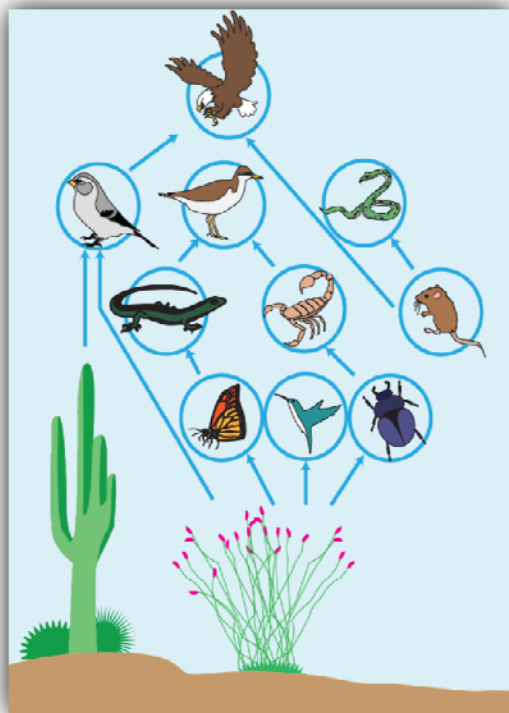


Reflect

How do you respond to environmental changes? Maybe you wear different types of clothes in different seasons. Maybe you only ride your bike during certain times of the year. What if you moved to a much colder part of the world? You would probably need a new set of clothes for the new environment. You would probably have to change some of your daily routines and activities also.

All organisms need to adapt to seasonal changes in their environment. And if the environment undergoes a long-term change, the organisms need to adapt to this new condition as well. In what ways are organisms able to adapt to the changing world?

**Earth's Major Ecosystems**

Successful organisms are able to thrive in the conditions of the **ecosystem** in which they live.

The three largest categories of ecosystems on Earth are

terrestrial, marine, and freshwater. Each ecosystem has specific advantages and disadvantages for organisms. In all of these ecosystems, there are complex interactions and interdependencies among the living systems and the environment. Evidence of such interactions can be found by examining food webs. For example, in the food web on the right, several interactions and interdependencies are shown. The cacti and flowering plants in the ecosystem

ecosystem: all of the living and nonliving components in a specific area

use sunlight to produce their own food through photosynthesis. The butterflies depend on the flowering plants as a food resource. In turn, the butterflies help the plants with **pollination**, a process that must occur for flowering plants to reproduce. The lizards depend on the butterflies as a food source. The hawks and the snakes compete for a resource because both animals depend on the rats for food.

pollination: the transfer of *pollen* (particles that carry male genetic material) from a male organ to a female organ of a flowering plant

Terrestrial ecosystems are the ecosystems found on land. These ecosystems are limited, to varying degrees, by the amount of water available. A few highly adapted desert organisms are able to store water for long periods of time. For example, cacti can store water in their large stems. However, most organisms that live on land are tied to water sources. They must stay close to water sources and travel if a water source they are using dries up. One advantage of terrestrial ecosystems is that the sunlight is not filtered through water. This more direct source of sunlight allows plants to photosynthesize more efficiently, which increases the food available for consumers.



Marine ecosystems are the ecosystems found in salty water such as oceans, seas, and gulfs. Although water is not limited in these ecosystems, obtaining nutrients and food is sometimes challenging for the organisms that live in these ecosystems. Many marine organisms live closer to the surface of the water because there is more access to sunlight and nutrients. Coastal areas, where marine ecosystems meet land, are often heavily populated because rivers bring a source of nutrients.



Freshwater ecosystems are those found in water with little salt content such as lakes, streams, ponds, and rivers. Freshwater ecosystems are generally smaller than marine ecosystems. This limits available *habitats*, the places in an ecosystem where organisms live. Because they have more shoreline, freshwater ecosystems generally have a more ready supply of nutrients than marine ecosystems. The soils along shorelines often contain a rich supply of nutrients that enter the freshwater and dissolve.

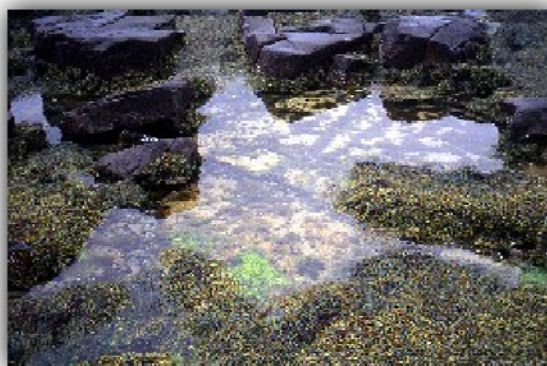


Natural Changes in Environmental Conditions

Organisms are adapted to the general conditions in their ecosystems. For example, land animals have legs for walking and many marine animals have fins or flippers for swimming. Environmental conditions in any ecosystem are not static, meaning they are continually changing. So organisms must also adapt to the changes that occur within their ecosystems.

