

Chapters In This Unit:

- 14 Medical Biotechnologies
- 15 Agricultural Biotechnologies





Unit Thematic Project Preview

Discovering Careers in Biotechnology

As part of this unit, you will learn about how biotechnology has improved our way of life. You will also read about the different kinds of biotechnologies, including medical, industrial, agricultural, and marine, along with the interesting jobs in these fields.

As you read this unit, use this checklist to prepare for the project at the end of this unit:

PROJECT CHECKLIST

- ✓ Think of at least two interesting jobs each in medical and agricultural biotechnology. Ask your teacher if these jobs are appropriate.
- ✓ Explore at least two job-search Web sites.
- ✓ Make a list of people you know who might work in biotechnology.

WebQuest Internet Project

- Go to glencoe.com to this book's Online Learning Center (OLC) to find the WebQuest activity for Unit 4. Begin by reading the Task. This WebQuest activity will help you find out about our genetic codes and the Human Genome Project.

Explore the Photo

Technology Meets Science Technologists are closely related to scientists, and sometimes they are the same. Innovations in medical biotechnology are improving the lives of many people. *What innovations in medical biotechnology are in the news?*

Medical Biotechnologies

Sections

14.1 Disease Prevention

14.2 Diagnosis of Disease

14.3 Treatment of Disease

What You'll Learn

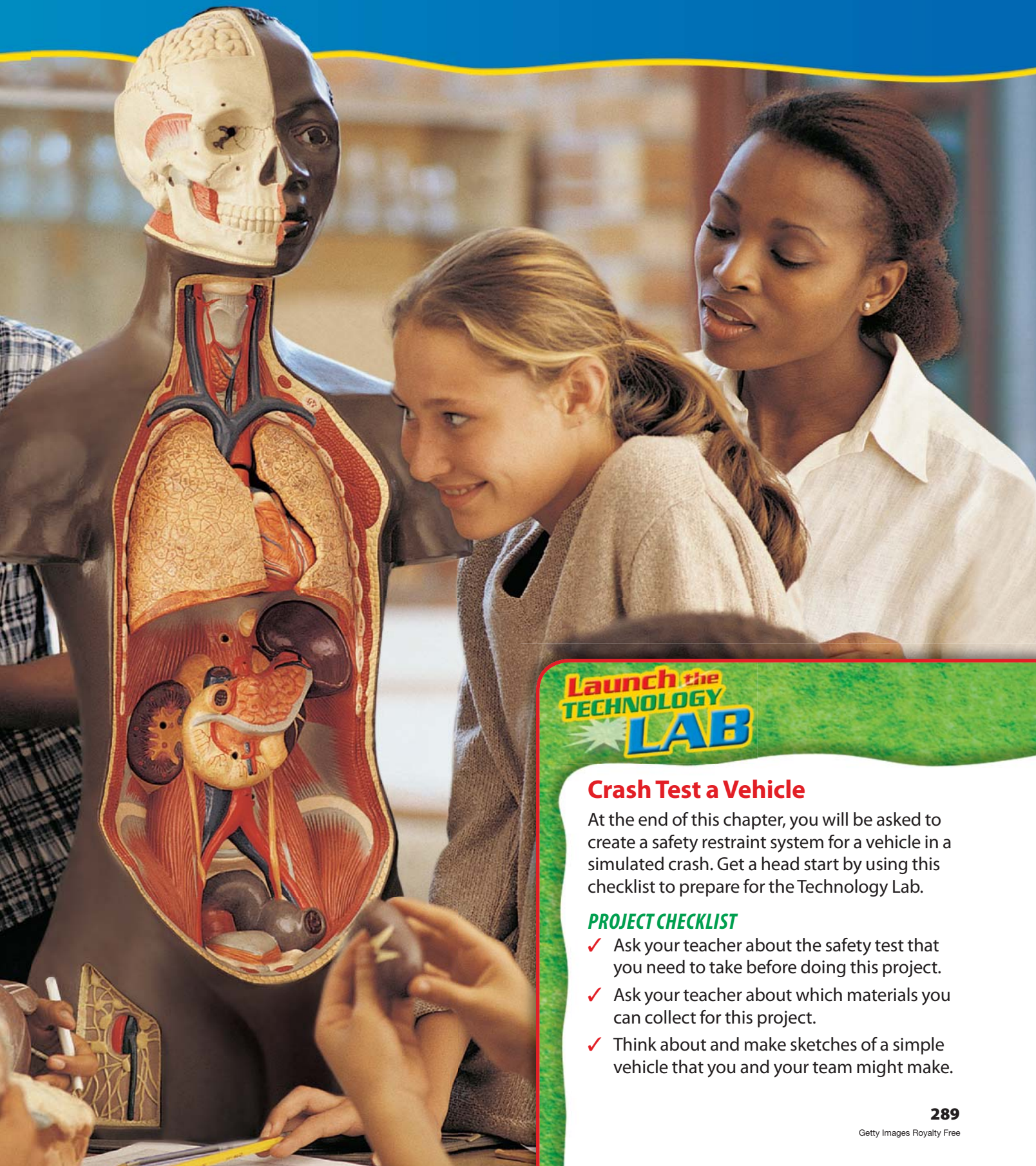
- **Identify** disease prevention technologies.
- **Explain** the difference between pasteurization and irradiation.
- **Explain** how immunization works.
- **Define** genetic testing.
- **Describe** imaging technologies.
- **Identify** tests used to read electrical impulses of the human body.
- **Explain** how antibiotics work.
- **Describe** three types of surgery.
- **Define** genetic engineering.
- **Explain** the purpose of bionics.

