CHAPTER 18

ACTIVITIES

CROSS-CURRICULAR EXTENSIONS

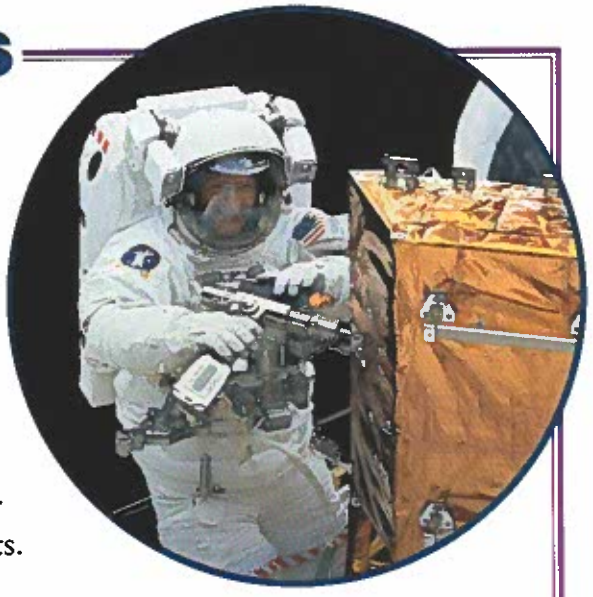
1. SCIENCE Make a sketch of what you think life forms from beyond the Earth might look like.

2. TECHNOLOGY Make a model of a space station. Include a living module, lab module, and other important modules.

3. COMMUNICATION Write a science fiction story about a space colony or lunar city of the future.

4. MATHEMATICS Research how air pressure changes with increasing altitude. Make a graph to show your findings.

EXPLORING CAREERS



Currently, space stations are used to conduct scientific experiments and serve as temporary homes for astronauts. Some day space stations may house factories, airports, hotels, schools, and hospitals. Many of the jobs on the space stations will be no different than those on Earth. However, those jobs will offer opportunities unheard of today!

Life Sciences Researcher How would plants and animals fare during a journey in space? To find out the answer to this and many other questions, life sciences researchers conduct many tests. They must be able to understand how one step in a life process affects the other steps. They must also work well in a team environment.

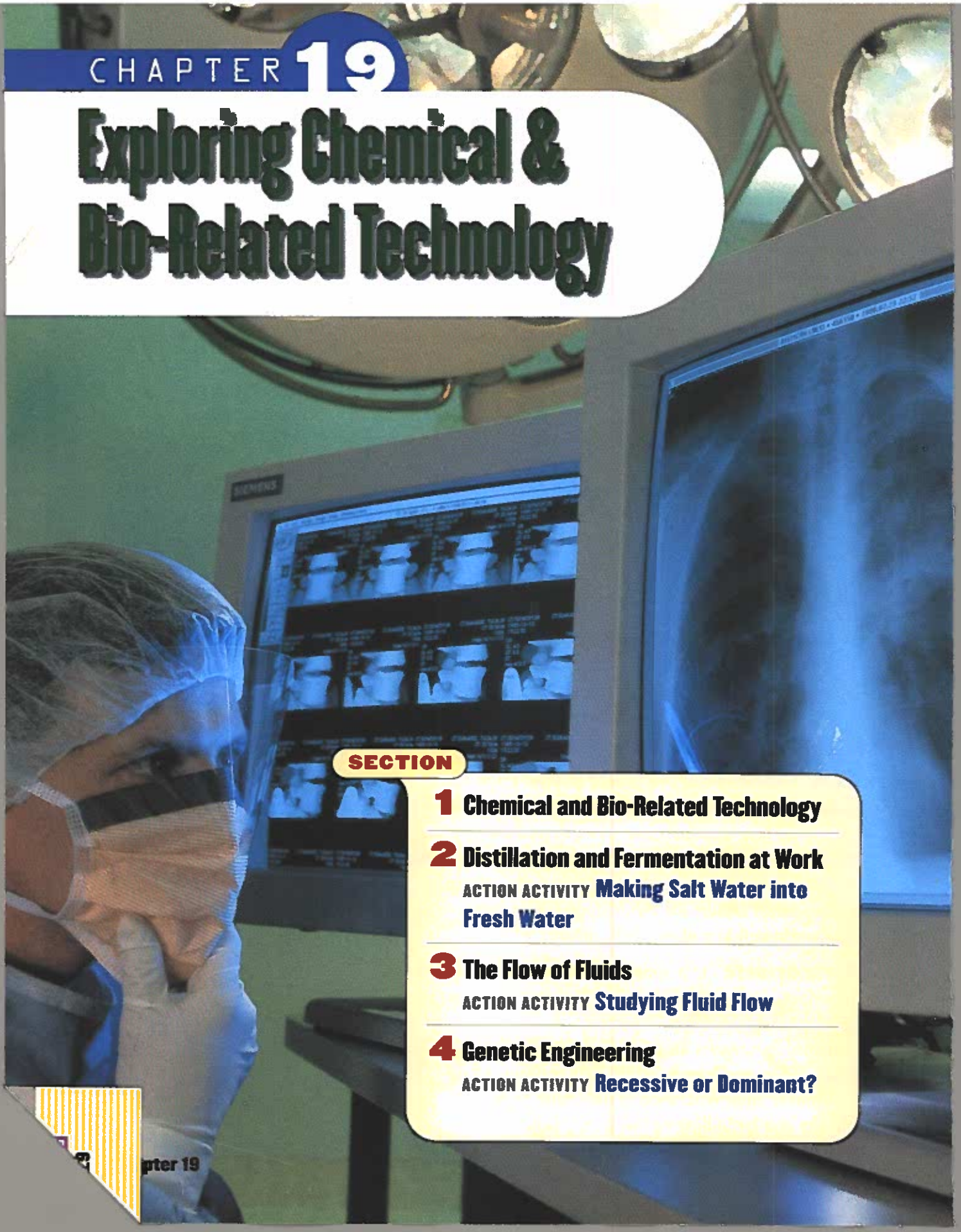
Astronaut On a space mission, each astronaut is responsible for a special area, such as biotechnology research, astronomy, or computer systems. Astronauts are well-qualified in their fields. They undergo hard physical training while continuing their education. They must be team players and be willing to work long hours.

