Grade 10 NTI Day #4 Biology

Assignment: Please read the following excerpt. Then answer the questions below.

Quick Lab — Guided Inquiry

Replicating Procedures

1. Working with a partner, assemble ten blocks into an unusual structure. Write directions that others can use to replicate that structure without seeing it.
2. Exchange directions with another team. Replicate the team's structure by following their directions.
3. Compare each replicated structure to the original. Identify which parts of the directions were clear and accurate, and which were unclear or misleading.

ANALYZE AND CONCLUDE

1. **Evaluate** How could you have written better directions?
2. **Construct an Explanation** Based on what you have learned in this investigation, explain why it is important that scientists write procedures that can be replicated.

Start Here

Peer Review Scientists share findings with other scientists by publishing their hypotheses, experimental methods, results, and analysis in scientific journals. Papers submitted to these journals are reviewed by anonymous, independent reviewers who work in the same field. Reviewers look carefully for mistakes, oversights, unfair influences, or fraud, in techniques and analysis. Their goal is to ensure that articles meet the highest standards of quality. This process is called peer review. ***Publishing articles in peer-reviewed scientific journals allows researchers to share ideas. It also allows other scientists to evaluate and test the data and analysis.*** Peer review does not guarantee that a piece of work is correct, but it does certify that the work meets standards set by the scientific community.

Sharing Knowledge and New Ideas After research has been published, it enters the dynamic marketplace of scientific ideas. How do new data fit into existing scientific understanding? For example, the finding that growth of salt marsh grasses is limited by available nitrogen sparks more questions: Is the growth of other plants in the same habitat also limited by nitrogen? What about the growth of different plants in similar environments, such as the mangrove swamp shown in **Figure 1-7**? These logical and important questions leads to new hypotheses that must be independently supported or rejected by controlled experiments.

READING CHECK **Explain** Why is it necessary for other scientists to evaluate the findings of scientists in their field?