Explore the Photo



Exchanging Organs The human body is made up of many different organs. Doctors and medical technologists can transplant some of these organs, including kidneys. They are also learning how to replace hearts and other body parts with artificial ones. *Would this type of organ replacement have a major effect on medicine? Why?*





Launch the TECHNOLOGY LAB

Crash Test a Vehicle

At the end of this chapter, you will be asked to create a safety restraint system for a vehicle in a simulated crash. Get a head start by using this checklist to prepare for the Technology Lab.

PROJECT CHECKLIST

- ✓ Ask your teacher about the safety test that you need to take before doing this project.
- ✓ Ask your teacher about which materials you can collect for this project.
- ✓ Think about and make sketches of a simple vehicle that you and your team might make.

Disease Prevention

Reading Guide

Before You Read

Preview What do you already know about pasteurization?

Content Vocabulary

- pathogen
- pasteurization
- irradiation
- sanitation
- immunization
- vaccine
- ergonomics

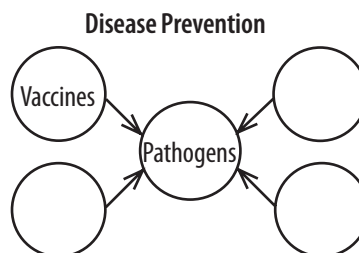
Academic Vocabulary

You will see these words in your reading and on your tests. Find their meanings at the back of this book.

- seek
- ensure

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.



Go to glencoe.com to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

- STL 5** Environmental Effects
- STL 14** Medical Technologies
- STL 15** Agricultural & Related Biotechnologies

ACADEMIC STANDARDS

Science

NSES Content Standard C Structure and function in living systems

English Language Arts

NCTE 1 Read texts to acquire new information.

- STL** *National Standards for Technological Literacy*
- NCTM** *National Council of Teachers of Mathematics*
- NCTE** *National Council of Teachers of English*
- NSES** *National Science Education Standards*
- NCSS** *National Council for the Social Studies*

Medical Biotechnologies

What is medical biotechnology?

When you combine knowledge of technology with knowledge of biology, you get “biotechnology.” Older biotechnologies use microorganisms and other biological substances to produce products. The newest biotechnologies use genetic engineering to create new biological agents not found in nature. Medical biotechnology uses biology and technology for disease prevention, diagnosis, and treatment. The first medical technologists used plant roots, herbs, and superstition to cure disease centuries ago.

As You Read

Identify What are the different ways to prevent disease?

Disease Prevention

How can disease prevention improve health?

If people never got sick, they would not need medicine and other treatments. That is the goal of disease prevention. Preventing disease involves many technologies. Some technologies, such as pasteurization and irradiation, sterilization, and water treatment, **seek** to remove or kill **pathogens**, which are organisms that can cause disease. Pathogens include bacteria, viruses, parasites, and fungi. Other technologies, such as immunization, can help the body stay strong so it can stay healthy.

Reading Check

Identify What is the goal of disease prevention?

Pasteurization and Irradiation

How are pathogens destroyed in foods?

Pasteurization and irradiation kill pathogens in foods.


Pasteurization is a heating process used to kill bacteria that turns milk sour and makes you sick. In 1864, a French chemist named Louis Pasteur developed this process.

Irradiation is also called “cold pasteurization,” because it uses radiation to kill pathogens without heat. Exposing food to X-rays, ultraviolet rays, or gamma rays increases the shelf life of food by killing parasites, insects, mold, and bacteria. Some people fear irradiation might make the food radioactive or change its nutritional value. The FDA and the World Health Organization have 40 years of research that proves irradiation is a safe process.

Reading Check

Connect What process sterilizes milk?



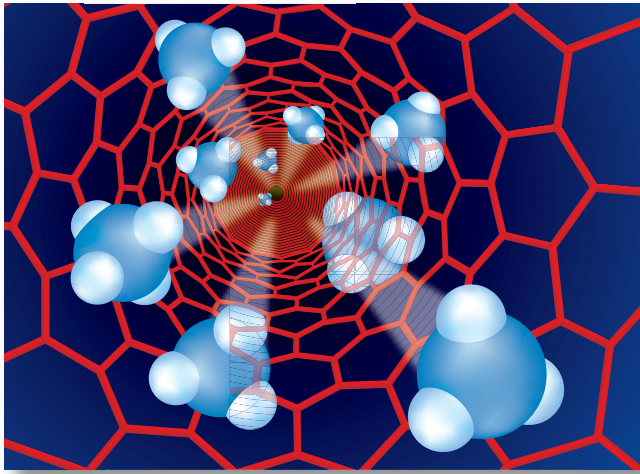
 **Keeping Clean** Doctors and nurses must be as germ-free as possible before performing any medical procedure. *Why might the medical profession warn the public against overusing hand disinfectants?*

Aim Low

Growing livestock, such as cows and chickens, requires a tremendous amount of grain, water, and resources. Eating less meat products and more fresh unprocessed foods, such as fruits and vegetables, which are low on the food chain, can reduce your impact on the environment.

Try This Become aware of what you are eating. Is your meal made of fresh or processed foods? Some ready-made foods are more processed than others. Look at packages and read the ingredients to find out what you are eating.

Figure 14.1 Nano Filtration



Water for Life
Nanotubes are tiny carbon atom tubes. Contaminated water or ocean water can flow out the tube as clean drinking water.
Why could this technology be a water purification breakthrough?

Sterilization

When did cleanliness become important to health care?

Until the late 1800s, doctors performed surgery in their street clothes and did not always wash their instruments or their hands. Hospitals were seldom clean. Pathogens thrived, and many patients died from infections. Joseph Lister, an English surgeon, discovered that infections could be prevented by washing items with disinfectants—chemicals that kill pathogens. The disinfectants he developed saved many lives.

Today medical procedures require sterile (very clean) methods. Surgical instruments are put in an autoclave, a device that uses steam and pressure to kill pathogens. Doctors scrub their hands and wear latex gloves and special garments.