ACTIVITY

Design and draw the home page of a website for a business you might find in space some day.

CHAPTER 19

Exploring Chemical & Bio-Related Technology



SECTION

Chemical and Bio-Related Technology

SECTION 1

THINGS TO EXPLORE

- Explain how chemical and bio-related technologies affect you.
- Describe the changes chemical and bio-related technology advancements might bring.
- Tell how advancements in chemical and bio-related technology raise ethical questions.

TechnoTerms
aquaculture
bionics
bio-related technology
ethics
genetic disease
hydroponics

Did you ever stop to think that the apple you ate for lunch or the cereal you had for breakfast may have been changed by technology? Rapid advancements in agriculture, health care, waste management, and other chemical and bio-related technologies affect you.

Chemical technology has to do with the many chemicals used to produce such things as plastics, paint products, and even fertilizers. **Bio-related technology** has to do with living things. Fig. 19-1. Bio-related technologies include

- **Genetic engineering:** The process of changing the gene structure of a plant or animal. It may also involve designing new life forms.
- **Bioprocessing:** The use of microorganisms to change materials from one form to another. One example is to use specially designed microorganisms to clean up oil spills, turning the oil into something harmless.
- **Bionics**, or *biomechanics*: Designing artificial parts, or *prostheses*, for the human body, such as arms, legs, hips, and teeth. Bionics also involves such things as computers and new wheelchair designs that make it possible for people with disabilities or degenerative (continually worsening) diseases to lead more productive lives.

OPPOSITE Bio-related technology has to do with living things.

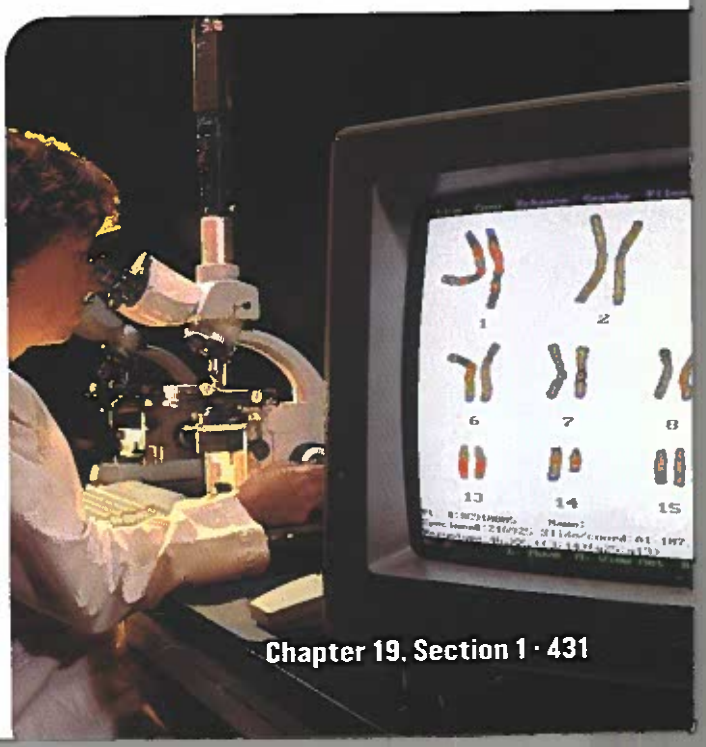


Fig. 19-1. A genetic researcher studies the chromosomes that carry genetic material. Chromosomes come in pairs. How many pairs do most humans have?

