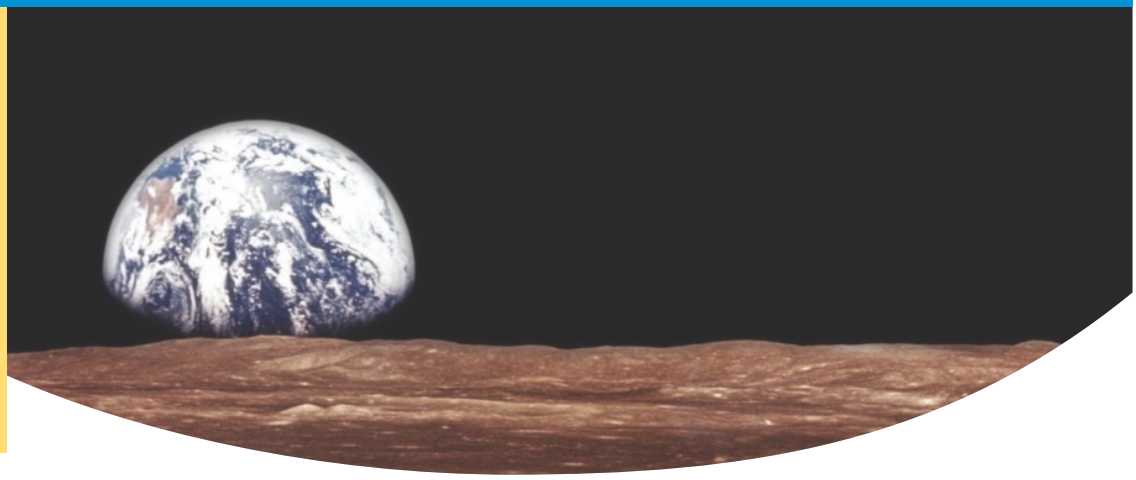
Grade 10 NTI Day #9 Biology

Assignment: Please read the excerpt below as an independent reading assignment. Then read and answer the questions below the excerpt.

LESSON 3.1

Introduction to Global Systems



KEY QUESTIONS

- *Why is ecology important?*
- *What methods are used in ecological studies?*
- *What are biotic and abiotic factors?*
- *How can we model global systems?*

VOCABULARY

biosphere
ecology
species
population
community
ecosystem
biotic factor
abiotic factor
atmosphere
hydrosphere
geosphere

READING TOOL

As you read, use the lesson headings and subheadings to help you organize this lesson into the table in your **Biology Foundations Workbook.**

VIDEO

Watch this video to learn about various sampling techniques.

In the early days of space travel, astronauts made lots of scientific discoveries about the moon and space. That was expected. But they also made some unexpected emotional discoveries when they saw our planet suspended in lifeless space. "We came all this way," Astronaut William Anders wrote, "to study the moon, and the most important thing is that we discovered the Earth." Scott Carpenter added, "It's small. It's isolated, and there is no resupply." Wally Schirra summed it up: "I left Earth three times and found no other place to go. Please take care of Spaceship Earth." How might we care for Spaceship Earth? A good start would be to understand the global systems that shape our planet.

Ecology: Studying Our Living Planet

Astronauts were impressed with Earth's beauty, and with their understanding that our planet is covered with a thin skin of life that biologists call the biosphere. The biosphere includes all life on Earth, from bacteria underground, to trees in rain forests, fishes in the oceans, mold spores floating in the air … and humans. Because all forms of life are tightly connected with their surroundings, the **biosphere** includes all parts of Earth in which life exists.

The Science of Ecology

All forms of life interact with each other and with their environments. ***Ecology is the scientific study of interactions among organisms, populations, and communities and their interactions with their environment.*** The root of the word *ecology* is the Greek word *oikos*, meaning "house." **Ecology** is the study of nature's "houses," organisms that live in those houses, and interactions based on energy and nutrients. *Oikos* is also the root of the word *economics*. Economics studies human "houses" and interactions based on money or trade, energy, and nutrients.

Why Study Ecology? Although economics studies human economy, and ecology studies the economy of nature, those two fields developed independently. For much of history, that wasn't a global problem. Human populations were small and scattered. Our environmental impacts were local. In many cases, human economies could function more or less independently from nature's economy … or so people thought.