Water Treatment

How is water purified?

Clean drinking water is important to health. Therefore, most local community water supplies are purified before water can pass through the distribution system.

The water may be given several treatments, depending on the quality of the untreated water and the local regulations. Water is pumped through a filtering system that uses sand, gravel, and minerals to filter out any remaining impurities.

Fluoride Treatment

Some communities add fluoride to the water to help prevent tooth decay. Fluoride is a chemical compound that hardens tooth enamel and improves dental health.

Nanotube Technology

The newest water purification technology uses a silicon chip that contains billions of nanotube membranes made of carbon atoms. Each nanotube is 50,000 times thinner than a single strand of your hair. Each nanotube strand purifies water by preventing anything wider than six water molecules from passing through it. (See Figure 14.1.)



List What are some different water treatment methods?

Sanitation

What is sanitation?

Sanitation involves the removal of waste products that could cause disease or contaminate the environment. Public sewage systems dispose of waste from homes, factories, businesses, and public streets.

Consumed water that is used to wash your hands or take a shower is now labeled *grey water*. Some new buildings channel grey water to be reused to water lawns and gardens. Water from toilets is labeled as *black water* and must go through several treatment stages to make it safe for the environment. When waste water from sinks and toilets is not separated, it must all be treated as black water.

Sewage Treatment

At a sewage treatment plant (see the photo below), water is removed from the waste, purified, and released back into the environment. Solid waste is treated to make it safe to transport to landfills or to be burned.

Hazardous Waste

Hazardous (dangerous) wastes from medical facilities require special separate treatment to protect people from harmful organisms and disease. If possible, the waste is treated to make it harmless. Otherwise, it is burned or buried. The proper disposal of medical products contributes to medical safety.



Reading Check

Explain Why is sanitation so important?



Waste Management

This aerial view shows a sewage treatment plant.

Is grey water treated differently than black water when it enters this plant?



Scorpion Venom Fights Cancer

Researchers from Seattle Children's Hospital and Fred Hutchinson Cancer Research Center found a way to eliminate cancer cells using protein from the deadly scorpion. Chlorotoxin, found in a scorpion's venom, combined with fluorescent molecules light up cancer cells. This allows surgeons to clearly see and remove all cancerous material and tumors.

Critical Thinking *Why is it important to remove all cancerous material during surgery?*



 Go to glencoe.com to this book's OLC read more about this news.

Immunization

How do vaccines prevent disease?

Immunization makes the body resistant to a disease by causing the immune system to attack the disease's pathogen. If you are immune to a disease, you cannot catch it or spread it.

History of Immunization

Before modern medicine, people recognized that if you survived certain illnesses, you would not catch the same disease again. Edward Jenner, an English doctor, noticed that people who caught cowpox, a mild disease, seemed to be safe from smallpox, which was often a fatal illness. In 1796, by using killed or weakened cowpox organisms, he created a vaccine for smallpox.

Vaccines do not cause disease, they just stimulate the body's immune system to recognize and attack the pathogen to prevent the disease. A vaccine cannot cure a disease you already have, so vaccines are usually given to you when you are young. Medical biotechnologists have recently developed a vaccine that can prevent cervical cancer.

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Tech Stars

Dr. Jonas Salk

Developer of Polio Vaccine


The paralyzing viral disease known as *polio* was first recognized in 1840. By the 1940s and 1950s, the illness caused panic and dread as epidemics struck in the United States. Over 21,000 cases were reported in 1952. Its effects were crippling. In addition to paralysis, many people had difficulty breathing. Years of research produced no cure or vaccine. But in 1955, a physician and researcher named Dr. Jonas Salk developed a vaccine against the disease.

Dr. Salk became famous overnight for his discovery. He founded the Jonas Salk Institute for Biological Studies in La Jolla, California. There he continued his research on the causes, cures, and preventions of various diseases, including AIDS and cancer.

Not for Profit Dr. Salk did not seek to patent or profit from his discovery. His own words were: "Who owns my polio vaccine? The people! Could you patent the sun?"

English Language Arts/Writing Describe in a few paragraphs how important vaccines are in battling highly contagious diseases such as polio.



 Go to glencoe.com to this book's OLC to learn about young innovators in technology.

Present and Future Immunization

Pharmaceutical (far-mah-SOO-tik-uhl) companies use special technologies to make current vaccines and develop new ones. Their goal is to find a weakened or dead strain, or even a small piece of a pathogen’s structure that will cause an immune response.



The First Shot

Children might not be anxious to go to a doctor to get an immunization. *What is a vaccine?*

Healthier Living

How does good nutrition help prevent disease?

Some diseases are not caused by pathogens. For example, heart disease may be related to unhealthy habits, such as smoking, eating diets high in certain types of fat, or lack of exercise. Proper nutrition helps keep the body strong and able to defeat or survive pathogens and other causes of disease. To keep medical costs down, laws have been passed to prohibit smoking in public places, eliminate trans fats in foods, and curb antibiotic and hormone use in our food.

Many food manufacturers add vitamins and other nutrients to their products to **ensure** that people receive adequate amounts. Major nutrients contained in processed foods are listed on food labels. Manufacturers also add preservatives to foods. Preservatives are chemicals that prevent spoilage.



Reading Check

Identify What kinds of laws have been passed to promote healthier living?