TechnoFact

WALKING IS NOT SO SIMPLE

Researchers are working on ways to help paralyzed people move again. One electronic system, called FES (functional electrical stimulation), uses low levels of electrical current to stimulate paralyzed arms and legs. How many muscles do you think you use taking a single step? The answer is thirty-two. A computer helping a person take one step needs almost 1,500 commands!

- **Biomaterials:** Human-made materials designed to be used inside the body.
- **Hydroponics:** Growing plants without soil. Hydroponics can be used in areas where land is limited, because you can grow more plants in a limited amount of space. In addition, the crops grow faster and produce more. You can even reuse the water and fertilizer.
- **Aquaculture:** Raising fish and food plants in water.
- **Pesticide management:** The use of chemicals to control insects and other pests.
- **Waste management:** The management of garbage and other things we throw away. Some wastes can be hazardous (dangerous) to both humans and the environment.

Uses for Chemical and Bio-Related Technologies

Continued advancements in chemical and bio-related technologies will improve health care, produce new foods, and help us manage environmental concerns. Fig. 19-2.

Vaccines will be produced in the next few years to protect you against many diseases. Many **genetic diseases** (carried from parents to children) are also being studied to find a way to reduce or change their effects.

Finding ways to improve food crops and animals is another important research area. *Growth hormones* make cows grow faster

Fig. 19-2. A scientist collects sperm from this endangered wild salmon. It will be used to fertilize the eggs of salmon on fish "farms." The qualities of the farm salmon will be improved. The genes of the wild salmon will be passed on.

and help them produce more milk than they normally would. Scientists can create a line of leaner, stronger, healthier cattle. You can even have "custom-made" calves. How would you like a turkey with more than two drumsticks? It might soon be possible.

Slowing the aging process, turning seawater into fresh water, and making new fuel sources are all areas of development for these technologies.

Bioethics

Chemical and bio-related technology can improve many things. Many people predict the future of bio-related technology to be bigger than the electronics industry is today. But some people fear what might happen if the technology is used strictly for profit or without thinking about how it could change our world. Fig. 19-3. Many ethical questions are raised. (**Ethics** involves following a high standard of conduct.)

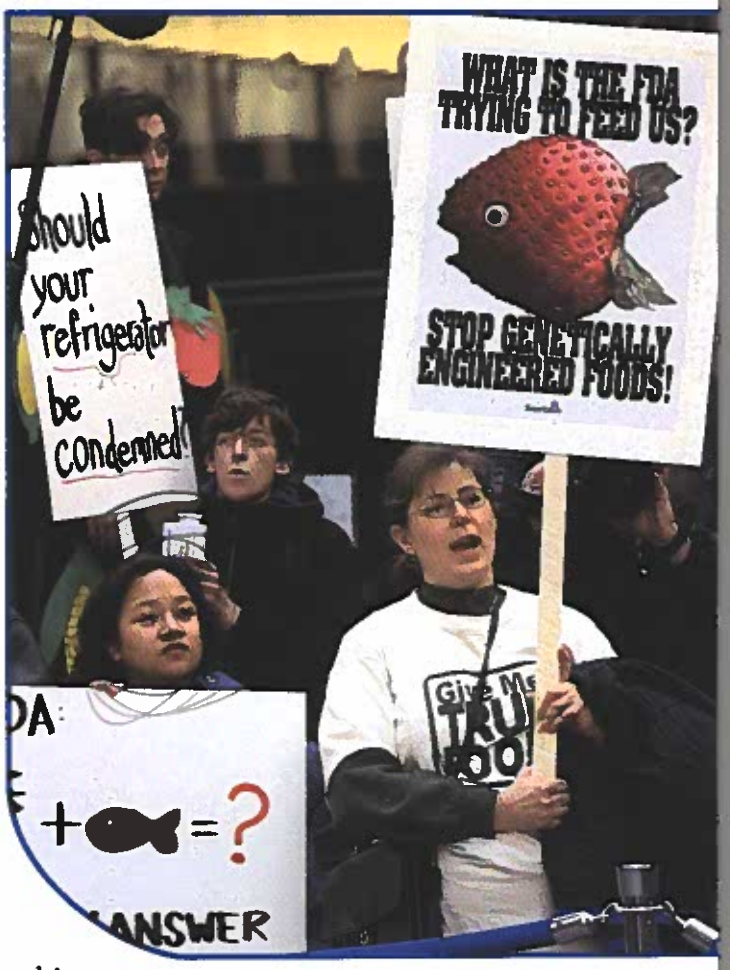


Fig. 19-3. Many people are concerned about the effects of bio-related technology. Do you think bio-related technologies should be regulated by the government? Give reasons for your answer.

