

Glencoe Science

Critical Thinking/ Problem Solving

Life Science



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To the Teacher

Critical Thinking/Problem Solving worksheets in this booklet exercise the students' abilities to apply thinking skills to situations related to concepts presented in the student edition. Students will apply their knowledge to a new situation, analyze the new information, and synthesize in order to respond in a creative way. A series of responses that students might give are provided for you at the end of this booklet.

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Critical Thinking / Problem Solving Skills Correlation

Skill	Activity																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Clarifying issues	✓																						
Comparing and contrasting					✓					✓													✓
Developing a perspective					✓				✓	✓							✓			✓			
Drawing conclusions			✓	✓		✓					✓				✓	✓	✓	✓	✓	✓	✓		
Evaluating information		✓																	✓	✓			
Extrapolating data/information	✓				✓						✓				✓						✓		
Generating and assessing solutions					✓	✓	✓																
Making a hypothesis							✓	✓			✓		✓										
Making predictions or interpretations						✓		✓						✓				✓			✓		
Making judgments				✓									✓	✓									
Observing and inferring			✓					✓		✓			✓	✓					✓				
Recognizing cause and effect			✓	✓				✓	✓			✓				✓					✓		
Recognizing logical thought	✓								✓			✓											✓
Summarizing/synthesizing																	✓						
Recognizing contradictions																✓							



Problem Solving

New Status for an Old Life-Form

Activity

1

When early scientists first began to classify life, they divided it into two kingdoms—the animal kingdom and the plant kingdom. Later, when they began looking at objects under microscopes, they discovered another category of life—one-celled organisms or protists.

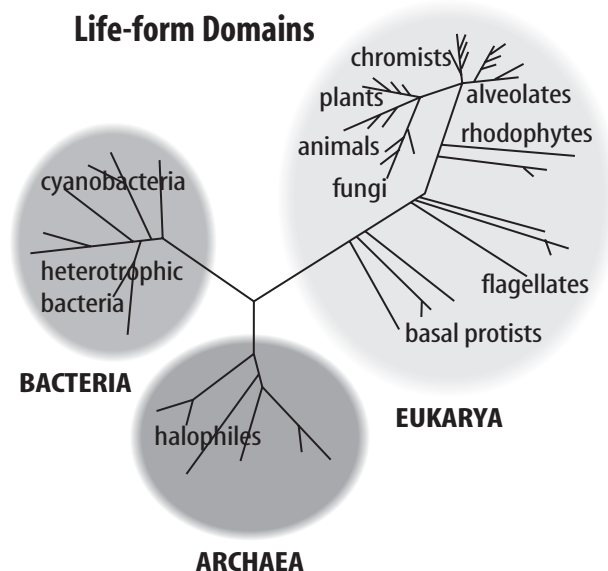
Adding a New Domain

Until recently, all three of those kingdoms fell under just two domains: prokarya and eukarya. Prokaryotes are bacteria or simple-celled organisms that do not have a true nucleus. Eukaryotes are plants, humans, animals, and other cells with a nucleus. However, in 1977, scientists made a discovery that prompted them to add a new domain to the classification system. The life-form that brought about that change is a single-celled organism called archaeabacteria.

For many years, archaea were considered to be bacteria, so they were placed in the prokarya domain. But scientists are discovering there's much more to prokarya than previously thought. For that reason, prokarya is now divided into two separate categories: bacteria and archaea. Instead of two domains, life-forms now are classified into three domains: bacteria, archaea, and eukarya.

Surviving the Extremes

Microscopically, archaea may look similar to bacteria but they are different. Archaea can thrive in many types of environments but are especially suited to survival in extreme habitats. They can live



in hot water and in cold water. They have been found near thermal vents on the ocean floor, 500 m to 600 m below ground, and in icy cold ocean waters around Antarctica. Archaea can adapt to extremely salty water and live in environments with little oxygen. Because of their adaptability to extreme conditions, scientists are considering the fact that similar organisms could be present below the surface of Mars and other planets.

Although scientists' understanding of archaea is still limited, the life processes of these organisms are of interest to more than just scientists. Manufacturers are hoping archaea can lead to improved cold-water laundry detergents, longer-lasting fragrances, and low-spoilage food processing.

Applying Problem Solving Skills

1. Write at least two questions a scientist would want to ask before creating a new domain for an organism.
2. Researchers think that archaea's ability to withstand extreme conditions will make them useful in medicines and other products, such as cold-water detergents. Describe a medicine or product that could benefit from archaea's adaptability to extremes.

**Critical
Thinking**

The Mechanics of Memory

Activity**2**

A concert violinist plays a difficult piece of music. A scientist forms a hypothesis. A toddler takes a few shaky steps and, a week later, is walking steadily. All of these processes—learning, reasoning, and thought—would not be possible without memory.

Getting the Message

Scientists who want to understand how memory works study the brain, nerve cells, and synapses, the pathways between nerve cells. Nerve cells, called neurons, transmit and receive messages throughout the body.

A neuron has three parts: a cell body, dendrites, and an axon. The star-shaped cell body is the part of the cell that contains the nucleus. Branchlike fibers, called dendrites, extend from the cell body and form the dendritic field. The dendritic field receives messages from other neurons and carries them back to the cell body. The axon is a tubelike structure extending from the nerve cell. It is the only part of the neuron that carries information away from the cell body, in the form of chemical signals, to the dendritic fields of other cells.

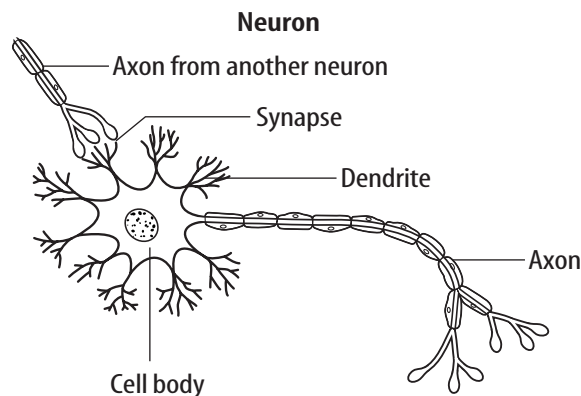
Fine-Tuning Connections

Some research shows that when thoughts or physical actions are repeated over and over, the shapes of neurons change. Axons have tiny fingers that spread out to cover a wide area. One theory is that when a particular message is repeated, these fingers come together. This change in the shape of the axon allows the neuron to work better. Therefore, the more a person

practices hitting a baseball or studies for a test, the more efficiently the information flows.

Synapses also change with learning. Synapses are structures that form junctions between neurons. The messages they transfer cause neurons to become either active or inactive. Neurons take in information from the synapses and then send messages to other nerve cells or to muscles in the body. Early in life, people have many more synapses than they do in adulthood. As people learn, the body prunes, or gets rid of, unnecessary synapses. The ones that remain become stronger and more focused. Throughout our lives, new synapses form as we learn from new experiences.

Most researchers agree that memory is part of a system. For example, if you use your memory to learn the lyrics of a song, more than one set of neurons is involved. One set might help you recall the words, another the tune, and another your feelings about the song. The combination of these messages form your memory.



Applying Critical Thinking Skills

1. How would you explain to a younger student the parts of neurons and how they transmit information? How would you explain the physical changes that take place in a neuron as a result of learning? Form an explanation in your own words.
2. One scientific theory suggests that the shapes of axons change as someone practices or learns more about a particular subject. Give an example of a situation that has occurred in your own life that supports this theory.

**Problem
Solving**

Cloning the Woolly Mammoth

Activity**3**

In 1999, scientists watched as a helicopter pulled a huge block of ice and soil from the ground in northern Siberia. Inside the 20-metric-ton frozen block was an animal that died 23,000 years ago—a woolly mammoth.

More than a Fossil

Many other mammoths have been discovered around the world, but this was the first time that the remains were nearly complete. This particular mammoth, known as the Zharkov mammoth, had been preserved with its skin, hair, and soft tissue—not just fossilized bones and tusks. It was airlifted to the Russian city of Khatanga, where it was stored in an ice cellar to maintain a temperature of -12°C .

Research teams hope that studying the woolly mammoth's remains would give them clues to explain why the animal became extinct. It is possible the woolly mammoth was hunted to extinction, or it might have been killed off by dramatic climate changes, malnutrition, or even a deadly virus.

Secrets Locked in DNA

While these discoveries are important to the scientific community, the real excitement lies with the possibility that scientists might be able to clone the male mammoth. Cloning is the process of producing a genetically identical organism. If DNA can be found in the body cells of the carcass, scientists could try to create a living version of the extinct woolly mammoth.

Because the body is so well-preserved, scientists hope the woolly mammoth's DNA still

exists. DNA has never been taken from the cell nuclei of an extinct species. Scientists don't even know if the DNA could survive more than a few thousand years. The same extreme temperatures that preserved the remains also might have damaged any chromosomes in the mammoth's body cells.

Fragments of mammoth DNA 50,000 to 100,000 years old have been found in other woolly mammoths. These findings allowed scientists to establish the close relationship between mammoths and elephants. The fragments also showed that there were once three subspecies of woolly mammoths.

A New Process

Cloning is unpredictable and has only been done successfully at the cellular level. When a sheep named Dolly was cloned in 1996, it was the world's first clone of a living adult female sheep. Dolly was cloned by taking an egg cell from one adult female, removing its nucleus, and then replacing it with the nucleus from a mammary gland cell from a different sheep.

Some scientists say that this type of cloning could not work on the mammoth without having some of the mammoth's living cells. Still others hope they can retrieve a cell nucleus from the woolly mammoth. If so, they will try to clone it using an elephant egg and an elephant as a substitute mother. If that doesn't work, they might be able to take frozen sperm chromosomes from the woolly mammoth and use them to create an elephant-mammoth hybrid.