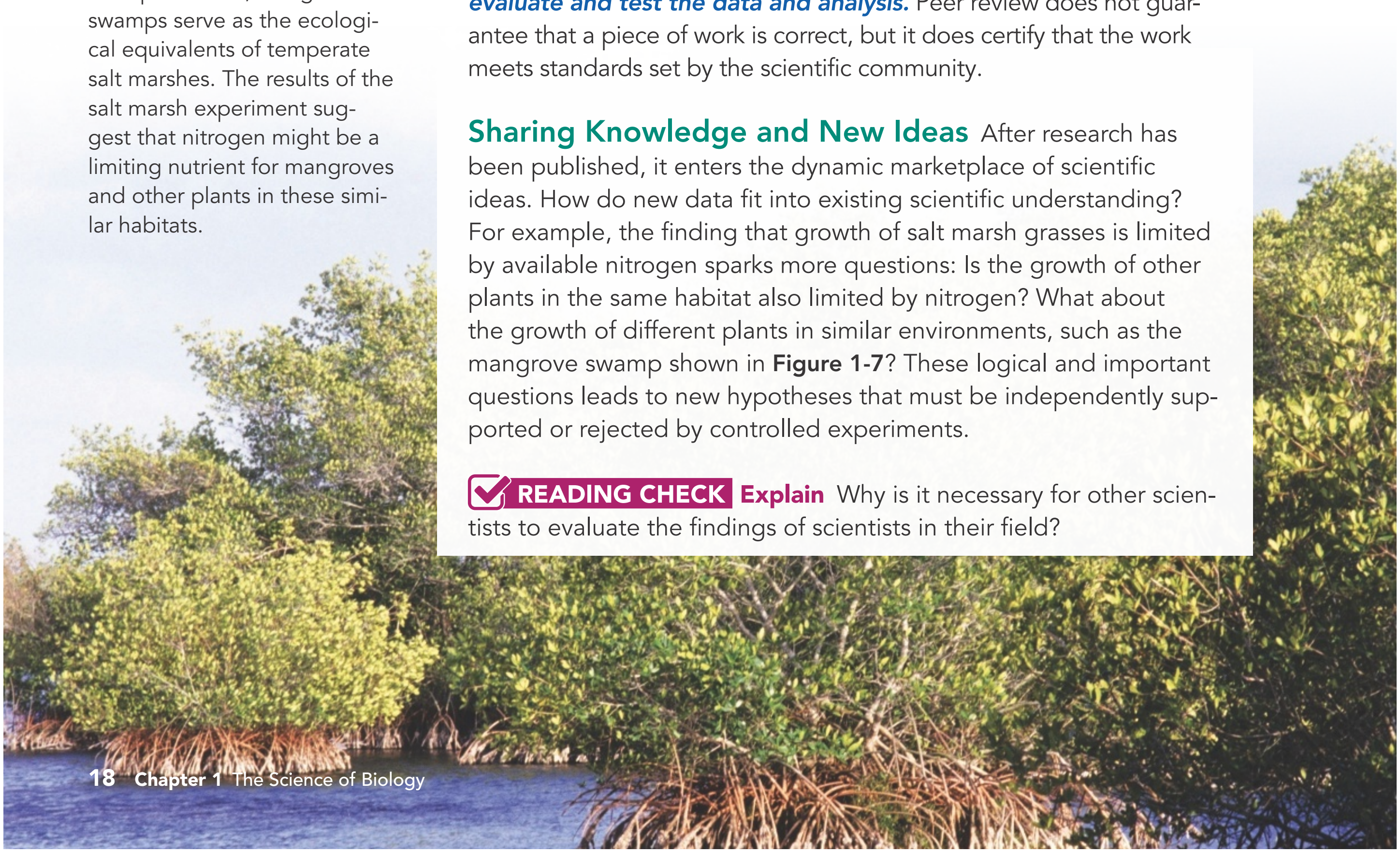


Figure 1-7

Mangrove Swamp

In tropical areas, mangrove swamps serve as the ecological equivalents of temperate salt marshes. The results of the salt marsh experiment suggest that nitrogen might be a limiting nutrient for mangroves and other plants in these similar habitats.

Benefits and Outcomes

Scientists, engineers, and scientific information interact constantly with our society, our economy, our laws, and our moral principles, as shown in **Figure 1-8**. Think of medical issues relevant to your life and the lives of others close to you. That list may include effect of drugs and alcohol, high blood pressure, diabetes, AIDS, cancer, and heart disease. Science and engineering also play an important role in guiding decisions about health, social, and environmental issues. Should communities produce electricity using fossil fuels, nuclear power, solar power, wind power, or hydroelectric dams? How should chemical wastes be disposed of?

As journalist Dan Rather wrote in a *Scientific American* blog: "In the end, science is about hope; it's about expanding our horizons, and endeavoring to understand more. It is an instinct so deeply human, and an instinct we need now more than ever." (Copyright Scientific American, A Division of Nature America, Inc.)

CASE STUDY

INTERACTIVITY

Design a solar still using the engineering design process as it relates to science.

Science, Ethics, and Morality

Useful answers to these questions require scientific information. But science alone is often not enough. In most cases, science and engineering can only tell us what is technically possible, or what we *could* do. Science and engineering alone can almost never tell us whether we *should or should not* do something. ***Applying scientific information involves understanding the role of science context in society and its limitations.***