Seasonal environmental changes require organisms to continually adapt to changing conditions. Adaptations for cold winters may not be useful during hot summers. Some animals, for instance, grow thick fur to adapt to cold winters. These animals must shed their fur to adapt to hot summer months.

Some ecosystems have extreme seasonal or daily fluctuations. Tide pools, like the one shown on the right, are small pools that form when the ocean covers the shore. Tide pools often dry out during low tide. As these pools dry out, the remaining water becomes very salty. Organisms that are adapted to live in tide pools must adapt to both standard marine conditions, high salt conditions, and dry conditions.



short-term environmental change:
environmental change that occurs quickly and affects organisms immediately

Changes in environmental conditions can affect the survival of individual organisms or an entire species. **Short-term environmental changes**, like droughts, floods, and fires do not give populations time to adapt to the change and force them to move or become extinct. (*Extinct* species no longer exist.) Hurricane Katrina caused devastation in Texas and other states in 2005. Millions of people were forced to leave the area. In addition to affecting humans, this short-term environmental change affected many other species. Organisms that could not flee, such as certain reptiles or aquatic species, may have had their population numbers reduced. Organisms that did flee or seek shelter may not have had habitats to come back to. Many plants, including trees, were uprooted or died after being exposed to salt



Forest fires are an example of a short-term environmental change.

Long-term environmental changes are much more gradual and allow populations the opportunity to adapt. For example, natural temperature fluctuations and cycles occur on Earth over thousands of years. These fluctuations may cause changes to an ecosystem that are too gradual to be observed directly. Over time, populations adapt in order to better survive in their changing ecosystems.

long-term environmental change: environmental change that occurs slowly over time and affects organisms over generations

Look Out!

Many species have characteristics to help them cope with natural, short-term environmental changes. These natural changes occur in cycles throughout the history of the species, which allows the species an opportunity to adapt. For example, plants that grow in areas that experience regular, seasonal fires may have a variety of adaptations to help them survive. Some plants are able to regrow from roots that survive the fires. Some plants are so well adapted to fire that their seeds will not germinate into new plants unless they are exposed to fire or smoke!

Humans' Effect on Environmental Conditions

Human activities affect the environment through agriculture, urbanization (the building of cities), use of resources, **pollution** from waste disposal, energy production, and climate change. Many of these activities can permanently alter ecosystems.

pollution: a change in an environment that is harmful to organisms

Oil spills occur when oil pollution quickly enters a natural ecosystem. They are an example of a short-term environmental change. Organisms in the area of the oil spill do not have time to move or adapt and will more than likely be killed. Areas damaged in this way may return to their original state, but often the entire area is affected for a long time after the spill.

Urbanization, or the building of cities, is also a short-term environmental change. Many populations of organisms lose their habitats due to urbanization, as terrestrial ecosystems like forests are cleared to build homes and other structures.



Oil spills are short-term environmental changes caused by humans.

Human activities can also cause long-term environmental change. Many scientists believe that Earth's average temperatures are increasing. One result, many believe, is a change in global weather patterns. Dramatic shifts in seasonal conditions could cause some species to die out. However, because climate change is a slow process, populations may be able to adapt to the new environment. In some cases, populations may increase. For example, increased rainfall in an area may increase insect populations that thrive under moist conditions.

Human activities affect the world around us. As individuals, we can minimize our impact by reducing the amount of materials we use, by reusing items, and by recycling our trash. Larger-scale human activities, like the development of housing and industry, require careful planning to minimize the environmental impact. Builders must consider what happens to the waste generated at the location and where the materials come from.