Knowing Your Nutrition

Many food products are labeled with nutritional information. *Why do you think this information is important?*

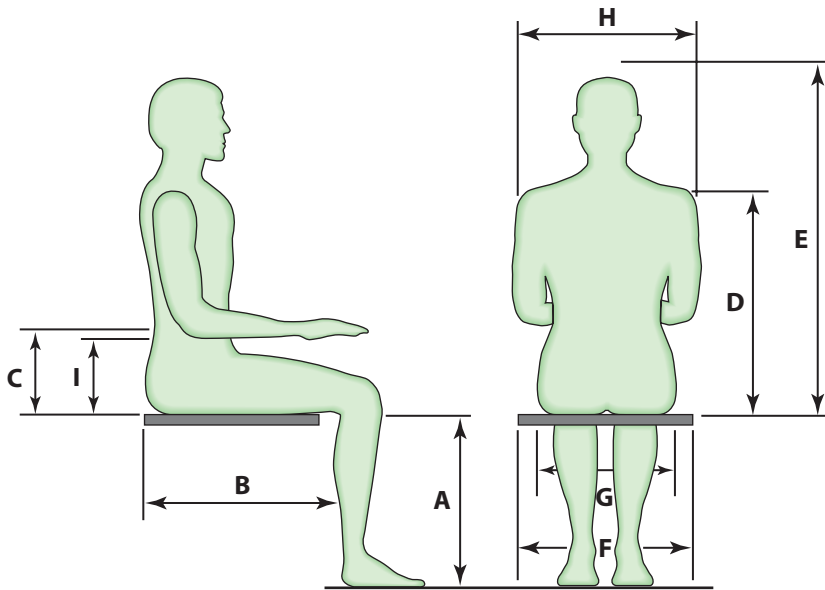
Ergonomics

Why is comfort important to health?

Ergonomics, or human factors engineering, is the design of equipment and environments to promote human safety, health, and well-being. The people who work in this field design products considering people’s limitations and comfort needs. (See **Figure 14.2.**) Have you noticed that certain tools, computer-game controllers, or kitchen utensils are comfortable to hold?



Figure 14.2 Ergonomic Dimensions



The Easy Chair
Specific dimensions are used to ensure the comfort and usefulness of a chair. *What is the relationship between the price of a chair and its level of comfort?*

Ergonomic designers try to produce products that are comfortable to use and easy to control. This is especially important in the workplace where repetitive actions often lead to stress and injury.

Ergonomic engineers also help create life-sustaining environments that are needed by astronauts, deep-sea divers, soldiers, and extreme sports enthusiasts.

section **14.1** assessment

After You Read Self-Check

1. Describe a pathogen.
2. Compare pasteurization and irradiation.
3. Explain how immunization helps the body fight disease.

Think

4. Explain how ergonomics affect human health.

Practice Academic Skills

English Language Arts/Writing

5. Imagine you are camping in the woods near a stream. Describe how you would make sure you had a clean supply of water.

STEM Mathematics

6. A pharmaceutical firm produces a vaccine for animals. 250 vials are produced every day. If about 1 percent of the vials are damaged before they can be used, how many animals can be vaccinated using a 20-day supply of the vaccine?

Math Concept **Multi-Step Problems** Multi-step problems require extra attention to solve.

1. Make notes to help you organize the steps that need to be taken. Start by multiplying to find how many vials are made in 20 days.
2. Reduce that amount by 1 percent to find the number of animals.



For help, go to glencoe.com to this book's OLC and find the Math Handbook.

Diagnosis of Disease

Reading Guide



Before You Read

Preview What is the meaning of the word *diagnosis*?

Content Vocabulary

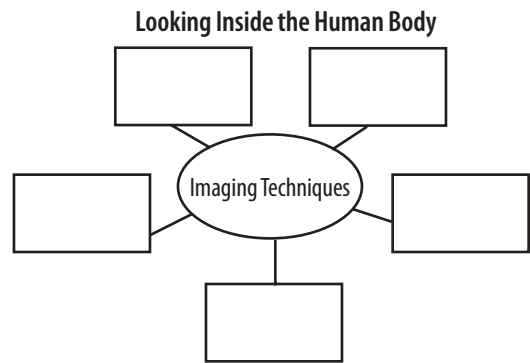
- genetic testing
- CT scan
- ultrasound
- MRI
- endoscope

Academic Vocabulary

- conduct
- internal

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.



Go to glencoe.com to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

- STL 2** Core Concepts of Technology
- STL 3** Relationships & Connections
- STL 4** Cultural, Social, Economic & Political Effects
- STL 14** Medical Technologies

ACADEMIC STANDARDS

Science

- NSES Content Standard E** Understandings about science and technology
- NSES Content Standard C** Reproduction and heredity

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Primary Physician

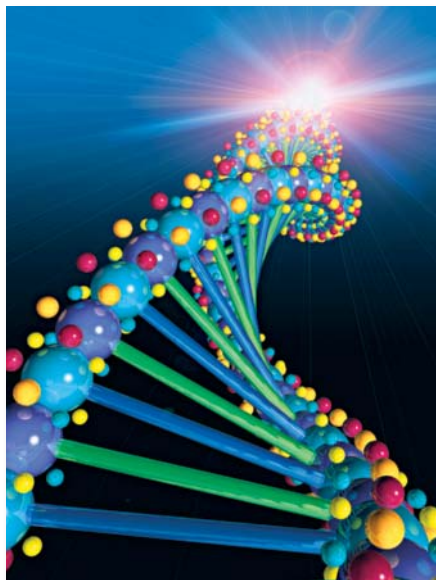
How do doctors diagnose an illness?

Disease prevention often starts with a general check-up with your primary physician. Your doctor will **conduct** some blood and other laboratory tests and use an 1816 medical invention called a “stethoscope” to listen to your heart, stomach, and lungs for abnormal sounds. A diaphragm in the stethoscope picks up the sound vibrations from your body and transmits them to the earpieces.



As You Read

List What are the tools used by doctors to diagnose illnesses?



Laboratory Tests

How does the microscope help diagnose illnesses?