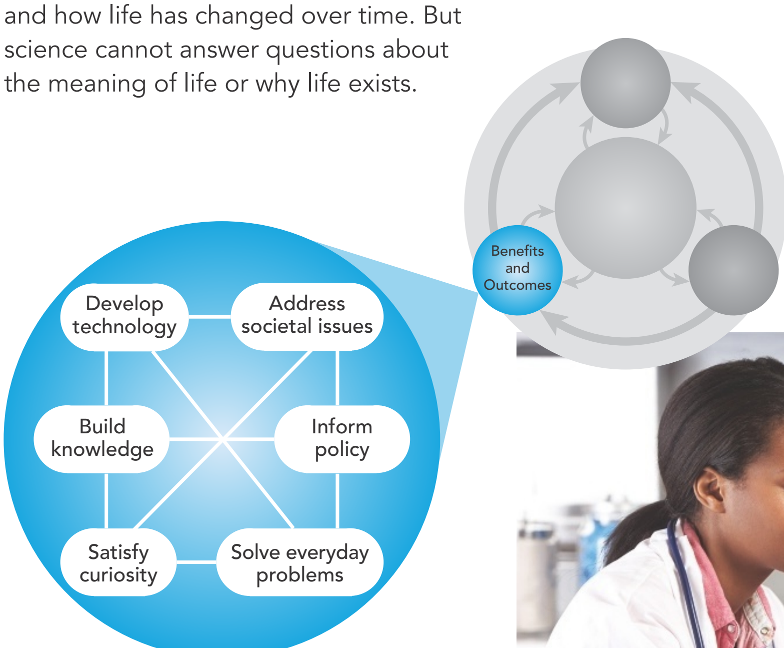
Science by itself does not automatically include ethical or moral viewpoints. When scientists explain "why" something happens, their explanation involves only natural phenomena. For example, biologists try to explain in scientific terms what life is, how life operates, and how life has changed over time. But science cannot answer questions about the meaning of life or why life exists.

CASE STUDY

Figure 1-8

Benefits and Outcomes

Science both influences society and is influenced by society.



Adapted from *Understanding Science*, UC Berkeley, Museum of Paleontology

INTERACTIVITY

Learn how the science and engineering practices are similar.

Avoiding Bias Scientists aim to be objective, but they have likes, dislikes, and biases. A **bias** is a personal, rather than scientific, point of view for, or against, something. Examples of biases include preferences for, or against, certain kinds of people or activities.

Given this background, it is no surprise that scientific data can be interpreted in different ways by scientists with different personal perspectives. Recommendations from 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 individuals and society.

READING CHECK **Explain** What might happen if a scientist were biased?

Science and Engineering Practices

In contrast to scientists, engineers design, and build machines and structures. Although this book focuses on the science of biology, many of the methods and practices—the things that scientists and engineers actually do—are very similar. As a result, when you practice and master science skills, you also are learning skills that are useful in engineering. For additional information about these skills, see the Science and Engineering Handbook.

If you wonder how the "testing ideas" part of science compares to the kinds of things that engineers do, look at **Figure 1-9**. ***Athough some of the specifics vary, the steps in scientific inquiry and engineering design are basically the same.*** Not surprisingly, engineers are trained in basic science as well as the principles of their profession.

Figure 1-9

Experimental Methodology

The experimental methodology used in scientific inquiry and engineering design are adaptations of the same approach to scientific research.

Scientific Inquiry	Engineering Design
Planned or chance observations, and/or personal or outside motivation generate a question	Colleagues and/or clients present a need to be solved through engineering design
Define/refine the question with colleagues/collaborators	Define/refine a design problem that addresses the need with colleagues and clients
Research how others may have answered the same question	Research how others may have solved the same design problem
Brainstorm hypotheses and choose one	Brainstorm design solutions and choose one
Design and conduct pilot experiment to test hypothesis; gather and analyze data	Design and create a prototype/model; test it to gather and evaluate performance data
Modify hypothesis and/or experimental protocol as needed based on analysis of data	Redesign prototype based on performance data
Conduct revised experiment; gather and analyze data	Test revised prototype; gather and evaluate performance data
Draw conclusion, write paper	Finalize design, make drawings
Submit paper for peer review; respond to consecutive feedback	Present best available solution to client; respond to client feedback
Publish the paper!	Build the project!

Developing and Using Models Both scientists and engineers use models, such as those shown in **Figure 1-10**. When you hear the word *model*, you may think of model trains or other representations of much larger objects. But there are many different kinds of models. Mathematical representations and computer simulations are examples, as are two-dimensional drawings, diagrams, and maps. In fact, the flowcharts used throughout this lesson are models. Models help visualize and summarize ideas and communicate ideas to others.