Recently we've learned (sometimes the hard way) that economics and ecology are actually tightly linked. As human populations have grown, and as the power of our technology have increased, our impact on local and global environments has also grown. The world is changing around us. As you will learn later in this unit, much of that change is caused by human activity. In the midst of this change in both local and global environments, some economists are discovering what biologists have known for years: Human economies depend on healthy ecological systems for essential needs such as drinkable water and fertile soil.

We need to understand ecology so that we can design human economies that are sustainable—which means that they can function without constantly degrading the environment. We also need to learn to design our economies in ways that offer resilience, which means that they can adapt and continue to function as global ecology changes around us.

Levels of Ecological Organization Ecologists study organisms and their environments on several levels. These levels of organization are shown in **Figure 3-1**. Some ecologists study individual organisms. Others study communities, ecosystems, or the entire biosphere. Ecological studies on a global scale are vital to charting a sustainable course for humanity.

READING CHECK Summarize What is the difference between a population and a community?

Figure 3-1
Levels of Organization

The kinds of questions that ecologists may ask about the living environment can vary, depending on the level at which the ecologist works.

CASE STUDY

Figure 3-2

Studying Environmental Conditions

Scientists gather ecological data in many ways. In this particular experiment, scientists are studying the effects of elevated levels of carbon dioxide on plant growth. Data collected in experiments such as this, can be used to model, make inferences, or apply to larger-scale experiments.

Gathering Ecological Data

Given the wide range of systems and levels of organization that ecologists study, it isn't surprising that their studies may use a wide range of approaches and tools. ***Ecologists generally rely on three main approaches, all of which are part of scientific methodology: observation, experimentation, and modeling. Many studies involve all three approaches, with ecologists using tools ranging from DNA analysis to data gathered from satellites.***

Observation Observation is often the first step in asking ecological questions. Some observations are simple, such as: Which species live here? How many individuals of each species are there in a community? Other observations are more complex: What happens if a particular species is removed from a community? How will organisms respond to climate changes? If these questions are asked properly, they can lead to the development of testable scientific hypotheses.

Experimentation Experiments are designed to test hypotheses by gathering data that support or reject those hypotheses. Some ecological experiments, such as the one shown in **Figure 3-2**, carefully monitor conditions in selected parts of natural environments. This can be difficult to do, because some variables, such as weather, cannot be controlled.

Alternatively, ecologists may design artificial environments, like Biosphere 2. Experiments in artificial environments show how plants, bacteria, animals, or artificial communities react to changes such as temperature, lighting, or carbon dioxide concentration.

Modeling Many ecological processes, such as climate change, occur over long periods of time or occur over areas as large as our entire planet. Ecologists often make models to help them understand these phenomena. Many ecological models consist of mathematical formulas based on data that have been collected through observation and experimentation. Useful models make predictions that lead to the development of additional hypotheses. Those hypotheses, in turn, may lead to the design of new experiments to test them. Additional data may also lead to changes in models that improve their ability to make useful predictions.

READING CHECK Apply Concepts When have you used the skills of observation, experimentation, or modeling? Describe an example of how you have used this skill.

Biotic and Abiotic Factors

When we talk about an organisms's environment, we are referring to all the conditions, or factors, around the organism that affect it in any way. Traditionally, these factors have been divided into biotic factors and abiotic factors.

Biotic Factors Living things affect one another, and are therefore parts of each others' environment. ***A biotic factor is any living part of the environment with which an organism might interact.*** **Biotic factors** important to the heron, for example, might include the fish it eats, predators that eat herons, and other species that compete with them for food or space.

Abiotic Factors Physical factors also affect organisms. ***An abiotic factor is any nonliving part of the environment, such as sunlight, heat, precipitation, humidity, wind or water currents, and soil type.*** For example, a heron could be affected by **abiotic factors** such as water availability and quality, temperature, and humidity.