Applying Problem Solving Skills

1. If scientists are able to create an elephant-mammoth embryo, what major obstacle might they face in successfully producing a mammoth hybrid?
2. Explain why fragments of DNA cannot be used in the cloning of long-extinct animals.
3. Aside from understanding how the woolly mammoth became extinct, what else might the remains of a 23,000-year-old woolly mammoth tell scientists?



New Hope After a Long Search

If defective genes can cause disease, can replacing those genes with healthy genes prevent disease? Because genes hold the blueprints for the human body, they also hold the codes for many types of disease. For that reason, researchers all over the world are experimenting with DNA and gene therapy to find cures for diseases such as cancer, arthritis, and immune-system-related illnesses.

Replacing DNA

DNA is the chemical in the nuclei of cells that codes and stores genetic information. In 1990, scientists experimenting with gene therapy inserted healthy DNA into children suffering from a rare condition called Severe Combined Immunodeficiency (SCID). Children with SCID have little or no immunity to disease and must live in sterile environments. Scientists hypothesized that the healthy DNA would reproduce and replace the DNA that caused the disease.

By April 2000, after receiving gene therapy, two infants in France with a form of SCID were showing signs of recovery. After one year, their bodies began reproducing the healthy DNA. Many of their symptoms disappeared. Researchers working with the infants must now wait to see how long the positive effects last.

Researchers use several methods to insert DNA into patients. Healthy genes can be transferred into cells by chemicals, by a very tiny

needle, or by attaching genes to certain viruses. Diseases caused by a single gene are the best choices for gene therapy. Single genes can be isolated and reproduced more easily.

Concerns About Gene Therapy

In June 2000, two international teams of scientists completed a basic map of human DNA. Called the Human Genome Project, this accomplishment was viewed as “a revolution in medical science.” Scientists were able to identify and to put in order the 3.1 billion units of biological information that make up the human genetic code.

Gene research is raising many questions, however. Some people worry that the information it reveals could be misused. They fear that if insurance companies or employers find out that a person’s genes might cause a particular disease, then that person might not be able to get health insurance or a job. The U.S. government already has started addressing some of these issues with new laws that prevent companies from denying insurance or employment based on genetic information.

Another concern is that some people might want to change genes that do not cause disease. They might want to produce a baby with high intelligence or a baby with a certain eye or hair color. Many people feel it is wrong to use gene therapy this way.

Applying Critical Thinking Skills

1. While researching the effects of gene therapy on children with SCID, what would scientists have used for their control group?
2. What are some possible advantages of gene therapy over other types of treatment?
3. Do you think the risks of misusing gene research outweigh the benefits? Explain.

**Problem
Solving**

Saving Tropical Rain Forests

Activity**5**

In 1800, there were 2.9 billion hectares of tropical rain forests in the world. There are fewer than 1.4 billion hectares today. In the last 40 years alone, more than 0.4 billion hectares of tropical rain forest have been destroyed. Rain forests contain more than half of the world's animals and plants. Thousands of these plants and animals are found nowhere else on Earth. Once destroyed, they are lost forever.

Nature's Medicine Cabinet

The rain forest also is a valuable source of medicine. In fact, 25 percent to 40 percent of all drugs come from tropical rain forest plants. Scientists have identified more than 2,000 plants that might have a use in the treatment of cancer.

Rain forests play a role in Earth's climate. Sometimes called the "lungs of the Earth," they help filter out excess carbon dioxide in the air which, in turn, helps regulate Earth's temperature.

The Root of the Problem

The world's growing population is responsible for the disappearing rain forests. Businesses cut down trees to sell the wood for construction and for fuel. Farmers burn forests to make room for grazing cattle and for growing crops.

In 1998, 20 percent of Roraima, a state in northeastern Brazil, was destroyed by fires that burned out of control. They were set by local farmers using the "slash-and-burn" method to grow crops during a time of drought in the region. For generations, they have used the same method.

History Offers a Solution

To save the rain forests, some researchers are looking to the past for help. They have learned that ancient civilizations in the Amazon region managed to grow crops without destroying the forest. They did this by clearing only small, circular patches of land. Within a few years, the people stopped planting the area. Then the forest plants, including fruit trees, would begin to grow again and animals would move back into the area.

Some environmentalists would like to see farmers who live in rain forest areas use similar techniques. To slow down the logging of the forests, they are encouraging businesses to create tree farms that can be grown for commercial use and then replanted to be harvested again.



Rain forests filter out excess carbon dioxide in the air and release oxygen.

Applying Problem Solving Skills

1. People who rely on rain forest land to earn a living probably have a different view of the value of rain forests than people who live in other parts of the world. How do you think these two viewpoints might differ? Which group's viewpoints might be focused on short-term goals? Which group would be more interested in long-term goals? Explain.
2. Since 1800, approximately what percentage of the rain forest has been destroyed? If 0.4 billion hectares of rain forest continue to be destroyed every 40 years, how many years will it take before all of the rain forests are gone?
3. What do you think would be the best way to prevent the destruction of tropical rain forests?

**Critical
Thinking**

Waste-Eating Bacteria

Activity**6**

Although some bacteria are harmful, some are useful. In fact, some bacteria can be used to clean up toxic spills and waste sites. When toxic chemicals are spilled or toxic garbage ends up in a landfill, they can contaminate the soil, air, and water nearby. If the toxins are not contained, they can get into the groundwater and contaminate the water you drink. The U.S. Geological Survey, the Environmental Protection Agency, and private companies have found a way to clean up some of these toxins with bacteria. This process is called bioremediation.

In 1987, a company in Pella, Iowa, discovered that three of its underground storage tanks were leaking. The tanks contained penta, a toxic wood preservative. The city's groundwater was in danger of becoming contaminated. The company was eager to clean up the spill and used bioremediation to do it.

Putting Bacteria to Work

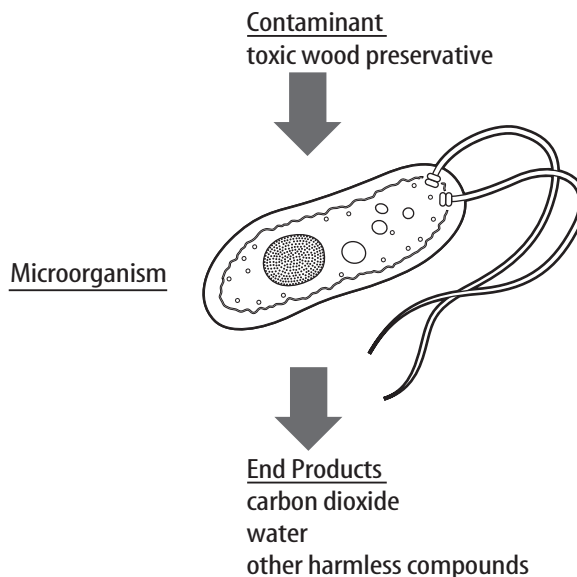
Flavobacteria are a kind of bacteria that love to eat penta. The bacteria eat the penta and leave behind carbon dioxide, water, and other harmless compounds. When the penta are gone, the bacteria die. Within a year, the level of penta in the soil at Pella had dropped by two thirds and still was declining. The cleanup was cheap and quick.

Bioremediation has been used for many years by sewage-treatment plants to clean wastewater. However, scientists still are learning how it can be used most effectively for toxic waste cleanup. The first step in the process is to release the correct type of bacteria at the spill site. Then nutrients important for bacterial growth are added.

Some bacteria used for cleanups already exist in the soil, and scientists need only to add nutrients to the soil to speed the cleanup. If the bacteria don't exist in the soil at the spill site, companies that grow bacteria for bioremediation can supply them. A spill might require a special mix of four or five kinds of bacteria to work.

Not Always Effective

Not all spills can be cleaned up this way. If the temperature is too cold, some bacteria cannot survive. To warm the contaminated soil, it is sometimes mixed with bacteria in a bioreactor. The bioreactor acts like an incubator, keeping the soil warm enough to allow the bacteria to do their job. Even with bioreactors, bioremediation can't work in some clay soils. Furthermore, scientists haven't found bacteria to break down every toxic chemical. Some chemicals are too dense for air to penetrate, and some bacteria need air to survive.



Applying Critical Thinking Skills

1. Name some possible positive effects of bioremediation. Name some possible negative effects.
2. How could bioremediation affect the way companies dispose of toxic wastes?

**Problem
Solving**

Dying Frogs Give Ecological Clues

Activity**7**

In the late 1970s and early 1980s, frogs began to disappear in Australia. It was an epidemic that spread from southeast Queensland up the coast. In 1989, Australia found out it was not alone. At the First World Congress of Herpetology (biologists who study amphibians and reptiles are known as herpetologists), scientists shared stories and realized that frogs were dying in alarming numbers. To date, two amphibian orders, 14 families, and 93 species have been affected.

The nearly 5,000 species of amphibians, including frogs, are said to be nature's warning flags. Their deaths, say scientists, are cause for concern. Because amphibians are more sensitive to changes in the environment, changes in their numbers might be a sign of a more serious environmental problem.

Frog Fungus

Researchers have identified a possible cause, a chytrid fungus. The fungus, which lives in the superficial layer of the frog's skin, coats the belly and underside of the legs. Scientists can't always see the fungus on frogs. Sometimes it turns bright red, but usually it just sits there, waiting to kill.

The fungus is fatal only to adult frogs. Tadpoles are not affected. They can, however, carry the disease. Scientists believe the fungus attacks the keratin protein in frogs. Because tadpoles have keratin only in their mouths, it doesn't affect their breathing ability. After metamorphosis, keratin becomes part of the frog's

whole body. Frogs breathe and take in water through their skin, particularly their undersides. As the fungus spreads, it kills them either by suffocating them or by releasing a toxin.

Is there more than one cause?

The fungus probably is not the only thing causing frogs to die throughout the world. Climate changes, pollution, and increased ultraviolet radiation due to the thinning of the ozone layer each might have an effect. However, frogs in protected areas, like rain forests and zoos, are dying, too.