For example, are the changes brought about by bio-related technologies good or bad? Are these technologies being used appropriately to help people and the environment? Changes are coming very rapidly, and many issues need to be evaluated. New standards of *bioethics* must be established that apply to people working in bio-related fields.

SECTION 1 TechCheck

1. Name some chemical and bio-related technologies.
2. List three changes that come from advancements in chemical and bio-related technology.
3. What are ethics?
4. **Apply Your Knowledge.** Research progress in biomechanics. Make a chart of the artificial body parts available for people.

SECTION 2

Distillation and Fermentation at Work

THINGS TO EXPLORE

- Define *distillation* and tell how it works.
- Define *fermentation*.
- Describe how distillation and fermentation help people and the environment.
- Distill salt water into fresh water.

TechnoTerms

biofuel
distillation
ethanol
fermentation
methanol
reverse osmosis

Did you know it's just as easy to die from thirst in the middle of the ocean as it is in the middle of the desert? That's because you can't drink salt water.

Distillation

A chemical process called **distillation** can change salt water into fresh water, making it drinkable. Fig. 19-4. Distillation separates substances based on their different boiling points. As salt water is boiled in a container, the water changes to a gas. The gas is collected in a tube where it is cooled and turns into a liquid again. Salt's boiling point is well over 1000°C, so it remains in the original container. However, distillation takes lots of energy to produce fresh water.

A new, less expensive method called **reverse osmosis** is being tested for use by desert nations. In this process a high-pressure pump forces sea water through microscopic openings in special filtering materials. These materials filter out the salt.

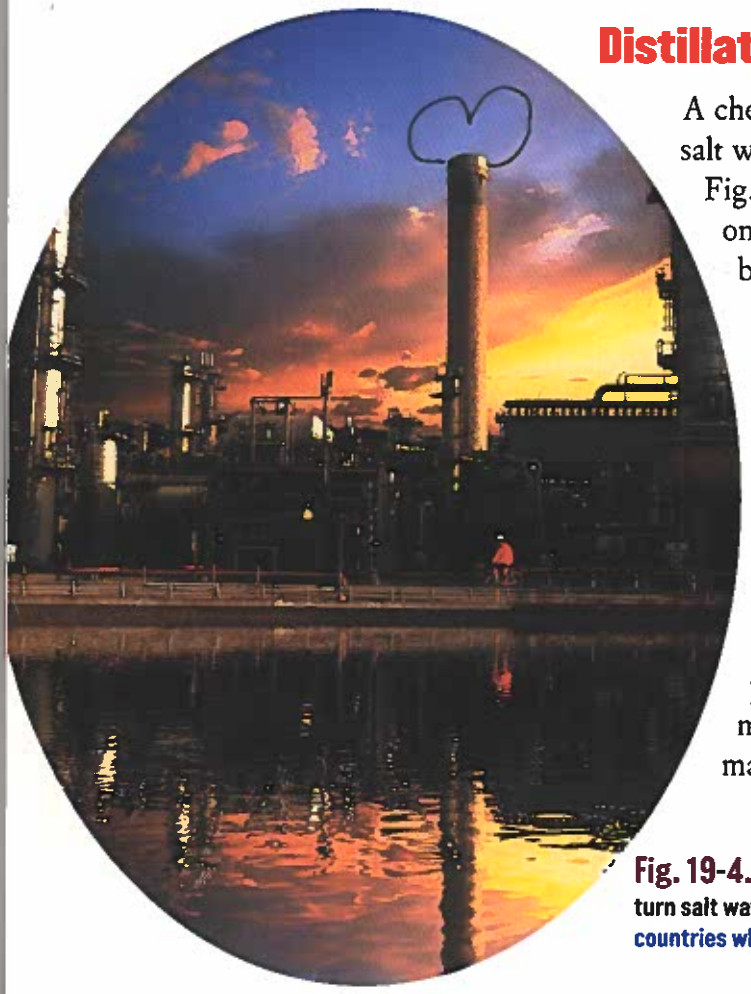


Fig. 19-4. Distillation plants, like this one, can turn salt water into fresh water. Name some countries where this process might be needed.

Microorganisms and Fermentation

Fermentation uses microorganisms to turn grains into alcohols. It is a promising source of **biofuels** (fuels made from biomass, which is plant or animal matter). Fig. 19-5. Almost any kind of biomass that contains starch or cellulose, from cornstalks to cow dung, can be changed by fermentation and distillation into **ethanol**, or grain alcohol.

When ethanol is mixed with gasoline, it produces *gasohol*, which can be used as an alternative to gasoline. While ethanol is presently somewhat more expensive to produce than gasoline, it can often be made from resources countries already have, such as sugar cane. In Brazil, for example, over half of the automobile fuel used is gasohol.