Microscopes make it possible to see pathogens and the cells that make up our bodies. Optical microscopes use lenses to magnify objects up to 2,000 times. Electron microscopes use a beam of electrons to magnify objects.

Using microscopes, doctors and technicians can examine body fluids for pathogens and other signs of disease. Along with other technical equipment, the microscope is an important laboratory testing tool.

Genetic testing is an evaluation to determine if your family has given you a gene that makes you more likely to get certain diseases. In genetic testing, DNA, the carrier of heredity, is examined. If test results say that you are at risk for a particular disease, you might be able to make certain lifestyle changes and reduce your risk of developing the disease.

Life's Code A strand of your DNA carries a lot of information unique to only you. *When would a doctor recommend genetic testing?*



Name What tool is used for lab tests?

Imaging Body Structures

How does an X-ray machine create a picture of broken bones in a person's arm?

Imaging machines can show doctors the inside of your body. The first imaging device was the X-ray machine. Fast-moving electrons give off X-ray radiation. This radiation passes through some parts of the body but not other parts.

Ethics in Action

Genetic Testing


Using just a few drops of blood, health care professionals can determine a person's risk for certain diseases. This is called "genetic testing," and it holds great promise for the future.

Disease Discrimination However, genetic testing has created new ethical questions. What if an employer does not hire a person because he or she is likely to develop a disease? What if an insurance company refuses to insure the person because treatment is too expensive?

English Language Arts/Writing

Facing the Future Each year, 4 million newborn babies in America undergo testing for genetic diseases. Some of the diseases do not have treatments. Should children be tested for diseases that have no cure? Parents and physicians have differing opinions.

1. Do some Internet research on current genetic testing.
2. Write your opinion in a paragraph and present it to your class.

 **CAT Images** This patient is undergoing a CT scan. *During a CT scan, what source of energy penetrates the body? What device converts the scan into images?*




The radiation not blocked by the bones of your body will expose the X-ray film. When the film is developed, your bones appear clear on the picture, and the areas where the film was exposed appear black.

To view places deep inside the body, a CT scan (computerized axial tomography) is used. In a **CT scan**, X-rays gather thousands of measurements of **internal** body structures. The measurements are then processed by a computer and are transformed into detailed images.

Ultrasound imaging bounces sound waves that you cannot hear off the structures inside your body. The reflected echo is interpreted by a computer and transformed into images. Ultrasound is popular for determining whether a fetus (an unborn baby) is developing properly. See the photo below. The newest form of ultrasound produces three-dimensional images.

For an **MRI** (magnetic resonance imaging), the patient is placed inside a magnetic field. As the magnetic field encounters internal body structures, it sends precise measurements to a computer. The measurements are interpreted, and then transformed into images.

 **Inside View** An ultrasound image can see an unborn baby so doctors can check the baby's health. *What else can an ultrasound tell parents?*



 **Reading Check**

List What are some imaging methods?



Magnetic Vision An MRI is another way for doctors to see what is going on inside the body. *When looking for problems in soft tissue, doctors might use an MRI instead of an X-ray. Why?*

To be sure of the diagnosis, doctors sometimes must examine a problem more directly. In these cases, they may use an **endoscope**. An endoscope is a flexible cable with a tiny camera and light. It is threaded into the body through a small incision or through the mouth. The doctor can view the image from the camera on a special screen. Endoscopes are commonly used to look inside a patient's stomach for ulcers and other problems.

Other Screening Methods

What are some other screening methods?

Some machines can read electrical impulses created by the body. One machine can produce an electrocardiogram this way. For an electrocardiogram (EKG), wires are attached to the patient's body, and a machine records the heart's electrical impulses. This information is printed out on a paper chart for doctors to read.

Another similar machine can create an electroencephalograph (EEG), a record of the activity of the brain. By reading the machine's EEG printout, doctors can tell if the brain is functioning properly.

section 14.2 assessment

After You Read

Self-Check

1. Describe genetic testing.
2. Explain the difference between a CT scan and an MRI.
3. Describe an electrocardiogram.

Think

4. Discuss the pros and cons of being genetically tested for a disease.

Practice Academic Skills



English Language Arts/Writing

5. Research and write a short report about the first stethoscope. Then design, make, and test your own stethoscope. Present your report and demonstrate your stethoscope to the class.



Mathematics

6. Josie went to a heart specialist for an evaluation. She walked on a treadmill while her heart was monitored. Her heart was beating 88 times a minute as she walked. If she walked on the treadmill for 35 minutes, how many times did her heart beat?

Math Concept **Using Equations** An equation can help you organize information to solve a problem.

1. Think of an equation as a math sentence that explains how one thing is equal to another.
2. Think through the steps. Then write an equation. Use a letter such as x for the unknown quantity.



For help, go to glencoe.com to this book's OLC and find the Math Handbook.

Treatment of Disease

Reading Guide



Before You Read

Connect What are some new medical treatments?

Content Vocabulary

- antibiotic
- laser surgery
- implant
- genetic engineering
- telemedicine
- bionics

Academic Vocabulary

- visual
- expert

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

New Surgical Procedures

1. Laser surgery _____
2. _____
3. _____



Go to glencoe.com to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

- STL 3** Relationships & Connections
- STL 11** Design Process
- STL 12** Use & Maintenance
- STL 14** Medical Technologies

ACADEMIC STANDARDS

Social Studies

NCSS Content Standard 8 Science and technology in society

Science

NSES Content Standard F Science and technology in society

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Medicines

How were effective medicines first developed?

Some diseases can be cured with the help of medicines and other treatments. For non-curable diseases, doctors try to relieve symptoms and make patients more comfortable.

Bacteria, viruses, and fungi can cause many diseases. In 1928, Alexander Fleming, an English physician, discovered penicillin. Penicillin was the first antibiotic. An **antibiotic** is a medication that can kill bacteria and other germs. Penicillin is still effective against many life-threatening bacterial infections.