Biotic and Abiotic Factors Together The difference between biotic and abiotic factors may seem clear. But many so-called abiotic factors are strongly influenced by organisms, which means that they aren't entirely abiotic. Bullfrogs, for example, often hang out in soft "muck" along the shores of ponds. You might think that muck is a strictly abiotic factor, because it contains nonliving particles of sand and mud. But typical pond muck also contains decomposing plant material from trees and other plants around the pond. Muck is also home to bacteria and fungi that decompose the remains of other organisms while using them as "food." That's a lot of "biotic" mixed in with "abiotic"!

READING TOOL

Use **Figure 3-3** to create a Venn diagram listing the biotic and abiotic factors in the pond ecosystem shown.

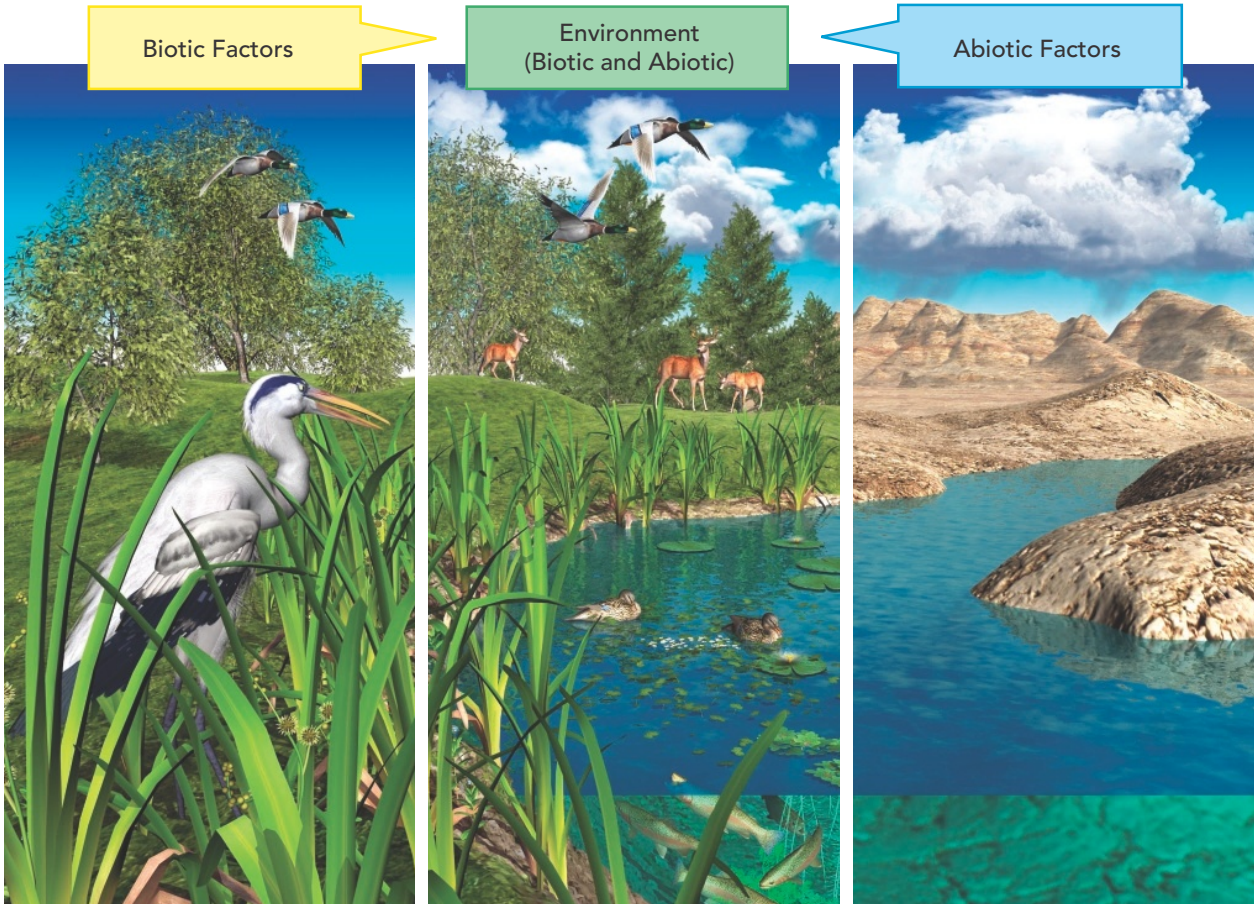
INTERACTIVITY

Measure how various abiotic factors affect organisms in a pond.