Fig. 19-5. Animal wastes flow into a special lagoon. When wastes can be recycled into fuels, they cause fewer problems for the environment. Is gasohol available in your area?

Biofuels, like ethanol, produce less air pollution than gasoline does. **Methanol**, a product made from fermented wood-product waste, is not as good an alternative as ethanol because it pollutes more. However, it still does not put as much carbon monoxide into the air as gasoline does. Many car manufacturers are planning to produce cars in the future that burn alternative fuels.

TechnoFact

FUEL SAVINGS If we replaced all gasoline in the United States with gasohol, we would cut use of gasoline by 10 percent and cut oil imports by 20 percent. Considering that we use about 19 million barrels of oil per day in this country, that's a lot!

SECTION 2 TechCheck

1. What is distillation?
2. What is fermentation?
3. How do distillation and fermentation help people and the environment?
4. **Apply Your Knowledge.** Research the use of gasohol in cars. What advantages are there to adding ethanol to gasoline for use as a fuel?

ACTION ACTIVITY

Making Salt Water into Fresh Water

Be sure to fill out your TechNotes and place them in your portfolio.

Real World Connection

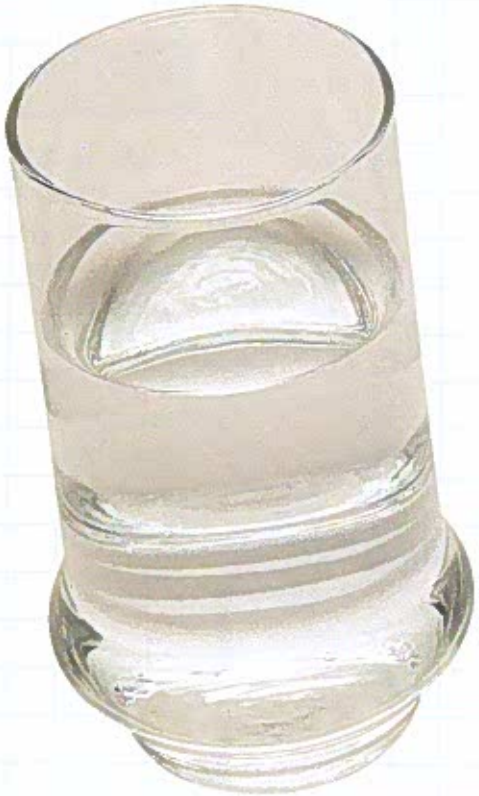
It seems strange that some countries are running out of drinking water when they are right next to an ocean. But drinking sea water can cause illness and even death. In this activity, you will be working as a chemical engineer to distill salt water into fresh water.

Design Brief

Turn salt water into fresh water using the process of distillation.

Materials/Equipment

- flask, rubber stopper, glass tubing
- food-grade plastic tubing
- ring stand, clamps
- beaker
- condenser
- table salt, water
- electric hot plate or Bunsen burner



SAFETY FIRST

- **Follow the safety rules listed on pages 42-43 and the specific rules provided by your teacher for tools and machines.**
- **All the equipment used in this experiment should be clean and free of any other chemicals.**
- **Do not start this experiment until your teacher has checked the setup.**

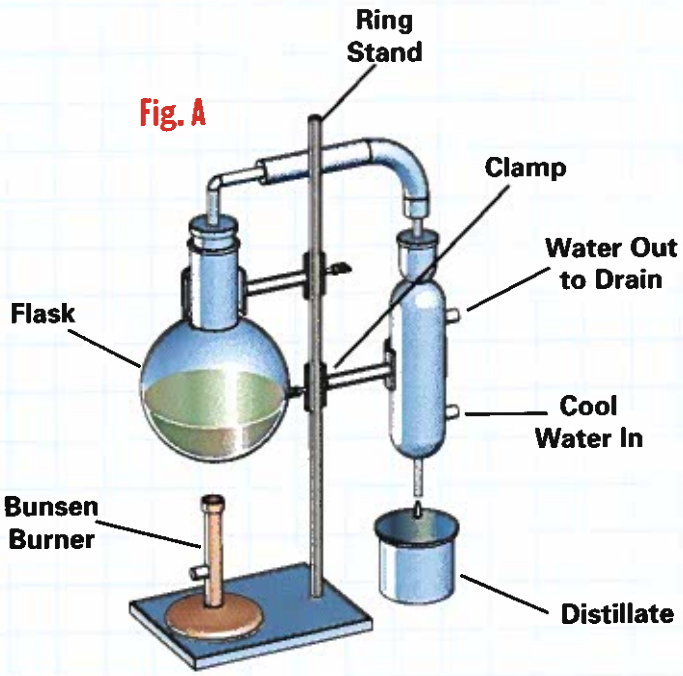
Procedure

1. Teams of students should work on the different tasks. Your teacher will make assignments.
2. Mix 50 cc of water with one teaspoon of salt.
3. Set up the ring stand, condenser, and hot plate as illustrated in Fig. A.
4. Connect the plastic tubing to the flask and condenser.
5. When everything is ready, pour the salt water into the flask. Turn on the hot plate or burner. Watch for the first signs of boiling and condensation.
6. Collect the distillate (condensed vapor) in a clean beaker or cup. Allow the distillate to cool.
7. Dip your finger in the distillate and taste the water.