As You Read

Define What is laser surgery?

Since 1928, many antibiotics have been created. However, because antibiotics have been overused, some strains of bacteria have grown resistant. This means the bacteria becomes too strong to be killed when exposed to the same antibiotics many times.

Some antibiotics can kill fungi, but no antibiotic works against viruses. Some common viral infections include colds, flu, and AIDS. Researchers have developed some antiviral drugs that suppress the infection. Some medicines, such as aspirin, relieve pain. Other medicines promote health, such as those that regulate blood pressure, reduce the spread of cancer cells, or control allergies.



Connect Have you taken antibiotics? Why?

Surgical Procedures

What new surgical procedures are being used?


More than 40 million surgeries are performed in the United States each year. Some doctors use computer simulations to plan difficult surgeries. Using a computer and an MRI scan, the doctor enters surgical possibilities, and the computer analyzes the effects.

Some surgeries can be done by using very small incisions (cuts). A doctor can insert an endoscope with a cutting tool into the incision and guide it to the right location. Scars are smaller with this procedure, and patients require less healing time. Endoscopes are also being used to operate on babies in their mother's womb.

In recent years, lasers have been used to stop ulcers from bleeding and to correct vision. **Laser surgery** is surgery done with a laser beam instead of a scalpel (knife). Unlike scalpels, lasers do not cause bleeding. The surrounding tissue is vaporized. Because the laser is computer-controlled, cuts can be very precise.

Sound waves are also being used for surgery. Doctors use high-frequency sound waves to break up kidney stones in patients.

With robotic surgery, the surgeon uses controllers to tell the robot, located in the next room, where and how deep to cut, what to dissect, and where to suture (sew up the incision). The incision is small, and a patient's recovery is faster than with ordinary surgery. A robotic surgical arm can match the movement of a beating heart during surgery.

 **Precision Robotic Surgery** Because a surgeon controls the robot via a computer, a robot surgeon can be very precise. *What kind of incision can a robot make?*



Identify What are some surgical methods?

Electronic Implants

What are implants?

Implants are small devices inserted into the body to treat or solve medical problems. People may recover partial or complete hearing when an electronic implant is placed in the head. (See Figure 14.3.) Vision implants may be inserted into the eye or directly into the brain. The implant sends electronic signals to the **visual** cortex of the brain, which creates the image.

Pacemakers are implants used to stimulate a heart with electrical impulses. Researchers are working to develop pacemakers that also deliver medicine to the heart, radio for help in an emergency, and provide the doctor with a computerized report.



Reading Check

Identify What are some uses of implants?

Genetic Engineering

What is genetic engineering?

Your genes can influence your risk for a particular illness. **Genetic engineering** is the process of altering or combining the genetic material in DNA to treat a disease or modify body characteristics. For example, if a person has a defective or missing gene, a normal gene could be inserted into a harmless virus that can take the new gene to the affected area. This is called “gene therapy.” Gene therapy has been experimental. However, researchers hope that it will prove useful in treating illnesses such as cystic fibrosis and cancer.

Other genetic engineering research focuses on developing drugs for treating disease. Genes that can affect a particular disease are placed in other organisms. The organism produces substances that can treat the disease. The substances, or medicines, include vaccines and treatments for burns and some cancers.



Reading Check

Explain What is gene therapy?



Hearing Signals Hearing implants send a signal to the middle ear. Nerves carry the information to the brain. *Why do you think hearing implants have been more successful than vision implants?*

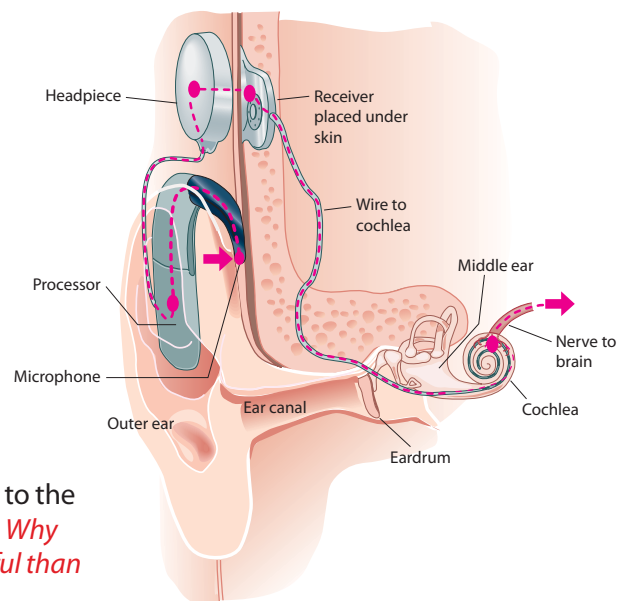
Academic
Connections
Science

Robotic Moves A robot's flexibility is measured in “degrees of freedom.” Flexibility relates to how the robot's hand or arm can move—up or down and in or out. If there are more degrees, the robot is more flexible. Most robots have no more than six degrees.

Apply Research the joints in a robot's hand and wrist. Then compare them to the joints in a human's hand and wrist.



Figure 14.3 Hearing Implants



Imagine This...

Tissue Engineering

In an organ transplant, a kidney or a heart is removed from one person and placed in another person. But a patient's body may reject the organ. Tissue engineering may allow a new organ to grow in the lab, using the sick person's own cells. This would prevent rejection. Burn victims are treated with skin transplants. *Do you think bionic organs would be rejected? Explain.*



Go to glencoe.com to this book's OLC for answers and to learn more about tissue engineering.

Telemedicine

How can doctors treat patients who are far away?