In the United States alone, the fungus has infected amphibians at the Bronx Zoo, the Philadelphia Zoo, and the Shedd Aquarium in Chicago. In Yosemite National Park, three of seven native frog and toad species have disappeared. Deaths in parks, zoos, and wetlands are more likely the result of a global problem like fungus, rather than a local problem like water pollution.

Of all the places in the world facing this problem, Australia remains the hardest hit with 46 species infected so far. Worldwide, scientists continue their research. Much more needs to be done, including confirming that the fungus is, indeed, the cause of the declining frog population. Scientists also want to gain a better understanding of the life cycle of the fungus and its ability to spread. They also want to work with DNA to identify how many strains of the fungus exist. Until then, conservation methods are being put in place in an effort to maintain what's left of the frog population.

Applying Problem Solving Skills

1. How might the frog fungus be spreading to remote and protected areas like rain forests, wetlands, and zoos?
2. What kinds of conservation efforts might be used to help maintain the frog population?

**Problem
Solving**

Using Photosynthesis to Reduce World Hunger

Activity**8**

Billions of research dollars are spent each year on the problem of world hunger. One solution might lie with photosynthesis. Photosynthesis is the process by which plants use energy, carbon dioxide, and water to produce food. Photosynthesis, however, is not efficient. Even plants considered to be extremely good at the process store only about one percent of the solar energy they receive. Scientists believe that by improving the process of photosynthesis, they can increase crop yields.

A Key Enzyme

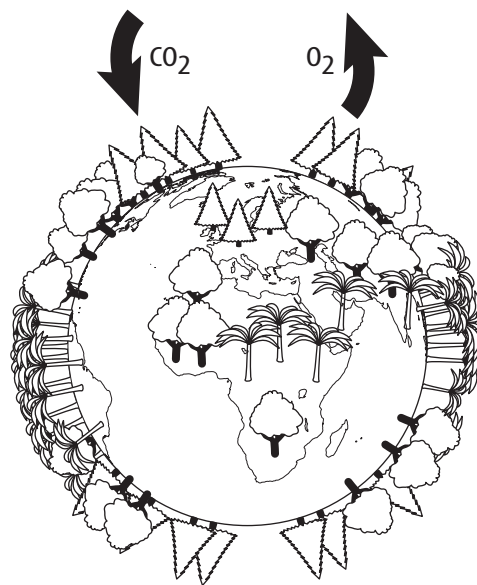
The RuBisCO enzyme is the target of much of the research. RuBisCO captures carbon dioxide and helps convert it into starches, sugars, and other compounds. Even though RuBisCO is the world's most abundant protein, it is slow and inefficient.

Recently, scientists found a more efficient form of RuBisCO in red algae. If they can replace the RuBisCO in some plants with the more efficient form, or if they can change it to resemble the red algae type, then photosynthesis might become more efficient. With improved efficiency, grain and other crops could be produced at a faster rate.

Some researchers say that there is no proven connection between increased photosynthesis and improved crop yields. Other researchers claim to have increased wheat yields by as much as 10 percent to 12 percent in a two-year period—just by temporarily boosting the process of photosynthesis.

Looking at Alternatives

Although improving the process of photosynthesis seems to hold promise for solving world hunger, scientists are a long way from making it work. In the meantime, other researchers are working on different ways to improve the efficiency of photosynthesis. One process is called “supercharging.” This process forces large amounts of carbon dioxide into a plant’s cells to make photosynthesis more efficient.



Speeding up the process of photosynthesis could increase the rate at which crops are produced.

Applying Problem Solving Skills

1. Photosynthesis requires light, carbon dioxide, and water. Do you think that improving the efficiency of photosynthesis could make up for a lack of one or more of these elements? Explain.
2. Besides increasing crop yields, what other advantages could improving photosynthesis provide?
3. Assume that more efficient photosynthesis means increased crop yields. What would happen if photosynthesis became too efficient?

**Critical
Thinking**

Rescuing Endangered Plants

Activity**9**

Did you know that many plants in the United States are endangered? More than one in ten native plants are at risk. Currently, 735 species of plants in the United States are on the endangered list, and well over 100 species are candidates for being placed on the list.

Borrowing from Native Plants

One reason scientists want to save native plants is for their potential use as crops. Most North American food crops were brought here by European settlers. These foods aren't native to North America and often are not resistant to diseases and pests common here. This is where wild species come in.

If a food crop, such as potatoes, is threatened by a disease, scientists can turn to the wild species for traits that make it naturally disease resistant. They can crossbreed the potato with a native plant to get a type of potato that is more resistant. Crossbreeding commercial crops with native crops also can produce a hardier plant that is not as susceptible to insects. This allows farmers to rely more on organic farming, or farming without pesticides.

One plant that grows in the United States that is becoming extinct is the wild rice plant. The wild rice plant lives on the bank of a single stream in Texas. Botanists are interested in this particular plant because it can survive drier

and hotter conditions than most other types of rice plants. Such traits might be needed if Earth's average temperature continues to increase. Even in the short term, these traits are necessary in central Texas where drought is not uncommon.

Another threat to native plants is the spread of genetically engineered crops. The crops, called biotech crops, are genetically altered to be resistant to insects, diseases, and fungi. If the seeds from the biotech crops pollinate with other plants, such as weeds that surround the crop fields, the weeds could become even more aggressive and threaten fragile native species. In one study, wind-carried pollen caused biotech seeds to create hybrid plants 91 m away from the original crop.

Weighing the Benefits

Although most experts see value in saving native plants, there is argument over the cost of saving them. Some experts say the diversity of plant species must be preserved for the health of the planet. Others say the cost for saving each plant is so high that people must determine its possible value before society pays the high cost of saving a species. In addition, some seed companies and farmers do not want to give up what they see as the money-saving potential of biotech crops.

Applying Critical Thinking Skills

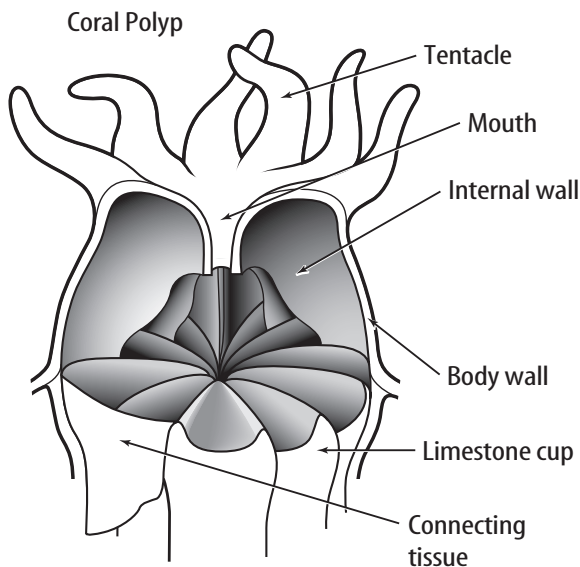
1. Saving wild plant species is expensive. Do you think the government should spend its limited resources to save native plants? Explain your answer.
2. What do you think about saving only those plants that might have a possible use to humans? Give reasons for your answer.
3. Why could weeds that crossbreed with biotech crops become more aggressive?

**Critical
Thinking**

Coral Reefs at Risk

Activity**10**

Coral reefs are one of the ocean's most beautiful and practical wonders. Reef colonies are home to large numbers of plants and animals. Even though reefs cover only two percent of the ocean floor, they contain nearly 25 percent of the ocean's species. The reefs also protect shorelines from erosion.



Years in the Making

Coral reefs are built over thousands of years by coral polyps and tiny, single-celled algae. The coral take in the algae and the algae carry on photosynthesis inside the coral. The algae help the coral change calcium salts in seawater into a hard calcium carbonate structure that makes up a reef. After the polyps die, they leave deposits of this hard substance. Living polyps build on these deposits.

Even though coral reefs appear to be hard, they are fragile. Corals must have warm seawater to live in, but not too warm. They are found in tropical areas of the world. The water they live in also must be clean. If it isn't, their feeding tentacles can be clogged by sediment. Corals also need sunlight for the process of photosynthesis, so they cannot survive in water more than 150 m deep.

Threats to a Fragile Ecosystem

More than one quarter of the world's coral reefs have been destroyed by pollution, tourism, overfishing, and the forces of nature. Tourists who take pieces of coral or buy it for souvenirs contribute to reef destruction. Boats pollute the water with petroleum products, sewage, and litter. Overfishing also upsets the balance of the reefs. Boaters crash into the reefs, and swimmers often bump or stand on the coral, causing it to weaken. Waves caused by hurricanes can cut through them. Higher water temperatures over time, possibly due to global warming, also have been blamed for coral damage.

Many national and international groups are working to save the coral reefs. However, in some nations, such as Indonesia, at least half of the reefs are already gone. In parts of the Indian Ocean, rising water temperatures already have destroyed 90 percent of the coral reefs.

Applying Critical Thinking Skills

1. Coral animals depend on algae to help them build reefs and obtain food for growth. How might the algae benefit from living inside the coral polyps?
2. Tourism and activities, such as fishing and diving, can help support a nation's economy. Should residents take more steps to protect the coral reefs even if it will hurt their economy? Why or why not?
3. Some scientists compare the loss of coral reefs to the loss of rain forests. How are the consequences similar?



Critical Thinking

Afraid of Snakes?

Activity

11

Although many people are afraid of snakes, only about 8,000 people in the United States are bitten by venomous snakes each year. Of those bitten, about 12 to 15 people die.

Most Snakes Not Poisonous

Of the many species of snakes in the United States, only about 20 are poisonous. These include rattlesnakes, copperheads, cottonmouths, and coral snakes. Rattlesnake bites are serious, though rarely fatal. Snakebites usually occur the most between April and October in the southern and southwestern states.

