested and supported by many lines of evidence may become the dominant view among the majority of scientists, but **no** theory is considered absolute truth. Science is always changing; as new evidence is uncovered, a theory may be revised or replaced by a more useful explanation.
Science and Society

What is the relationship between science and society?
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What is the relationship between science and society?

Using science involves understanding its context in society and its **limitations**.
Science and Society

Many questions that affect our lives require scientific information to answer, and many have inspired important research. But none of these questions can be answered by science alone.

Scientific questions involve the *society* in which we live, our economy, and our laws and moral principles.

For example, researchers test shellfish for toxins that can poison humans. Should shellfish be routinely screened for toxins?
Science, Ethics, and Morality

When scientists explain “why” something happens, their explanation involves only natural phenomena. Pure science does not include ethical or moral viewpoints.

For example, biologists try to explain in scientific terms what life is and how it operates, but science cannot answer questions about why life exists or what the meaning of life is.

Similarly, science can tell us how technology and scientific knowledge can be applied but not whether it should be applied in particular ways.
Avoiding Bias

The way that science is applied in society can be affected by **bias**, which is a particular preference or point of view that is personal, rather than scientific.

Science aims to be objective, but scientists are human, too. Sometimes scientific data can be misinterpreted or misapplied by scientists who want to prove a particular point.

Recommendations made by scientists with personal biases may or may not be in the **public interest**. But if enough of us understand science, we can help make certain that science is applied in ways that **benefit** humanity.
Understanding and Using Science

Don’t just _memorize_ today’s scientific facts and ideas. Instead, try to _understand_ how scientists developed those ideas. Try to see the _thinking_ behind the experiments and try to pose the kinds of questions scientists ask.

Understanding science will help you be comfortable in a world that will keep _changing_, and will help you make complex decisions that also involve cultural customs, values, and ethical standards.
Understanding biology will help you realize that we humans can **predict** the **consequences** of our actions and take an active role in directing our future and that of our planet.
Understanding and Using Science

Scientists make recommendations about big public policy decisions, but it is the Voting citizens who influence public policy by casting ballots.

In a few years, you will be able to exercise the right to vote. That’s why it is important that you understand how science works and appreciate both the power and the limitations of science.
1.2 Assessment

What does it mean to describe a scientist as skeptical? Why is skepticism an important quality in science?

He or she questions existing ideas and hypotheses. Scientists need to refuse explanations without evidence.
1.2 Assessment

What is peer review?

The process by which scientific papers are reviewed by anonymous, independent experts.
1.2 Assessment

An advertisement claims that studies of a new sports drink show it boosts energy. You discover that none of the study results have been peer-reviewed. What would you tell consumers who are considering buying this product?

There is no guarantee that the studies meet scientific standards.
1.2 Assessment

How does use of the word theory differ in science and in daily life?

In science, theory means a well tested explanation. In everyday usage, theory means an idea or a hunch.
1.2 Assessment

A study shows that a new pesticide is safe for use on food crops. The researcher who conducted the study works for the pesticide company. What potential biases may have affected the study?

Science must take societal issues into account. Many questions cannot be answered by science alone and need input from society.