Figure 3-3

Biotic and Abiotic Factors

Like all ecosystems, this pond is affected by a combination of biotic and abiotic factors. Some environmental factors are a mix of biotic and abiotic components. Biotic and abiotic factors are dynamic, meaning that they constantly affect each other.



"Abiotic" conditions around a pond's mucky shore are also shaped by organisms. Trees and shrubs around the pond provide shade from strong sun, affecting the amount of sunlight and the range of temperatures the muck experiences. Those plants can also provide protection from dry winds, affecting the humidity of air above the muck. Plant roots determine how much soil washes into the pond during heavy rains. If pine trees grow nearby, decomposing needles make the soil acidic. Decomposing oak leaves, on the other hand, make soil more alkaline.

READING CHECK **Explain** Give two examples of how abiotic factors are influenced by biotic factors.

Modeling Global Systems

A dynamic mix of biotic and abiotic factors shapes all ecosystems—from ponds to global systems. So understanding global ecology is tough! Yet that understanding is vital to humanity's future. How can we handle this challenge? ***One way to understand global systems is to develop a model that shows those systems, the processes that operate within in each system, and ways those systems and processes interact.*** One model, shown in **Figure 3-4** begins by identifying four major global spheres—the biosphere, the atmosphere, the hydrosphere, and the geosphere.

INTERACTIVITY

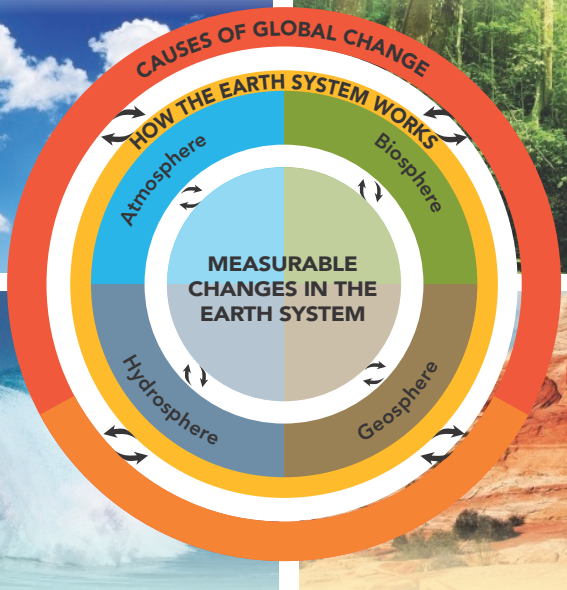
Figure 3-4

Model of Earth Systems

Earth's four global systems are constantly interacting. **Infer** What are some ways that the biosphere interacts with the other three systems?

The **atmosphere** includes all the gases that surround Earth.

The biosphere includes all living organisms and the environments they live in.



The **hydrosphere** consists of all Earth's fresh water and salt water, including water vapor and rain in the atmosphere, water underground, and ice.

The **geosphere** includes all the "usually solid stuff"—rocks, continents, and the ocean floor. Deep inside Earth, portions of the geosphere are liquid.

Global Systems and Change Our model has three main parts, each of which represents a category of ecological concepts and processes. You will see this model referred to throughout this unit.

The model's outer ring, labeled "Causes of Global Change," represents a combination of human activities and nonhuman events and processes that can drive changes in Earth's global systems. In this chapter, we will discuss several nonhuman causes of global change. Human causes of global change will be discussed in Chapter 7.

The model's middle ring, labeled "How the Earth System Works," represents events, processes, and cycles within the biosphere, atmosphere, geosphere, and hydrosphere. This part of the model includes some phenomena we discuss in this chapter, including the global climate system. It also includes cycles of matter, energy flow, and interactions among organisms that we will discuss in later chapters.

The model's inner circle, "Measurable Changes in the Earth System," contains the kinds of changes in global systems that scientists can measure. These include changes in climate, sea level, air and water quality, and so on. We emphasize "measurable changes" to emphasize that these represent data, not hypotheses.