Most venomous snakes in the United States, are called pit vipers. Their name stems from the deep pits located in their cheeks between their eyes and nostrils. The pits are heat receptors that help the snakes detect their prey and gauge how much venom to use to kill it.

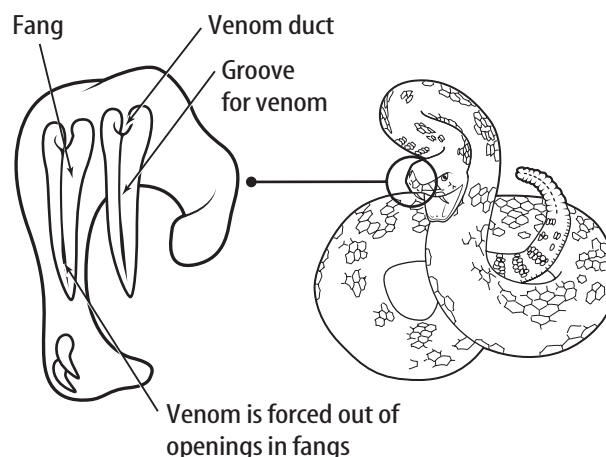
Exercise Caution

The safest way to avoid a snakebite is to practice caution. Step on a log, rather than over it. If a snake is on the other side, it will hear you and have time to move. Lift stones, wood, or other objects on the ground with a stick instead of your bare hands.

When camping, set up your tent in a clearing and do not gather firewood in the dark. If you must walk around at night, use a flashlight and wear boots. When hiking, do not put your hands or your feet in places that you cannot see, such as the crevices of rocks or brush-covered holes.

Nature's Masquerade

Many harmless snakes have defenses that might trick you or their predators into being afraid of them. The North American hognose snake is



Poisonous snakes have hollow fangs connected by a narrow tube to a venom duct.

one harmless snake that is able to make itself look fierce. When threatened, it flattens its head and neck until it looks much larger than it really is. Then it opens its mouth to discourage its enemies. If this trick fails, it rolls over onto its back and plays dead.

Some harmless snakes frighten their enemies with behaviors that resemble those of poisonous snakes. The king snake and rat snake vibrate their tails against dry leaves to mimic the sound of a rattlesnake. The markings on a harmless scarlett king snake are similar to those of the poisonous coral snake.

Snakes are an important part of Earth's ecosystem. They help control the number of rodents, and therefore control the spread of diseases carried by rodents. In most cases, snakes will bite humans only when attacked, surprised, or injured. Most slither away when approached or stay hidden to avoid human contact.

Applying Critical Thinking Skills

1. What role does venom play in the survival of venomous snakes?
2. To avoid being bitten by a snake, what clothing would you suggest that someone wear while hiking in the woods or on rocky terrain?
3. If so few deaths are caused by poisonous snakes, why do you think so many people fear them?

**Problem
Solving**

Global Warming and Migration Patterns

Activity**12**

A spectacular scene unfolds in many parts of the world each spring and fall. Birds, by the thousands, begin their long flights to their seasonal nesting grounds. Birds migrate mainly because the availability of their food changes with the seasons.

As they make their semiannual journeys (some over thousands of miles), migrating birds must find places to eat and rest along the way. They might stay in a habitat for several days before continuing their trek. Birds look for habitats that provide a plentiful source of food, as well as safe resting places in forests, fields, or on water.

Detour Ahead

Bird scientists, known as ornithologists, fear that global warming might threaten the temporary habitats that birds have come to depend on during their migration. Higher global temperatures could cause coastal flooding and destroy feeding areas and habitats.

Global warming also might cause a major change in migration routes. If global warming destroys traditional feeding centers, birds will need to go outside their regular migration routes to find food to replenish their reserves and complete their journeys.

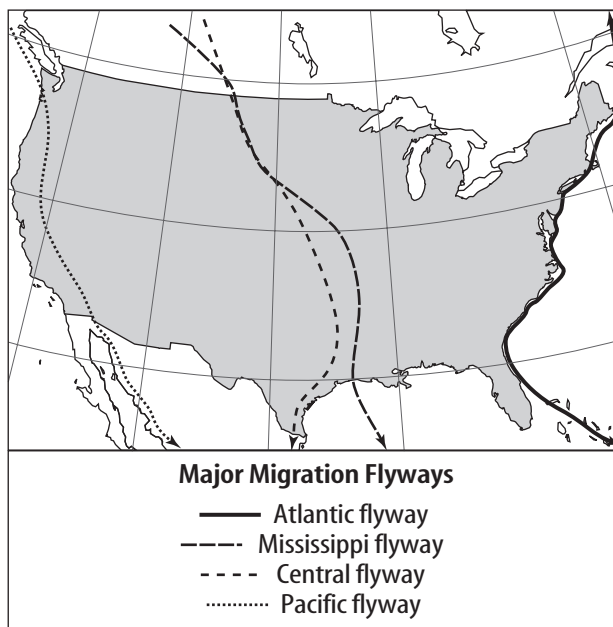
Experts also are concerned that a delay in finding food might mean birds will have less time to mate. This could result in a decrease in the population of some species.

Adapting to Survive

Some birds already are beginning to adapt to climate changes. On the East Coast of the

United States, some birds are making longer layovers on their routes to find food. In central Europe, some migratory birds are delaying the start of their migration. Britain's and Finland's finch populations are moving farther north, and some of Europe's thrush population have stopped migrating altogether.

Some scientists fear that global warming is occurring at such a fast pace that some species might not be able to adapt quickly enough. This could reduce the size of bird populations and possibly lead to the extinction of some species.



The four main North American migration routes, or flyways, run north and south along coasts, mountain ranges, and river valleys.

Applying Problem Solving Skills

1. Why do you suppose bird migration patterns usually follow coastal areas, mountain ranges, and river valleys?
2. How might a change in migratory routes affect the ecosystems that existed on the old migratory routes? The new migratory routes?

**Critical
Thinking**

The Everglades—Protecting a Delicate Balance

Activity**13**

In the early part of the twentieth century, when rainwater and springwater filled the creeks and lakes around Orlando, Florida, the water emptied into the Kissimmee River. It flowed south into Lake Okeechobee before spreading across the flat, wide-open land. The sheet of slow-moving water was 80 km wide but only a few centimeters deep. It eventually created the Everglades, a shallow river system that flows into the Gulf of Mexico. The Everglades was a thriving ecosystem rich with crab, fish, alligators, and wading birds.

Everglades National Park was established in 1947. One of its main purposes was to provide a safe haven for the many kinds of South Florida wading birds. Aside from the American alligator, the wading birds of the Everglades were the most-watched creatures in the park. At one time, the Everglades was home to 2.5 million wading birds. Yet, even though they were protected in a national park, the number of South Florida wading birds decreased dramatically—by an estimated 90 percent.

Draining the Life Out of the Everglades

In the 1950s and 1960s, a series of canals and levees were constructed in this area. They were built to prevent flooding and to drain large areas for farming and development. Billions of liters of water were pumped into the Atlantic Ocean and the Gulf of Mexico. This severely disrupted the ecosystem of the Everglades. Less water meant fewer nutrients to support the animals and plants that lived there.

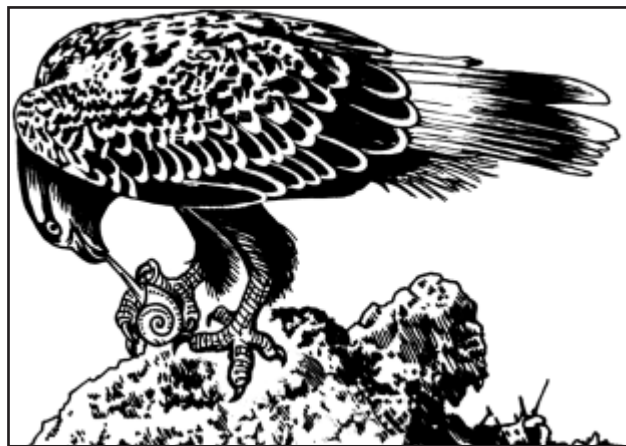
The changes in the water flow also affected the levels of salt in the water. Some species were able to tolerate the salty water and salty food; others were not. Aquatic plant life died. Fish, such as the sheep's head minnow, sailfin molly,

and marsh killifish, were able to survive in the salty water. However, they couldn't survive without the food and shelter previously provided by aquatic plant life that had disappeared.

Wading Birds Move On

Without these fish to feed on, the wading birds moved to other areas. Many moved to Louisiana where water levels stayed constant and they could find enough fish to eat. As a result, alligators and other animals in the Everglades lost some of their food supply.

Then, in the mid-1990s, record rains restored the flow of freshwater in the Everglades. The Everglades almost reached the level it had been at before construction of the canals and levees. Biologists studied the new conditions. They found that vegetation, fish, and invertebrates like crabs, spiders, and dragonflies returned. Unfortunately, the new supply of freshwater had no effect on the wading birds. Scientists still are doing research to find out why these birds are not returning to the Everglades.



Lower water tables reduced the population of snails, which are the primary food source for Everglades snail kites.

Applying Critical Thinking Skills

1. Why did the inflow of freshwater from above-average precipitation cause vegetation, invertebrates, and fish to return to the Everglades?
2. How did the plants and animals of the Everglades reveal to scientists the state of the ecosystem?
3. Make a hypothesis about why the wading birds are not flocking back to the Everglades. Then explain how you might test your hypothesis.

**Critical
Thinking**

The Human Body in Space

Activity**14**

Since the beginning of the space program, NASA has been monitoring the bodies of animals and humans to see how they react to extended periods in space. Space does have some negative physical effects on astronauts, as NASA already knows.



U.S. astronaut Ellen Ochoa plays her flute while floating weightless in space.