Evaluation

1. Did the distillate taste salty? Explain.
2. Why is it so expensive to make water fresh by distillation?
3. **Going Beyond.** Design a solar-powered desalination plant. How do you think the output of the solar-powered plant would compare with distillation using traditional fuels?
4. **Going Beyond.** Calculate the output of your distillation experiment. How long would it take to make the fresh water you use in one day using the equipment in this distillation experiment?
5. **Going Beyond.** Make a list of five ways your family could save water.
6. **Going Beyond.** Can you filter out the salt in sea water using filter paper? Explain.

Fig. A



SECTION 3

The Flow of Fluids

THINGS TO EXPLORE

- Explain why scientists are studying fluid flow.
- Describe some ways fluid flow affects you.
- Design, build, and test a fluid-flow device.

TechnoTerms
cholesterol
crystal

In chemistry, the term *fluid* can refer to a gas or a liquid. A fluid is a substance that flows. Unlike a solid, a fluid has no shape of its own. Instead, it conforms to the shape of its container.

Why Study Fluids?

Scientists study the flow of fluids carefully to understand, control, and improve many natural and industrial processes.

INFOLINK
See Chapter 8 for more information about fluids.

The fact that fluid moves is important both in nature and in technology. Your blood is a fluid that brings oxygen and nutrients to your cells. The air we breathe and the water we drink are fluids. What would happen if air couldn't expand? The movement of fluid powers many products of technology, such as automobile brakes, hovercraft, and jackhammers.

TechnoFact
JUST ANOTHER PHASE Did you ever stop to think that three of the four states of matter (gas, liquid, and plasma) are fluids? Even the fourth state (solid) behaves like a fluid under many conditions.

Fluid flow affects your everyday life. Studying fluid flow can help us understand such things as

- How chemical processes can build better products
- How **cholesterol** (a fat-like substance) is moved through the blood
- How crystals form to make new medicines. (A **crystal** is a solid whose atoms are arranged in a repeating pattern.)
- How pollutants are carried in water and air
- How car engines run, airplanes fly, home heaters operate, and rocket engines work

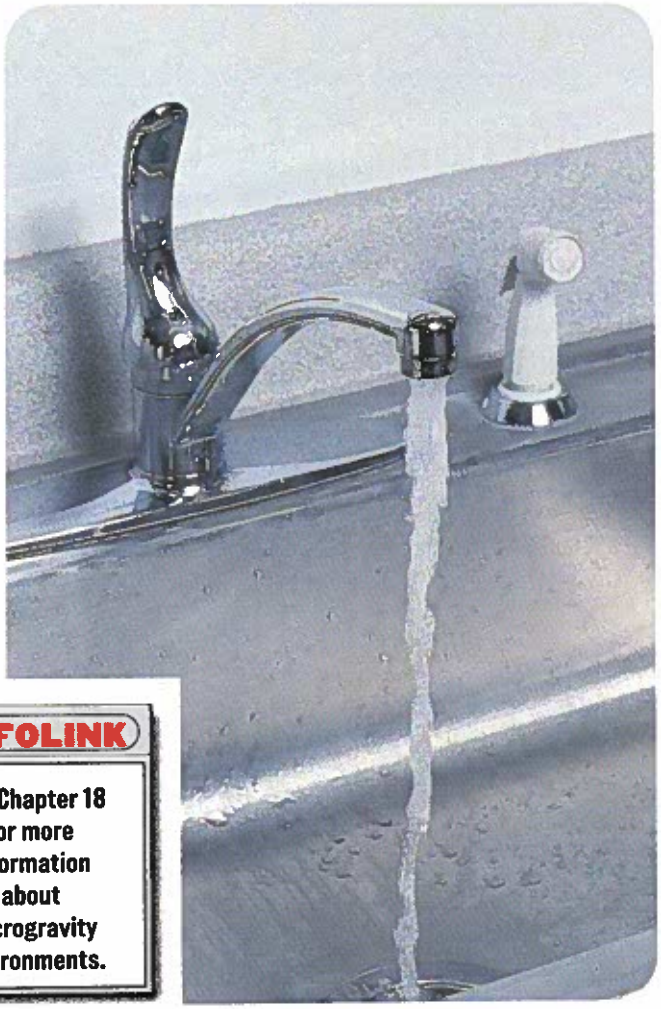


Fig. 19-6. **Water rushing from a faucet is filled with movement.** Try to describe this flow as accurately as possible in three or four sentences.