This model, like most models, can't describe everything as accurately as we might like. For example, the hydrosphere includes water that is physically located in the atmosphere and the geosphere. The biosphere as we defined it earlier includes parts of the atmosphere, hydrosphere, and geosphere. Still, as we develop this model, you will see that it provides a useful framework for organizing information, demonstrating cause and effect, arguing from evidence, and examining connections among ecological events and processes. The model includes changes in global systems that scientists can measure, and the effects those changes have on ecological systems, including human society.

BUILD VOCABULARY

Multiple Meanings In geometry, a *sphere* is the shape of a round ball. In terms such as *biosphere* and *atmosphere*, it is a region or area.

INTERACTIVITY

Explore a tundra to learn about the levels of organization, Earth systems, and abiotic and biotic factors that make up this biome.

In Your Neighborhood Lab Open-Ended Inquiry

Abiotic Factors and Plant Selection

Problem What plants will grow well in a garden near you?

For plants to grow, they need the right combination of biotic and abiotic factors. In this lab, you will collect data about abiotic factors in your region. Then, you will plan a garden by selecting the plants that can grow successfully in your area.

You can find this lab online in your digital course.

Visual Analogy

Figure 3-5

The Earth Systems Model as a Jigsaw Puzzle

The earth systems model is similar to a jigsaw puzzle. Each piece of the puzzle represents a different process within the biosphere. As you work through this unit, you will see references to the model and the icons that represent the processes.

Building and Using The Model Where do we go from here in building the model, and how will it be useful? To answer those questions, let's start by saying that you will be learning about a lot of events, processes, and interactions in this unit. If that was all you learned, you would be left with a long list of facts to memorize, without a clear way to understand how those individual pieces of information relate to the way the world works. You would have no way to relate those facts to one another.

In a sense, you would have what you could think of as lots of separate pieces of a very complicated jigsaw puzzle …without a clear idea of how those pieces fit together to form a picture of global systems. It would also be difficult for you to relate individual events and processes to important crosscutting concepts in biology.

That's where the Understanding Global Change model comes in. The model serves as a kind of "information organizer." Whenever we discuss important ecological events and processes, each of them will be assigned a visual icon, like those shown in **Figure 3-5**. Some icons represent processes in Earth's systems. Other icons represent causes of global change. Still other icons represent measurable effects of change. As we learn about these events and processes, we will add their icons to the model in much the same way that you would assemble a puzzle.

As we build the model across the unit, it will help you create concept maps that show how, for example, different aspects of weather and climate influence organisms, and how various causes of global change can affect climate. As you build the model, you can use it to explore connections among causes and effects in global change.

Lesson Quiz

3.1 Introduction to Global Systems

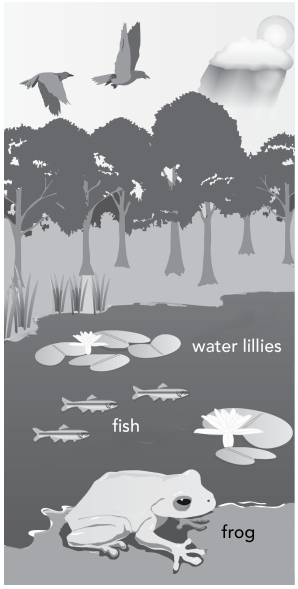
Directions

For multiple choice questions, write the letter that best answers the question or completes the statement on the line provided. For other question types, follow the directions provided.

1. For each missing word, circle the choice that correctly completes the sentence.

Lana concludes that all of the deer in a forest are members of the same **(geosphere / ecosystem / species / hydrosphere)** because they look alike and breed with one another. She observes how the deer **(population / community / ecosystem / biosphere)** interacts with trees, wolves, and other living things of the forest **(population / community / species / geosphere)**.