Weightlessness Takes a Toll

The circulatory system of astronauts is affected in space. On Earth, the heart pumps blood more forcefully to the upper body than to the lower body, where gravity helps the blood flow along. In space, the heart continues to pump the blood more forcefully to the upper body without the balancing force of gravity pulling the blood to the lower body. This uneven blood flow causes astronauts' faces to become puffy and their lower bodies to become thin.

The shape of the spine also changes in space. Without the force of gravity pushing the vertebrae closer together, the spine stretches out and causes pain in some cases.

Another system affected in space is the body's balancing system. To balance itself, the brain takes in information from the eyes, muscles and tendons, and a set of sensors (called the vestibular apparatus) in the inner ear. In space, the only balancing information that can be relied on comes in through the eyes, so astronauts have difficulty moving around.

The most serious problem for astronauts, however, is bone loss. In space, the bones lose minerals such as calcium, potassium, and sodium. The bone loss in the legs can be as high as ten percent, and even exercise doesn't completely solve the problem.

Laboratory in Space

With the completion of the International Space Station (ISS), NASA will be able to study some of the effects of long-term exposure to weightlessness. NASA also plans to expand its studies to better understand how the immune system is affected and how radiation, which is much higher in space, affects humans. Radiation can pose serious health threats, including cancer and neurological damage.

Because people working together on the ISS will be in small spaces for long periods of time, NASA plans to study how working in confined spaces affects astronauts' personalities.

Applying Critical Thinking Skills

1. What does NASA expect to gain by studying the effects of long-term space travel?
2. Do you think an international orbiting space station was a good idea? Why or why not?
3. Describe what you think NASA's space program might be like in 50 years. What types of projects do you think NASA will be working on? What might NASA already have accomplished by then that it has not accomplished now?

**Critical
Thinking**

Are sports drinks beneficial?

Activity**15**

Sports drinks, or glucose-electrolyte beverages, were first developed for athletes to replace body fluids lost through sweat during exercise. Only recently have they become popular among casual exercisers and nonathletes.

Today, consumers are being bombarded with a variety of claims about which sports drink to buy. How do you choose? Are these beverages all the same, or do some provide benefits not found in others? What ingredients, if any, are beneficial?

High-Performance Benefits

When used to replace fluids, sports drinks can provide real benefits for athletes and nonathletes alike. Drinking enough fluid to prevent dehydration has been proven to improve exercise performance. If a person exercises and does not replace the fluid and salt lost by sweating, performance decreases. A loss of body fluid can affect the heart's performance and lower blood pressure. If exercise continues for longer than one hour, replacing carbohydrates, as well as lost fluids, becomes important.

The ideal sports drink contains water, carbohydrates, salt, and other electrolytes. Carbohydrates, in the form of sugars, not only make the drink pleasant-tasting, they also provide energy. To be most beneficial, sports drinks should contain between four percent and eight percent carbohydrates. This helps the body absorb the fluid quickly.

Fluid Replacement

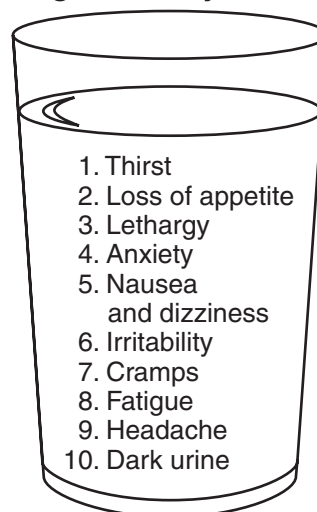
When the body loses water, it also loses electrolytes. The major electrolytes added to sports drinks are sodium, potassium, and phosphate. Sodium is a recommended additive because it increases the absorption of sugar and water and

helps restore the body's volume of plasma. Sodium also helps maintain the natural desire of thirst. And sodium helps the body retain the fluid once it's consumed.

Water, rather than sports drinks, might be a better choice for those who exercise less than 30 min. Fluid replacement is more important than energy replacement in this instance. However, sports drinks are an excellent choice for endurance athletes who need water for hydration plus carbohydrates for energy. Endurance athletes use water to cool themselves during events in high-temperature weather. However, they pour the water over their bodies rather than drink it.

The fluid that athletes and exercisers choose should depend on what tastes good, and the sport in which they are participating. People who exercise always should consume adequate amounts of fluid to maintain peak performance.

Signs of Dehydration



Thirst is a poor indicator of dehydration. Dehydration can happen quickly and have serious consequences. Watch for these signs and protect yourself.

Applying Critical Thinking Skills

1. From a health perspective, why is it important that a sports drink taste good to the person drinking it?
2. During which activities would water be a better choice than a sports drink?

**Critical
Thinking**

More Is Not Always Better

Activity**16**

Most people need to eat foods containing iron to stay healthy. Iron is an important part of hemoglobin, the pigment that gives blood its color. Hemoglobin carries oxygen. In fact, oxygen binds to the iron in hemoglobin.

If you have too little iron, your blood will not be able to carry enough oxygen to your body tissues. As a result, you will have headaches, feel tired, and your heart will beat rapidly in an effort to carry more oxygen to your cells.

Iron Overload

However, for a small percentage of the population, iron is a poison. About 1 million Americans have a condition called hereditary hemochromatosis (HH). Their bodies absorb too much iron from their food and they become overloaded with iron. Most adults absorb ten percent to 15 percent of the iron they consume. People with HH absorb about 30 percent of the iron in the food they eat and about 50 percent of the iron in vitamins.

HH is caused by a genetic defect and is relatively easy to treat. At this time, no cure exists for HH, but early detection and treatment can

prevent serious illness. Unfortunately, many people do not know that they have HH until it has caused serious problems. Nearly 95 percent of HH cases go undiagnosed.

In its early stages, the condition has many different symptoms—fatigue, weakness, sore joints—which could be caused by any number of diseases. Severe symptoms can take decades to show up. In 70 percent of cases, the condition is found in people 40 to 60 years old. That's because many of these patients suffer from liver cancer, heart disease, diabetes, and arthritis. Only during treatment of these diseases do doctors discover the cause—decades of iron buildup from HH.

Early Detection

There is now hope for earlier detection. Some experts suggest adding a test for iron levels to all standard blood tests. One medical testing laboratory recently started testing all blood for iron levels. The Centers for Disease Control and Prevention in Atlanta is working to make early testing for HH a standard practice.

Applying Critical Thinking Skills

1. Hemochromatosis is relatively common, so why do you think doctors sometimes overlook this condition?
2. A diet rich in iron is good for most people. After reading this article, do you think it's a good idea to eat spinach and other foods rich in iron or to avoid them? Explain.
3. One of the most common conditions in the world is caused by too little iron in the diet. Too little iron can lead to anemia, a condition with symptoms similar to some symptoms of hemochromatosis—dizziness, weakness, and headache. To prevent anemia, iron often is added to breads and cereals. But the extra iron is a problem for those with hemochromatosis. Do you think it's a good idea to add iron to foods? Why or why not?

**Critical
Thinking**

The High Risks of Smoking

Activity**17**

Most people are aware that cigarette smoking has been linked to lung cancer in humans. But did you know that the U.S. Department of Health considers cigarette smoking to be the principal cause of unnecessary, preventable illness and early death?

Links to Other Diseases

In addition to lung cancer, the long list of illnesses linked to cigarette smoking includes heart disease; gum disease; mouth, esophageal, larynx, bladder, kidney, stomach, pancreas, and colon cancers; and cancer of the reproductive tissues and organs. Studies show that the risk of colon cancer remains high for people who smoke even decades after they quit. Smokers are ten times more likely than nonsmokers to develop emphysema or bronchitis, and smokers suffer more from asthma and respiratory infections.

Recently, the National Cancer Institute found a link between cigarette smoking and nutrition. They discovered that smokers tend to eat fewer fruits and vegetables and less fish and poultry than nonsmokers. These foods are healthy, contain generous amounts of vitamins A and C, and are thought to be helpful in the prevention of cancer.

Another study showed that smoking increases the risk of death in people with diabetes. The risk of death was especially high for women with diabetes who smoke. Diabetes normally causes people to have a higher risk of heart disease. Because smoking accelerates heart disease, people with diabetes should avoid smoking.

Slower Healing

Doctors who perform plastic surgery have found that patients who smoke suffer more skin loss after surgery than nonsmokers. The nicotine in cigarettes causes the blood vessels of smokers to constrict. The lack of blood circulating in the affected skin doesn't allow it to heal properly.

Many health risks are linked to cigarette smoking, and scientists are continuing to find more. In fact, smoking even poses health risks to those who don't smoke. Environmental tobacco smoke can increase a nonsmoker's risk of heart disease by up to 30 percent.

Tobacco smoke contains more than 4,000 chemicals including:

ammonia
arsenic
benzene
cadmium
carbon monoxide
formaldehyde
hydrogen cyanide
lead
nickel
urethane
vinyl chloride



Applying Critical Thinking Skills

1. Imagine that your friend has been experimenting with cigarette smoking. What facts would you use to persuade your friend to stop smoking?
2. What type of results from skin graft surgery to repair burned skin would you expect in a patient who is a nonsmoker compared to a patient who smokes?
3. With all the health hazards connected with cigarette smoking, why do you suppose people continue to smoke?

**Problem
Solving**

New Hope for Treating Spinal Cord Injuries

Activity**18**

The human body has an amazing ability to repair itself. For nearly a century, doctors, scientists, and researchers believed the central nervous system, however, was unable to repair itself. Now, experts are saying that repairing nerves and nerve impulses—once unthinkable—might be possible in the near future.

Each year, some 10,000 Americans receive spinal cord injuries. Scientists are hopeful that they might be able to treat this once untreatable condition. New treatments, ranging from drug therapy to tissue transplantation, have put researchers closer than ever to understanding nerve growth and repair.

Blueprints for Stem Cells

One of the more promising but controversial treatments involves the use of embryonic stem (ES) cells. Researchers have found that human stem cells from fetal tissue can, under the right conditions, develop into almost any kind of cell needed by the human body. ES cells can be described as “unprogrammed” cells. They can take on the characteristics of just about any type of cell. This means that ES cells have the potential to repair nerves and grow tissues and possibly even entire organs.