Studying fluids is difficult. Look carefully at water running from a faucet and try to study its movement. Fig. 19-6. Can you appreciate how difficult it is to accurately describe? That's why scientists often study fluid flow in a microgravity environment. The lack of gravity changes the way the fluid moves. If the flow of fluids can be made two-dimensional and controlled carefully, it is easier to study. That's what you will do in the activity for this section.

INFOLINK

See Chapter 18 for more information about microgravity environments.

SECTION 3 TechCHECK

1. What is fluid flow and why do scientists study it?
2. Why is studying fluids difficult?
3. List three ways fluid flow affects your world.
4. **Apply Your Knowledge.** Research fluid flow. Share the results with your classmates.

ACTION ACTIVITY

Studying Fluid Flow

Be sure to fill out your TechNotes and place them in your portfolio.

Real World Connection

Fluid flow is an important field of study for rocket scientists as well as medical researchers. In this activity, you will make a two-dimensional fluid-flow device to investigate how fluids move. You will create a film made of a thin layer of soap on each side of a single layer of water molecules. The film will be so thin that it can be considered to have no thickness.

Design Brief

Design, build, and test a fluid-flow device. Place different shapes in the fluid to study how they disturb the flow.

Materials/Equipment

- 2-liter plastic soda bottle
- utility knife
- fishing line
- rubber stopper with one hole
- medicine dropper
- adjustable hose clamp
- 1/4" washer
- dishwashing soap (such as Dawn liquid soap)
- drip pan
- weight
- plywood (3/4" x 6" x 12")
- scroll saw
- rubber tubing

SAFETY FIRST

- **Follow the safety rules listed on pages 42-43 and the specific rules provided by your teacher for tools and machines.**
- **Use liquid soap to make it easy to push the glass medicine dropper into the hole in the rubber stopper. Be careful not to break the glass.**
- **Wear safety goggles to avoid contact with soapy water.**
- **Clean up any spills immediately to prevent someone from slipping.**
- **Use caution when using a utility knife.**

Procedure

1. Work in groups of two or three students. Divide the following tasks among members of your team.
2. Cut off the bottom of an empty 2-liter plastic soda bottle using a utility knife.
3. Remove the bulb from a medicine dropper. With your teacher's help, carefully push the glass part of the dropper through the hole in the rubber stopper.
4. Place a 2"-long piece of rubber tubing on the end of the medicine dropper. Attach the tubing clamp to the rubber tubing.
5. Cut a double strand of fishing line as long as the height of your fluid-flow device. Try to make your device at least as tall as you are.
6. Tie both strands of fishing line to a 1/4" washer.
7. Thread the two free ends through the hole in the bottle and the medicine dropper and rubber stopper as shown in Fig. A.
8. Tie the loose ends to a weight. Tie four short pieces of fishing line to the two main strands as shown in Fig.B on the next page.
9. Cut the plywood to make a support for the bottle. Clamp the support to the top of a door or other steady structure.
10. Mix a weak solution (2%-10%) of dish soap and water. Fill the bottle half full of soap solution.
11. Place the drip pan under the weight to catch the soap solution.