Changes to an Ecosystem and Genetic Variations

All populations have **genetic variations**. These genetic variations lead to different observable traits, or characteristics, in different individuals within the population. For example, moth coloration can vary from light to dark. The coloration of the moth is important for helping it hide from predators. If trees in the moth's environment have dark-colored bark, then the darker moths are better hidden. Predators will more likely eat the lighter moths. The darker moths will be more likely to survive and pass on their darker coloration to next generation. If trees in the moth's environment have lighter bark, then the lighter moths will be more likely to survive and pass on that trait. This is an example of natural selection, in which populations gradually change over time when a favorable trait is passed on more frequently than a similar but less than favorable trait.

genetic variation:
differences in traits among organisms in the same population or species



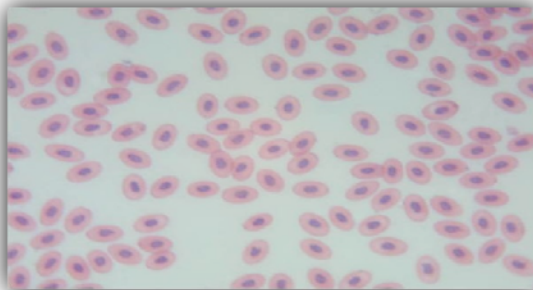
Sometimes the environment naturally changes to make one trait more favorable than another. But, sometimes humans can trigger a change instead. For example, in England during the 1800s, many new factories were built that produced a lot of coal soot. The soot covered nearby trees that originally had light-colored bark. The moth population was also mostly light. The soot-covered bark became darker in color and helped the darker moths hide and reproduce.

Over time, the population of moths changed from mostly light-colored moths to mostly dark-colored moths.

Everyday Life: Adapting to Antibiotics

The discovery of antibiotics in 1928 changed human medicine forever. Antibiotics are medicines that kill bacteria. Patients take antibiotics in order to treat various infections caused by bacteria. However, the overuse and misuse of antibiotics has created a problem – some bacterial populations are becoming resistant to antibiotics. In other words, the antibiotics do not destroy these bacteria as successfully as they once did.

In any given bacteria population, there may be a few individuals that have the trait related to antibiotic resistance. These are called “resistant” bacteria. If a person does not take antibiotics, the bacteria living in that person’s body do not experience antibiotics in their environment. So, the few resistant bacteria will not have any advantages over “non-resistant” bacteria and will not reproduce more than others. So this trait for resistance to antibiotics will not be “favored” and passed on to offspring over time. In other words, the bacteria population will not adapt a resistance to antibiotics.



Bacteria reproduce rapidly, so changes in bacteria populations can occur much faster than changes in other populations.

If a person does take antibiotics, the resistant bacteria will survive and reproduce, while the non-resistant bacteria will die. If this process continues, eventually most of the bacteria population will have the trait for antibiotic resistance.

If antibiotics are taken rarely, the population will not have time to adapt to the antibiotic resistance and the bacteria will be killed. The more often antibiotics are taken, the more chances the bacteria have to adapt and develop a resistance.





What Do You Think?

People spray pesticides on crops to kill insects that eat and destroy the crops. However, these insects are becoming resistant to the pesticides. Is this an example of a natural or human-induced change in the environment? Do you think the insects are adapting to a short-term or long-term environmental change? Explain your reasoning.

What Do You Know?

Take a look at the chart below. The left column lists examples of environmental changes. For each example:

- Identify whether it is a short-term or long-term environmental change.
- Identify whether human activity, natural activity, or both likely caused the change.
- Describe one adaptation that an organism would need to survive in the new environment. Be creative but accurate, there are many possible answers!

Environmental change	Short-term or Long-term?	Human, natural, or both	Sample adaptation
 <p>Flood</p>			
 <p>Toxic Substance Spill</p>			
 <p>Destructive Tornado</p>			
 <p>Melting Glaciers (huge sheets of ice)</p>			

Connecting With Your Child: Visiting Areas Impacted by Humans

To help students learn more about environmental changes and visualize human impacts on an area, visit and compare two areas with different amounts of human interference. For example:

- A strip mall and a nature preserve
- An apartment complex and a park
- A neighborhood and a stream

Students can compare the variety of organisms in each area by counting the number of different types of plants and animals, and then they can compare the abundance of each type of plant and animal in the chosen areas. Have your child bring a notebook or journal to each area and record descriptions of different plants and animals. Working together, try to rate the abundance of each type of plant and animal on a number scale from 1 to 5. For example, if there are only a few water lilies in a pond, rate them as 1. If there are a lot of minnows, rate them as 5. While this type of scale is useful in certain situations (it would be extremely difficult and time-consuming to count all of the organisms in the area), ask students to think about the limitations of using a qualitative scale similar to this one.

Here are some questions to discuss with students:

- What kind of short-term changes did humans cause in each area? Do you think any of them will result in long-term changes?
- Which area has more variety and abundance?
- How healthy do the organisms appear to be in each area?
- Are there any visible adaptations of organisms to each of these areas?