If ES cells were turned into nerve or brain cells, they could be used to treat spinal cord injuries as well as other disorders of the central nervous system, such as Alzheimer’s and Parkinson’s diseases. However, because ES cells are taken from aborted fetuses or from embryos made in test tubes, ethical and moral issues need to be considered. As a result, scientists also have

tried using ES cells from mouse, sheep, pig, rabbit, and hamster embryos.

When researchers transplanted ES cells into adult rats with damaged spinal cords, they discovered that the ES cells caused the production of myelin. Myelin is the protective coating that insulates nerves. A nerve whose myelin has been rebuilt might be restored to its full function. For people confined to a wheelchair, that could mean regaining movement of a limb or control over bowel and bladder functions.

Making a Connection

In addition to ES cell research, scientists are looking at ways to encourage injured nerves to reestablish connections with one another. One such experiment involved rats who received inosine, a compound found naturally in humans. The introduction of inosine into the rats caused the regrowth of nerve fibers in four out of five rats. This demonstrated to scientists that the nerves are capable of reestablishing connections. In another experiment, tissue from a pig’s snout was transplanted into a rat with an injured spinal cord. The myelin in the rat’s nerve cells regrew, and nerve impulses were restored.

Many years of research and experimentation lie ahead for each of these treatments. Although moral and ethical discussions must take place in the medical and scientific communities, scientists are encouraged by their rapid progress. For the first time, doctors might be able to offer new hope to patients who were once told they would never walk again.

Applying Problem Solving Skills

1. ES cells have the capacity to become almost any kind of human cell. What other medical problems, in addition to nerve regrowth, might be solved by their use?
2. An estimated 200,000 Americans are paralyzed by old injuries. Might scientists’ new understanding of nerve growth and repair help them? If so, how?



Critical Thinking

More than Skin Deep

Activity

19

Jim Lewis and Jim Springer are identical twins. They both married women named Linda. Both later divorced and then married women named Betty. They gave their first sons the same name and had dogs named Toy. While in school, both liked math and hated spelling. They drive the same kind of car, like to vacation at the same beach in Florida, and both enjoy woodworking. They both bite their fingernails.

What is unusual about these twins is that they were adopted by different families when they were only four weeks old. They didn't grow up together and didn't find each other again until they were 39 years old. Their environments were different, so what caused them to be so much alike?

Heredity vs. Environment

For many years, scientists believed that the environments people grow up in form their personalities. Because most identical twins are raised in the same house by the same parents, their personalities are expected to be similar. However, this theory did not explain how identical twins raised apart could be so similar. It also did not explain how brothers and sisters who were not twins but were raised together could be so different.

Scientists now think heredity might be just as important as environment in forming personality. Scientists at the University of Minnesota have studied about 60 pairs of identical

twins who were adopted by different families as babies and raised in different environments. To their surprise, they found that identical twins raised apart had many similar personality traits.

Because many of these twins had similar personalities, scientists thought it could be a result of their shared genes and not how they were raised. In fact, according to statistics from the study, 80 percent of the traits shared by the twins were the same—from their physical characteristics to their opinions.

Scientists Disagree

The debate over twin studies is intense, however. Factors that influence behavior are complex and difficult to isolate for the sake of studies.

In general, most scientists now agree that there is a genetic basis for intelligence and personality. The debate now centers on what impact environment and personal choices might have on inherited genetic tendencies.

Naturally occurring multiple births	Probability
twins	1 in 80 births
triplets	1 in 6,400 births
quadruplets	1 in 512,000 births
quintuplets	1 in 40,960,000 births

Applying Critical Thinking Skills

- Which do you think is more important in forming personality—environment or heredity? Explain your answer.
- Give an example of a personality trait you have in common with a family member. Is it a result of your environment or heredity? Explain.
- Do all the traits that Jim Lewis and Jim Springer have in common seem to be linked to a genetic factor? Do all the traits mentioned in the passage mean that scientists should study inherited characteristics? Explain.

**Critical
Thinking**

Fighting Disease Through Immunization

Activity**20**

Thanks to vaccines, serious diseases that were once common threats are now under control. Before a polio vaccine was developed, as many as 20,000 cases were reported in the United States. As a result of vaccinations against the disease, only 5,000 cases of polio were documented worldwide in 1999.

Building Up Immunity

Vaccines cause the body's natural immune system to work against the diseases. A solution made from weakened bacteria or viruses that cause disease is injected into the body. The immune system then develops antibodies against the disease. After the required number of booster shots, the vaccinated person is protected from the illness.

The United States requires that all children receive certain vaccines before they start school. Some exceptions are made for families who are opposed to vaccines.

Why Use Vaccines

As with all medications, risks and side effects are associated with vaccines. Common side effects include fever, soreness at the site of injection, and crankiness. Severe side effects are rare and affect less than one percent of people who are vaccinated. The risks associated with disease are much greater than those associated with getting a vaccination.

For example, diphtheria is an infectious disease of the upper respiratory system. Symptoms include fever, sore throat, and tiredness. The disease sometimes can cause heart failure and lead to death.

Polio, mumps, and measles are viral diseases. Polio produces a range of symptoms, the most common of which is paralysis of certain voluntary muscles. Fever, congestion, and a rash are symptoms of measles. Complicated cases of measles can, however, lead to pneumonia and even death. Mumps causes swelling of the salivary glands and, in rare cases, can lead to a dangerous inflammation of the brain.

Haemophilus influenzae type b is a disease that can cause death, permanent brain damage, meningitis, pneumonia, sepsis, arthritis, and skin and throat infections.

Chicken pox (*varicella*) is a highly contagious viral disease. In addition to blisterlike sores on the skin, it can cause skin infections, brain swelling, and pneumonia.

Hepatitis A and B are viral diseases of the liver. Symptoms include yellow skin or eyes, fatigue, nausea, and sore joints (in the case of hepatitis B). The diseases eventually cause severe liver damage or liver cancer.

Applying Critical Thinking Skills

1. Some children are not receiving recommended immunizations. List at least four reasons why parents might not immunize their children.
2. Do you think risks posed by immunizations outweigh risks of the diseases themselves? Explain.



Problem Solving

Invasive Species

Activity

21

In a healthy ecosystem, predators and parasites control the populations of the organisms they eat. When many species are abundant in a community, it is considered stable. But, when a new species is accidentally or deliberately introduced into an ecosystem, it can disrupt the ecosystem's stability. These species, called invasive species, don't have natural predators to keep them in check.

Most invasive species are introduced by humans when they import goods, experiment with non-native species, or empty ballast tanks of ships filled with foreign waters. Invasive species pose one of the greatest environmental threats worldwide and cost the United States nearly \$137 billion a year.

Animal Invaders

The introduction of the sea lamprey to the Great Lakes is an example of what can happen when a new species is accidentally introduced. When the Welland Ship Canal was completed in 1833, it opened a path from the Atlantic Ocean to Lake Erie through the St. Lawrence River. The sea lamprey slowly spread throughout Lake Erie and the other Great Lakes.

By 1960, the large lamprey population killed off many other fish and caused a decline in the numbers of whitefish, sturgeon, and trout. Eventually, scientists began using chemicals to bring the lamprey population under control—at a cost of \$13 million a year.

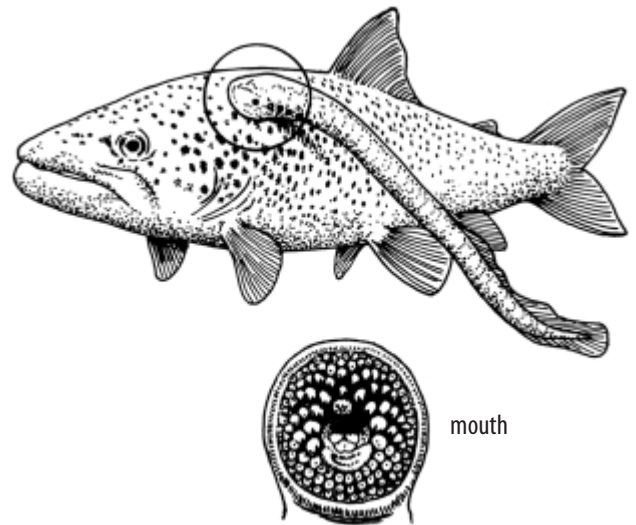
Another example is the introduction of gypsy moths. In 1866, a scientist who was hoping to breed a better silkworm brought gypsy moths to Massachusetts. Today, these moths destroy 4

million hectares of trees each year in southern Canada, the midwestern United States, and Texas. Scientists now are using parasitic wasps and insecticides to try to control the moths.

Plant Invaders

Plants also can disrupt ecosystems. Purple loosestrife spreads across 480,000 hectares of land in a year. Originally imported as an herb, it also was carried here in sheep wool and in the ballast of ships. Kudzu vines, which were brought to the United States from Japan and China, were introduced to help prevent soil erosion. Today, the vines blanket many forests in the southeastern states.

Efforts to combat invasive species include the use of pesticides, the introduction of natural predators, and the restrictions of non-native species.



Sea lampreys attach themselves to fish feeding on their blood and tissues.

Applying Problem Solving Skills

1. In some cases, foreign species have been introduced into ecosystems without disrupting them. Name four things a scientist would want to know before introducing a new species into an ecosystem.
2. What explains the overpopulation of animals such as the lamprey and the gypsy moth?
3. How could the methods that are now being used to control sea lampreys further affect the stability of the Great Lakes ecosystem?
4. What would happen if a tourist visiting the Amazon in South America brought back a piranha and released it into one of the Great Lakes? Would it pose a threat to that ecosystem? Explain.

**Problem
Solving**

Nitrogen Fertilizers— Too Much of a Good Thing?