Telemedicine is medicine practiced at a distance. **Expert** medical advice or treatment is given to patients through the use of computers, telephones, and/or Internet connections. A medical practitioner attaches electronic diagnostic equipment to the patient. The readings are then sent to the doctor who is usually miles away—sometimes in a distant country.

Bionics

What is bionics?

Medical engineers are developing systems that can replace many human body parts if they are missing, injured, or diseased. This medical area is called **bionics**. Regaining mobility or movement, due to loss of a limb, can help people have equality of opportunities.

Artificial organs are important because too few donor organs are available. However, all the materials to make the organs must be biologically neutral, so that the person's immune system will not attack what it considers to be a foreign body.

The new part must work in the environment of the human body for many years. It must duplicate the function of the part it replaces and not cause a breakdown in a body system. If a replacement heart valve causes blood clots, it cannot be used. If a replacement joint causes bones to break, it cannot be used. The AbioCor II artificial heart is a completely artificial heart that can be surgically implanted in place of a person's dying heart.

section 14.3 assessment

After You Read

Self-Check

1. Explain why some antibiotics have become ineffective.
2. List at least three types of surgery.
3. Name some advantages of telemedicine.

Think

4. If you needed surgery, would you want a robot to do it? Explain why or why not.

Practice Academic Skills



English Language Arts/Writing

5. Research and write two paragraphs on any bionic device, such as an artificial heart. Make a poster or a model of the device and label its parts and functions.



Science

6. Research how genetic engineering is helping to fight certain diseases. Write a few paragraphs describing the pros and cons of genetic engineering and the names of diseases that might be cured using it.

Exploring Careers ⁱⁿ Technology

Kristen Dezzani

PHARMACEUTICAL ENGINEER

Q: *How did you get interested in your field?*

A: At 18, when I decided to major in chemical engineering, I wasn't sure what I wanted to do when I got out of college. My decision to become a chemical engineer was influenced by the fact that my father is a chemistry teacher and my brother is an engineer.

Q: *What do you do on a typical day?*

A: I work closely with my team to obtain status updates on our projects, as well as to make decisions on the path going forward. Most of my job has to do with interfacing with people, following up on projects with my team members, or reporting to upper management. The projects that we do are either facility- or equipment-related. We might bring in new storage tanks for solvents used in the manufacture of drugs or install a new process hot-water system to aid in the cleaning of manufacturing equipment.

Q: *What do you like most about your job?*

A: The challenges. Being a project manager is not as easy as it might seem. I have to meet deadlines and budgets. It's a very fast-paced environment that keeps me motivated and brings out the best in me. No two projects are alike, so I'm never bored. I also like interacting with people, which allows me to develop close personal and professional relationships. That's what keeps me coming back every day.



English Language Arts/Writing

Career Levels There are a variety of jobs that relate to most types of technology. Research different jobs related to chemical engineering or any other medical biotechnology:

1. Find a job for each of these levels of education: high school diploma, one-year certificate program, two-year degree, bachelor's degree, master's degree, and Ph.D.
2. Choose two of the jobs and find out the courses and training needed for these jobs. Then check job-search Web sites to find possible job openings.
3. Write a short report on your findings.



Go to glencoe.com to this book's OLC to learn more about this career.

Real-World Skills

Problem solving, adaptability, research, communication

Academics and Education

Chemistry, engineering, mathematics, English language arts

Career Outlook

Growth faster than average for the next ten years

Source: *Occupational Outlook Handbook*

Chapter Summary

Section 14.1 Medical technology is a biotechnology. Biotechnologies make use of information about living things. Prevention involves technologies that remove or kill pathogens. Governments remove pathogens from water supplies. Sanitation removes waste that causes disease or contaminates. Immunization helps the body fight disease. Ergonomics is the design of equipment and environments to promote safety, health, and well-being.

Section 14.2 Using microscopes, doctors and technicians can examine body fluids for pathogens and other signs of disease. In genetic testing, a person's genes are examined. Genes are the carriers of heredity. Imaging machines show doctors the inside of the body. The first imaging machine was the X-ray machine. Imaging technologies include CT scans, MRIs, ultrasound, and endoscopes.

Section 14.3 Penicillin was the first antibiotic. Many important medicines have been developed. In recent years, laser surgery has become important. Lasers do not cause bleeding. Implants are small electronic devices inserted in the body. People who are blind or deaf may recover partially or completely. Genetic engineering alters or combines genetic material to treat a disease or modify the body. Telemedicine is medicine at a distance.

Review Content Vocabulary and Academic Vocabulary

- On a sheet of paper, use each of these terms and words in a written sentence.

Content**Vocabulary**

- pathogen
- pasteurization
- irradiation
- sanitation
- immunization
- vaccine
- ergonomics
- genetic testing
- CT scan
- ultrasound
- MRI
- endoscope
- antibiotic
- laser surgery

Academic**Vocabulary**

- seek
- ensure
- conduct
- internal
- visual
- expert

Review Key Concepts

- Discuss** disease prevention technologies.
- Explain** pasteurization and irradiation.
- Explain** how immunization works.
- Discuss** genetic testing.
- Describe** several imaging technologies.
- Identify** tests that read electrical impulses in the body.
- Explain** how antibiotics work.
- Explain** genetic engineering.
- Tell** the purpose of bionics.



Real-World Skills

- 11. Understanding Nutrition** From package labels, collect the nutritional information from food you eat in a day. Make a chart listing the food and percent of the recommended daily amounts. Write a paragraph describing your diet. Discuss possible diet changes.

STEM Technology Skill

- 12. Imaging Systems** There are many different types of imaging systems that doctors use to diagnose diseases.
- Use the Internet to research different types of imaging systems. Research the diseases each system diagnoses.
 - Create a poster with an illustration of one of the systems. Include an image from the machine and text that explains the diseases.