_____ **2.** The illustration shows biotic and abiotic factors in a pond ecosystem.



Which are biotic factors of the pond ecosystem?

a. fish, water lilies, and frogs
b. pond water and rain that falls on the pond
c. air above the pond, and the pond water
d. the sunlight that shines on the pond

_____ **3.** Scientists generally use three approaches to study ecology. Which is an example of experimentation?

a. counting the number of migrating geese that visit a pond
b. using a computer program to predict the growth of a forest
c. raising ants in terrariums, each identical except for the clay content of the soil
d. observing frogs as they swim across a pond

_____ **4.** Most organisms in the biosphere exchange the gases oxygen and carbon dioxide with the atmosphere. Which of the following describes an exchange of matter between the atmosphere and the geosphere?

a. a volcanic eruption releasing carbon dioxide into the atmosphere
b. carbon dioxide dissolving from the atmosphere into ocean water
c. the remains of living things settling on the floor of the ocean, and then becoming rock
d. water vapor condensing in the air to form clouds

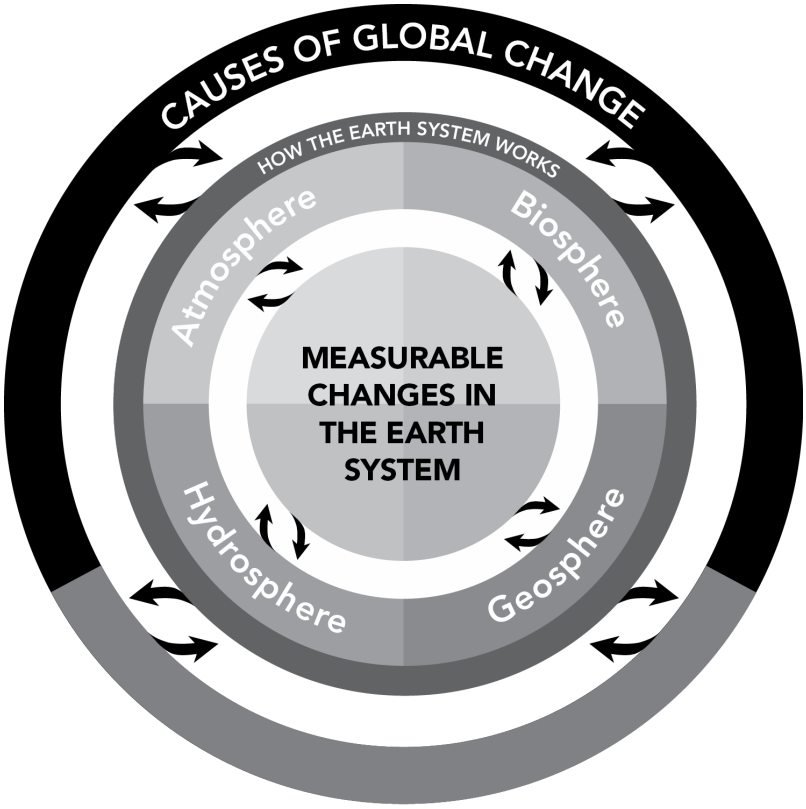
_____ **5.** Which of the following BEST describes the hydrosphere?

a. bodies of water on the surface of Earth, but not the water in the atmosphere or underground
b. salt water in the oceans, but not fresh water
c. water that is underground or mixed into the geosphere
d. water in any location on Earth, including the atmosphere, surface, and underground.

_____ **6.** Harvey is studying the turtles that live in a pond. His knowledge of ecology will be MOST USEFUL for explaining which of these observations of the turtles?

a. The carapace (shell) of the turtle appears to be an extension of its spine.
b. A female turtle lays a clutch of eggs along the shore of the lake, and not in the water.
c. One summer, the size of the turtle population suddenly increases, but then gradually decreases.
d. A turtle may remain underwater for several minutes, but then surfaces for at least a brief moment.

_____ **7.** The diagram is a simplified model of Earth systems and their interactions. The model is used to analyze the causes and effects of global changes to Earth systems, such as changes to Earth's climate.



Adapted from *Understanding Global Change*, UC Berkeley

Which statement BEST explains why the model is useful for analyzing global changes to Earth systems?

a. The causes and effects of global changes involve one Earth system only.
b. The causes of global changes involve two Earth systems, and the effects involve the remaining two Earth systems.
c. Earth systems interact with one another, and the causes and effects of global changes involve all of the systems.
d. The causes and effects of global changes act separately on each Earth system, and the systems do not interact with one another.

_____ **8.** Ecology includes studying ecosystems at different levels. Which is the largest or broadest level?

a. biome **c.** community
b. biosphere **d.** ecosystem