Activity**22**

It takes a lot of food to feed the 6 billion people on this planet. Thanks to the invention of nitrogen fertilizers, however, more of the world's population now has enough to eat. Nitrogen fertilizers help plants grow and increase the amount of crops that are harvested. The use of all this nitrogen fertilizer, however, can cause some environmental and health problems.

Decades of Runoff

In the 1960s, researchers first noticed lakes and rivers that were suffering from the effects of large amounts of nitrogen. Too much nitrogen results in excessive plant growth in water. Plants such as algae choke out other life-forms that cannot get enough oxygen. Decades later, researchers say nitrogen fertilizers are having a negative effect on forests and coastal waters, as well. Nitrogen washes off farmland and into rivers, lakes, and oceans. Much of the nation's land no longer can absorb or break it down.

In the 1980s, scientists found that well water in a northeastern Iowa community had been contaminated. The water contained dangerous levels of nitrates, a kind of by-product of nitrogen fertilizer. Scientists traced the problem back to the increased use of nitrogen fertilizer by local corn growers.

Corn needs a lot of fertilizer, so farmers were spreading manure on their land, applying nitrogen fertilizer to the crops, and growing legumes every other season. (Legumes, such as soybeans, leave nitrogen in the soil even after harvest.) This triple dose of nitrogen became part of the agricultural runoff that seeped into the groundwater and made the area's well water unsafe.

In addition to making drinking water unsafe, nitrogen can kill water plants and algae. With plants and algae gone, fish and other living organisms that rely on them for food also disappear.

Even though nitrogen is good for plants and helps them grow, too much of it affects the trees and soils of the world's forests. Nitrates in acid rain take important minerals out of the soil. Nitrates also can get into the leaves of the trees. This makes the trees grow, but because the soil lacks necessary minerals, the trees are weak. They become targets for mildew, insects, and disease.

Possible Solutions

Recognizing the dangers of excess nitrogen is the first step in fixing the problem. To help, farmers can rotate their crops. First, they can plant legumes to leave nitrogen in the soil. Then they can plant corn to take nitrogen out of the soil. If farmers plant soybeans one year and corn the next, the nitrogen left by the soybeans lets them use less nitrogen fertilizer during a corn crop year.

Another way for farmers to cut back on the use of nitrogen fertilizer is to monitor the soil carefully. The need for fertilizer changes with weather and crop conditions. If farmers are able to predict nitrogen levels in their crops, they can adjust the amount of fertilizer needed by that crop at different times during the growing season. Because wetlands naturally absorb nutrients like nitrogen, another way to reduce excess nitrogen is to restore the nation's wetlands.

Applying Problem Solving Skills

1. Detail the journey of nitrogen, from application on a farm to runoff in the ocean. Where would it go and how might it affect the environment?
2. Do the benefits outweigh the problems caused by nitrogen-based fertilizer? Justify your answer.

**Problem
Solving**

The High Cost of Wetlands Destruction

Activity**23**

Muddy waste. That's what wetlands look like to some people. So, filling them in and paving them over seems like a good idea, right? Not necessarily. Wetlands are important to the environment. They provide a natural habitat in which wildlife can thrive. They help prevent flooding of farmland and housing communities. They even act as a natural water filter for many environmental and chemical pollutants.

Unfortunately, within a 200-year period ending in the 1980s, 53 percent of the wetlands in the United States were destroyed. Even now, 28,000 hectares to 36,000 hectares of wetlands continue to be destroyed each year.

Loss and Destruction

Major wetland losses occurred during the land development boom from the mid-1950s to the mid-1970s. A federal farm policy now discourages the draining of wetlands for use as croplands, but land development continues. The Army Corps of Engineers, which has the authority to issue permits for the draining and destruction of wetlands, grants 90 percent of all requests it receives.

Large areas of aquatic plant life have been killed off in the Chesapeake, Florida, and Tampa bays as well as in branches of the Potomac River. The loss of coastal marshes is particularly great in Florida, Texas, California, Louisiana, and in the Northeast.

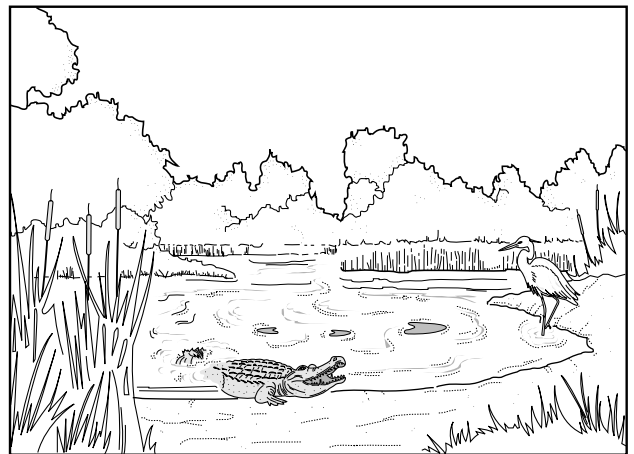
Aquatic plant life is at the heart of the food chain in these areas. Wetland plants, such as arrow arum, pickerelweed, and spatterdock, absorb nutrients and are a source of much-needed food and shelter for the animals, fish, and insects that live there.

In addition to destroying wildlife habitats, the loss of wetlands can increase flooding. Because wetlands store extra water like a sponge, they are better at preventing floods than dams and reservoirs.

A wetlands ecosystem acts as an air and water purifier. Approximately 80 percent of wetlands water comes from agricultural runoff. That water can contain fertilizers, sediment, and other pollutants. Wetlands control these pollutants by acting as a kind of natural filter, trapping sediment and absorbing excess nutrients.

Restoring Nature's Filter

Voluntary programs might help restore these ecosystems and their benefits. For example, the Wetlands Reserve Program pays money to landowners who restore wetlands. As a way to control flooding, the Conservation Reserve Program gives farmers money for not farming or developing parts of their land. Finally, individuals and environmental groups are helping by lobbying Congress and transplanting aquatic plants in wetlands.



Wetlands help to purify air and water.

Applying Problem Solving Skills

1. Compare and contrast manufactured flood control systems such as dams and levees with nature's flood prevention system, the wetlands.
2. What are the benefits of transplanting wetland's plant life?



Activity 1 _____ page 1

New Status for an Old Life-Form

1. **Recognizing Logical Thought:** Students should write at least two questions. Questions might include: How is the organism different from other organisms in the same domain? Can the organism be traced back to any other organism in that domain?
2. **Extrapolating Data/Information:** Answers will vary, but students should take into account that archaeabacteria can withstand high and low temperatures, high salinity, and low oxygen levels.

Activity 2 _____ page 2

The Mechanics of Memory

1. **Clarifying Issues:** Answers will vary. Students should explain in simple language that neurons are made of a cell body, the dendritic field, and axons connected by pathways called synapses. The cell body contains the nucleus. Input occurs in the dendritic field, and messages travel along axons and through synapses to other neurons. With repeated actions, axons come closer together and become more focused. As people grow from childhood, they lose unnecessary synapses so that necessary connections become stronger. Throughout people's lives, they continue to form new synapses as they learn.
2. **Evaluating Information:** Answers will vary. Students should relate to an incident in their lives in which practice or study improved their mastery of a situation.

Activity 3 _____ page 3

Cloning the Woolly Mammoth

1. **Drawing Conclusions:** Although the woolly mammoth and the elephant are closely related, one major obstacle to producing a mammoth hybrid might be the elephant's inability to accept the embryo and carry it to full-term birth.
2. **Recognizing Cause and Effect:** Fragments of DNA cannot be used in the cloning of long-extinct animals because the fragments do not contain cell nuclei, which are necessary to

direct the cell's activities.

3. **Observing and Inferring:** By studying the remains of a 23,000-year-old woolly mammoth, scientists might be able to understand the Siberian environment in which the animal lived. Scientists might be able to tell what the woolly mammoth ate and drank and what it was doing when it died.

Activity 4 _____ page 4

New Hope After a Long Search

1. **Recognizing Cause and Effect:** The control group would consist of children who had the disease but were not treated with gene therapy.
2. **Drawing Conclusions:** It could prevent disease rather than just treat it. It addresses the cause of the disease rather than the effects. A one-time procedure could result in a lifetime cure.
3. **Making Judgments:** Answers will vary, but students should recognize that there are risks as well as benefits to consider. Their answers should examine the overall merits of each.

Activity 5 _____ page 5

Saving Tropical Rain Forests

1. **Comparing and Contrasting; Developing a Perspective:** Students should recognize that people who rely on the rain forest to earn a living are more interested in the short-term goals of earning money and feeding their families. Their needs are more immediate, which would make it more difficult to identify with the long-range effects of their actions. People who do not live in the area probably would be able to focus more easily on the long-term implications because their livelihoods are not directly affected.
2. **Extrapolating Data/Information:** approximately 50 percent; approximately 140 years
3. **Generating and Assessing Solutions:** Answers will vary. Some students will agree that the ancient farming techniques are a possible solution. Others might suggest that more research is needed. Students might suggest that national agencies train farmers to use techniques that do not cause long-term harm. They also might recommend that logging companies research the

Answer Key (continued)

long-term advantages to raising and logging plantations where trees are grown for commercial use.

Activity 6 _____ page 6 Waste-Eating Bacteria

1. **Drawing Conclusions:** Answers will vary. Positive effects: Bioremediation could help clean up toxic chemical spills efficiently without causing any environmental damage. Negative effects: Bioremediation might release disease-causing bacteria accidentally.
2. **Making Predictions or Interpretations:** Answers will vary but could include ways that companies might maintain bioreactors or landfill sites for toxic waste and use bacteria to clean the soil continually.