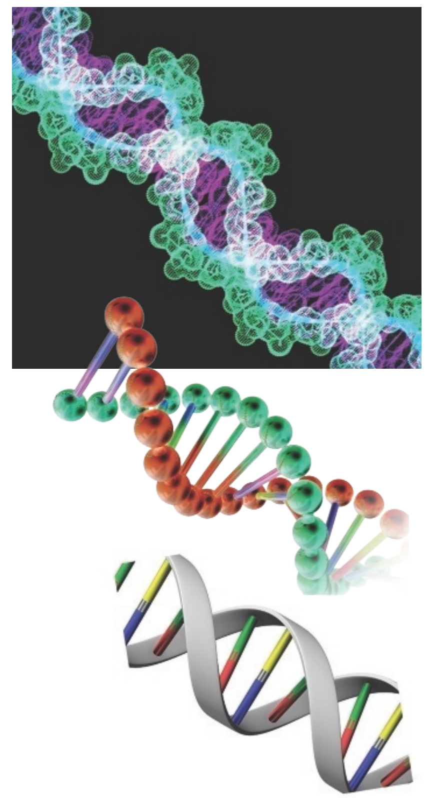
Using Mathematics and Computational Thinking
Mathematics and computational thinking (the process of mathematical calculation) are also important tools. The relationships between variables are essential to the understanding of scientific phenomena. Ratios, rates, percentages, and unit conversions are used to analyze and interpret data. A mathematical representation can represent and model data; it can also support claims and explanations.

Constructing Explanations and Designing Solutions
Scientists aim to construct explanations for events in the natural world that caused them to ask a question. After a scientist collects data, analyzes and interprets that data, and finds that it supports the hypothesis, the next step is to construct an explanation. An explanation describes how variables relate to one another, and it is supported by evidence. In engineering, the goal is to design a solution to a problem within certain constraints.

Engaging in Argument From Evidence In science, an argument is a reason or set of reasons used to persuade others that an idea is right or wrong. Once a scientist has constructed an explanation, the next step is to use evidence (analyzed and interpreted data) to persuade others that the explanation is correct. Part of this process is receiving critiques and responding thoughtfully. Engineers defend claims that a design solution is effective or evaluate competing design solutions.

Figure 1-10
Models

Models can be elaborate pictures that a computer generates (top), physical models, (middle), or illustrations (bottom). All three of these models show DNA, a molecule essential for life.



LESSON 1.2 Review

KEY QUESTIONS

1. How are both curiosity and skepticism useful in science?
2. How can peer review help scientists improve their work?
3. How is the use of science related to its context in society?
4. Why is testing ideas an important part of all science and engineering practices?

CRITICAL THINKING

5. **Apply Concepts** 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?
6. **Apply Concepts** 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?

Assignment: Science, Peer Review, and Society

Multiple Choice (Choose the correct answer for each question)

1. **What is the main goal of peer review in science?**
   a) To make experiments easier to perform
   b) To ensure scientific work meets high standards of quality
   c) To guarantee that scientific work is always correct
   d) To help scientists become famous
2. **Why is it important for scientists to publish their findings in peer-reviewed journals?**
   a) So the public can easily access the research
   b) To allow other scientists to evaluate and replicate the work
   c) To prove that they are the best in their field
   d) To prevent any future modifications to the research
3. **What might happen if a scientist conducting a study is biased?**
   a) The results will be more reliable
   b) The study could influence public policy
   c) The data may be interpreted incorrectly, leading to inaccurate conclusions
   d) Other scientists will automatically accept the results
4. **Which of the following is an example of how science and society are connected?**
   a) Scientific research influencing decisions about environmental policies
   b) Personal opinions shaping scientific conclusions
   c) Science providing answers to moral questions
   d) Society determining what is scientifically possible
5. **What is a key difference between scientists and engineers?**
   a) Engineers are trained in basic science, while scientists only perform experiments
   b) Scientists focus on understanding natural phenomena, while engineers focus on solving practical problems
   c) Scientists build machines, while engineers conduct research
   d) Engineers rely on theories, while scientists test hypotheses
6. **Why is it important for scientific procedures to be replicable?**
   a) So that other scientists can confirm the accuracy of the results
   b) To limit the number of people who can perform the experiments
   c) To reduce the time it takes to publish results
   d) To make experiments easier to understand

Short Answer

7. **In one to two sentences, explain how bias might affect the interpretation of scientific data.**