Academic Skills

STEM Science

- 13.** The design of products must consider a person's limitations and comfort level. Think of something you use often. Write a few paragraphs about its design.

STEM Mathematics

- 14.** Courtney wants to know the age of her brother's wife. Her brother told her that his wife is one-eighth of their mother's age younger than him. If Courtney's mother is 64 and her brother is 35, how old is her brother's wife?

Math Concept Algebra Some problems can be easier to solve if you write an equation. An equation is like a sentence that explains how to solve a problem. The unknowns can be represented as letters such as x or y .



WINNING EVENTS

Scientist, Medical Technologist, and Ethicist

Situation You are part of a research team that will investigate a medical technology innovation.

Activity Brainstorm medical technology innovations. Choose one topic to study. Conduct research, prepare a report, develop sketches and drawings, and build a model and display of the technology. Give a formal presentation in class.

Evaluation The team's work will be evaluated by the following criteria:

- Report—well researched and written
- Sketches and drawings—accurate
- Display and model—attractive, accurate
- Presentation—informative, interesting



Go to glencoe.com to this book's OLC for information about TSA events.

Standardized Test Practice

Directions Choose the letter of the best answer. Write the letter on a separate piece of paper.

- How much is $\frac{1}{16}$ of 438?
A 28.785 **C** 21.5
B 27.375 **D** 26.375
- CT scans do not use a magnetic field to create images of body structures.
T
F

Test-Taking Tip Re-read all questions that include negative wording, such as *not* or *least*. Look out for double negatives used in a question.

Crash Test a Vehicle

Your family car is designed to protect you in case of a crash. Its safety system includes: the front and rear bumpers, steel-reinforced door panels, lap and shoulder seatbelts, airbags, padded instrument panels, headrests, and a collapsible steering column.

The engineers who originally developed these systems considered the physical features of the human body. They tested their systems by using dummies in actual car crashes before a safety agency would approve the systems.

Tools and Materials

- ✓ Lumber for ramp and vehicle
- ✓ Technical drawing equipment or computer and CAD software
- ✓ 2 axles for each vehicle
- ✓ 4 wheels for each vehicle
- ✓ 2 eye hooks for each vehicle
- ✓ Uncooked eggs
- ✓ Ziplock®-style plastic sandwich bags
- ✓ String
- ✓ Protractor
- ✓ Glue
- ✓ Foam rubber
- ✓ Paper
- ✓ Rubber bands
- ✓ Balloons
- ✓ Camcorder



Set Your Goal

Your goal for this lab is to design and create a safety restraint system that can protect a raw egg from breaking during a vehicle collision. You and your team of three to five students will work together on this activity.



Know the Criteria and Constraints

In this lab, you will:

1. Be sure vehicles are the same so only the safety system is tested.
2. Include anything in your design that will directly or indirectly protect the egg. But you may not interfere with the vehicle's speed.
3. Be sure the egg or its shell is *not* strengthened in any way, including by hard-boiling it or coating it with nail polish.
4. Place all eggs in plastic bags before testing.
5. Send the vehicle containing the egg down a ramp at a 75 degree angle. Then it will crash into a wall. If the egg survives the crash, the design is successful!



Design Your Project

Follow these steps to design your project and complete this lab.

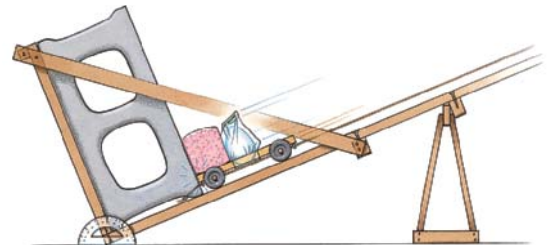
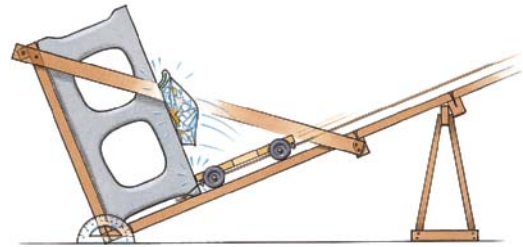
1. In teams, design a vehicle.
2. Build the vehicle from the design.
3. Design a ramp.
 - Build the ramp long enough so you can increase vehicle speed by starting the cars higher up on the ramp.
 - Build a protractor into the design so you can increase the ramp angle by specific degrees. A higher angle increases the vehicle's speed at impact.

! SAFETY

Reminder

In this lab, you will be using tools and machines. You must pass a safety test. Follow appropriate safety procedures and rules so you and your classmates do not get hurt.

4. Place a string guide through eye hooks on the vehicle to guarantee it runs the full track.
5. As a class, select the vehicle that works the best.
6. Mass-produce this vehicle so that every team has a vehicle of the same design for testing their safety system.
7. Along with your teammates, design a safety restraint system.
8. Place your egg in a Ziplock bag for easy cleanup.
9. Run a test of your restraint system and improve its design if necessary.
10. Hold a class-wide competition to see which team's restraint system allows the egg to survive the most violent crash.
11. If possible, record the competition on film.



Evaluate Your Results

After you complete the lab, answer these questions on a separate piece of paper.

1. Did your egg survive the crash? What part of your design seemed to be most effective?
2. Did any team's egg survive more than one crash? What method did that team use to protect it?
3. Did the protections correspond to those used in an automobile? Explain.

Academic Skills Required to Complete Lab

Tasks	English Language Arts	Math	Science	Social Studies
Design a vehicle as a team.	✓		✓	
Build vehicle and test it on ramp.	✓	✓	✓	
Choose the best vehicle design as a class.	✓		✓	
As a team, design a restraint system and test it to see if your egg "survives."	✓	✓	✓	
Record the competition with camcorder.	✓		✓	