Activity 7 _____ page 7 Dying Frogs Give Ecological Clues

1. **Making a Hypothesis:** Because the fungus is appearing in remote and protected areas as well as in the wild, it's possible that the fungus is spreading because the frogs are changing their habitat or are being introduced into new environments by humans. Also, if the development of the fungus is related to other environmental factors, such as water pollution or the thinning of the ozone layer, the fungus could be spreading as a result of that factor or factors.
2. **Generating and Assessing Solutions:** Answers will vary. Conservation methods could include keeping frogs in their natural habitat rather than moving them from an infected area to one that might not be infected; cleaning the keratin protein buildup off the frogs; raising tadpoles and introducing them into the wild after their metamorphosis into frogs; continued herpetology research; and developing a fungicide to kill the chytrid fungus.

Activity 8 _____ page 8 Using Photosynthesis to Reduce World Hunger

1. **Recognizing Cause and Effect:** Even if photosynthesis is improved, plants that lack any of these essential elements still would not produce a maximum yield.
2. **Observing and Inferring:** Answers will vary, but students might infer that the quality of

individual crops could be improved, that more crops could be grown in a shorter period of time, or that less fertilizer might be required.

3. **Making Predictions or Interpretations:** If photosynthesis became too efficient, it could mean that ecosystems could be thrown off balance or that some people would have more food than they could use.

Activity 9 _____ page 9 Rescuing Endangered Plants

1. **Developing a Perspective:** Answers will vary. Some students probably will say that it is worth it to save species for future generations and for the role they play in the ecosystem. Others might say that it is more important to spend the money on other worthy causes.
2. **Recognizing Logical Thought:** Answers will vary. Many plants that have no known use now might have important uses in the future. Saving plants that aren't useful to humans is still necessary because other organisms might depend upon these plants for survival. On the other hand, with budget restrictions, some plants might be targeted for saving while others are allowed to become extinct. In this situation, it would be best to determine which plants are likely to be useful in the near future.
3. **Recognizing Cause and Effect:** If the weeds crossbreed with biotech crops that are resistant to pests, for example, the weeds will have fewer natural predators. Without as many natural predators to control their growth, the weeds become even more widespread and could possibly choke out more fragile plants.

Activity 10 _____ page 10 Coral Reefs at Risk

1. **Making Inferences:** Students might say that the algae gain protection and nutrition by living inside the coral polyps.
2. **Developing a Perspective:** Answers will vary. Some students might answer that the economy is more important than protecting the reefs. Others might say that if no efforts are made to preserve the undersea world, there might not be any corals or other plant and animal life left in the future to support the economy.

Answer Key (continued)

- 3. Comparing and Contrasting:** Students should recognize that rain forests, like coral reefs, support thousands of different life-forms. Their destruction can disrupt food chains and result in the extinction of life-forms.

Activity 11 _____ page 11

Afraid of Snakes?

- 1. Drawing Conclusions:** protection from predators; allows them to capture food
- 2. Extrapolating Data/Information:** hiking boots, long pants, gloves
- 3. Making a Hypothesis:** Answers will vary. Students might refer to their appearance, their exploitation in the media, or the fear of being bitten by any type of wild animal.

Activity 12 _____ page 12

Global Warming and Migration Patterns

- 1. Recognizing Cause and Effect:** Migration routes are based on the availability of food for refueling. Coastal areas, mountain ranges, and river valleys provide a seasonal bounty of much-needed food.
- 2. Recognizing Logical Thought:** Answers will vary, but students should realize the impact on food chains that would result from the presence or absence of the birds.

Activity 13 _____ page 13

The Everglades—Protecting a Delicate Balance

- 1. Recognizing Cause and Effect:** High levels of precipitation resulted in significant amounts of freshwater being introduced into the Everglades. When the construction of canals and levees made the water saltier, plants and animals died off or moved. When water became more plentiful and less salty, plants and animals were able to thrive once again.
- 2. Observing and Inferring:** In the case of the birds and plants, the decrease of their populations revealed that the ecosystem was affected. The inability of some species to adapt to conditions, such as extra salty water and shallower water, revealed that the characteristics and amounts of water were critical to their survival.
- 3. Making a Hypothesis:** Hypotheses will vary. Students might deduce that the birds have

reestablished themselves in other areas and will never return. Students should explain how they would test their hypotheses. In this case, they might propose studying the populations of the birds in other states to see if they remain relatively constant. Accept any reasonable hypothesis and test.

Activity 14 _____ page 14

The Human Body in Space

- 1. Observing and Inferring:** Students should recognize that by studying the effects of long-term space travel, NASA will be able to determine what is safe and what is not safe for future astronauts and come up with methods to remedy some situations.
- 2. Making Judgments:** Answers will vary. Some students might say that the space station was a good idea because it supports more space research and encourages international cooperation. Some students might say it was a bad idea because of the expense or because the money could have been spent on other space projects that might seem more useful.
- 3. Making Predictions or Interpretations:** Answers will vary, but students should be creative in their predictions. Answers might include reference to travel to other galaxies, orbiting space cities or colonies, or space travel that is available to everyone.

Activity 15 _____ page 15

Are sports drinks beneficial?

- 1. Drawing Conclusions:** A person will be more likely to drink adequate amounts of fluid and become hydrated if he or she likes the taste of the drink.
- 2. Extrapolating Data/Information:** Activities lasting less than 30 min might only require water to replace fluids, while sports drinks might be more beneficial if the activity requires greater endurance.

Activity 16 _____ page 16

More Is Not Always Better

- 1. Recognizing Cause and Effect:** Because hemochromatosis masquerades as so many different diseases, it is possible that doctors often do not recognize it.

Answer Key (continued)

2. **Recognizing Contradictions:** Although hemochromatosis is a relatively common genetic condition, only about one in 200 people have it. Thus, the odds are that you do not have it and it is better to eat foods rich in iron.
3. **Drawing Conclusions:** Although adding iron to foods can harm some people, it probably does much more good than harm. If people suffering from hemochromatosis are identified and told how to take care of their condition, they can avoid the foods with added iron.

Activity 17 _____ page 17 The High Risks of Smoking

1. **Developing a Perspective; Summarizing/Synthesizing:** Students might list all the health hazards connected with smoking. They might tell their friend they are concerned for his or her health as well as their own, because exposure to smoke places them at risk, as well.
2. **Drawing Conclusions:** Patients who are non-smokers probably would experience greater success from the skin graft. Their blood would have a better chance of reaching the newly grafted skin.
3. **Drawing Conclusions:** Answers will vary but might include addiction, social pressure, or habit.

Activity 18 _____ page 18 New Hope for Treating Spinal Cord Injuries

1. **Making Predictions or Interpretations:** Answers will vary but could include replacement of damaged heart tissue in heart attack victims; improved insulin production in diabetics; creation of human tissue banks; regeneration of skin for burn victims; and treatments for arthritis, multiple sclerosis, muscular dystrophy, blindness, and more.
2. **Drawing Conclusions:** Yes. Because scientists have learned recently that the central nervous system is capable of repairing itself, it won't matter to the body if the injury is old or new. The treatment for old and new injuries using ES cell transplantation will be the same.

Activity 19 _____ page 19 More than Skin Deep

1. **Drawing Conclusions:** Answers will vary but might include that personality is formed by a combination of environmental factors and heredity.
2. **Making Inferences:** Answers will vary. Traits students have in common with family members who do not live with them might be attributed to heredity. Adopted students might attribute their personality traits to their environment.
3. **Evaluating Information:** Students should note that some traits mentioned in the article, such as having wives with the same name, are mere coincidences and are not indicators of inherited traits.

Activity 20 _____ page 20 Fighting Disease Through Immunization

1. **Drawing Conclusions:** Prohibitive cost, religious beliefs, possible adverse reactions to the vaccines, ignorance of the immunization schedule itself and the successive boosters needed for some of the diseases, and the misconceptions that the diseases have been eradicated or are difficult to contract are some reasons parents choose not to immunize.
2. **Evaluating Information:** In most healthy children, the risks posed by the diseases themselves are much more dangerous than the side effects that might occur from the vaccines.

Activity 21 _____ page 21 Invasive Species

1. **Recognizing Cause and Effect:** Answers will vary but might include any four of the following: existence of predators; characteristics of existing plants and animals in that ecosystem; characteristics of new species—diet, mating patterns, resistance to disease, adaptability to climate; or a method to remove the species if necessary.
2. **Drawing Conclusions:** The species that were introduced had no natural predators in the communities into which they were introduced.
3. **Making Predictions or Interpretations:** Students should recognize that the chemicals being used to control the lampreys could affect the

Answer Key (continued)

plants and animals that are native to the area.

- 4. Recognizing Cause and Effect:** Students should deduce that the piranha might pose a short-term threat but that the colder climate would limit its ability to survive.

Activity 22 _____ page 22

Nitrogen Fertilizers—Too Much of a Good Thing?

- 1. Extrapolating Data/Information:** Answers will vary but might include the following: Some of the nitrogen applied to farm soil would likely be absorbed by the crops in the field. Some would stay in the soil, and the rest would become part of the agricultural runoff and flow into nearby water. In water, the nitrogen would provide nutrition for aquatic plants, but it could cause algae to bloom excessively, depleting some of the water's oxygen and killing some organisms.
- 2. Developing a Perspective:** The benefits of a nitrogen-based fertilizer are that it can increase crop yields and can help produce enough food for Earth's population. Problems associated with it can include environmental contamination, water pollution, and the destruction of plants and wildlife. Students should discuss whether benefits outweigh the problems and justify their conclusions.

Activity 23 _____ page 23

The High Cost of Wetlands Destruction

- 1. Comparing and Contrasting:** Manufactured flood control is less efficient and more costly than nature's flood prevention system.
- 2. Recognizing Logical Thought:** Transplanting wetlands plants will help restore the ecosystem. Adding plants where there are none (or replacing plants that don't belong with ones that do) will likely restore the food chain and bring animals, fish, and insects back to the wetland area. Also, the quality of water will improve because the newly transplanted plants can trap sediment and absorb pollutants and excess nutrients.