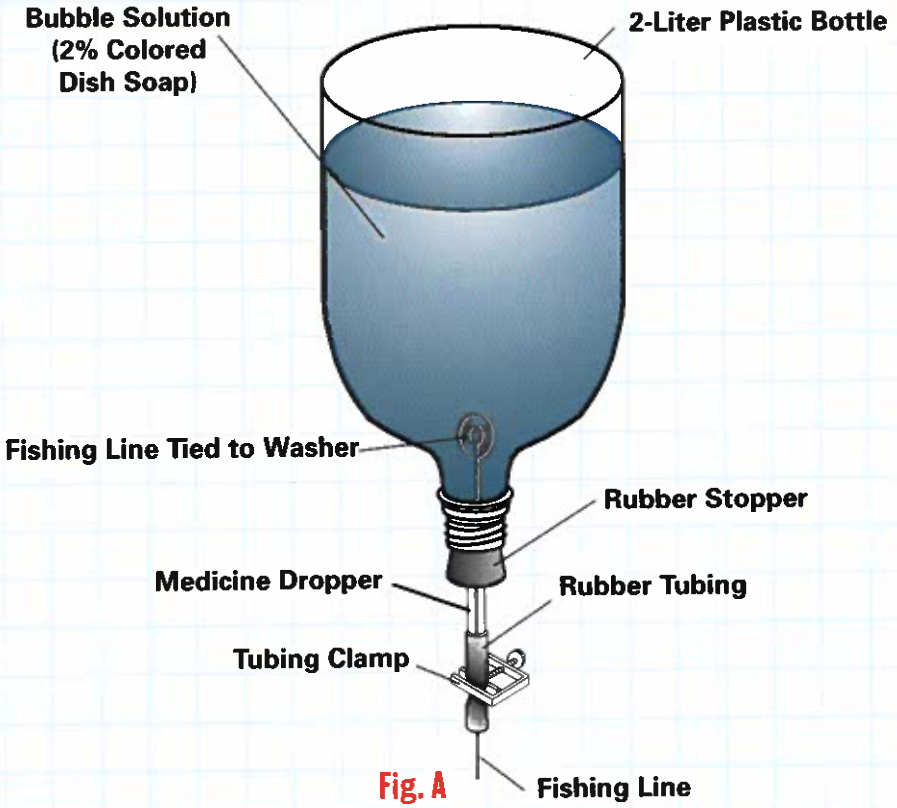


Fig. A

(Continued on next page)

ACTION ACTIVITY

12. Adjust the flow so the soap solution drips slowly down the fishing line. When the solution reaches the weight on the bottom, slowly pull the short strings apart to form a film of fluid. Fig. B.
13. Adjust the size of the soap film and the flow of the solution so it continues to flow.
14. Wet your finger in the soap solution. Poke your finger through the bubble film and watch the flow carefully. Notice the pattern of flow downstream of your finger. Look for a spiral-shaped pattern called a *vortex*.

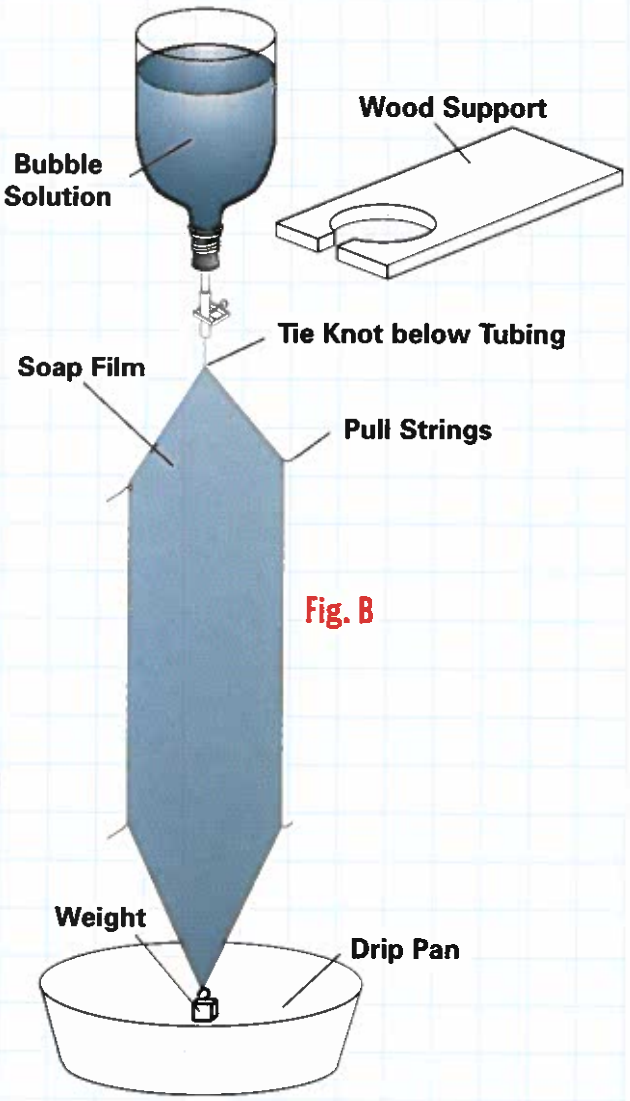


Fig. B

Evaluation

1. Why is it easier to study a two-dimensional fluid flow than a three-dimensional fluid flow?
2. List some real-world applications for studying fluid flow.
3. What is a vortex?
4. **Going Beyond.** Use a camcorder to tape the vortex patterns produced by different shapes placed in the fluid flow. Experiment with different camera angles, backdrops, and lighting to get the best picture. Play the tape to analyze the patterns.
5. **Going Beyond.** With your teacher's help, take the fluid-flow device to the top of a stairs or ladder. Try to make the fluid flow as large as possible.

Genetic Engineering

SECTION 4

THINGS TO EXPLORE

- Define *genetic engineering.*
- Describe ways genetic engineering helps us.
- Explain Mendel's Law of Dominance.
- Use a Punnett square to show the genotypes and phenotypes in a genetic cross.

TechnoTerms

gene
genetic engineering
genotype
Mendel's Law of Dominance
phenotype
Punnett square

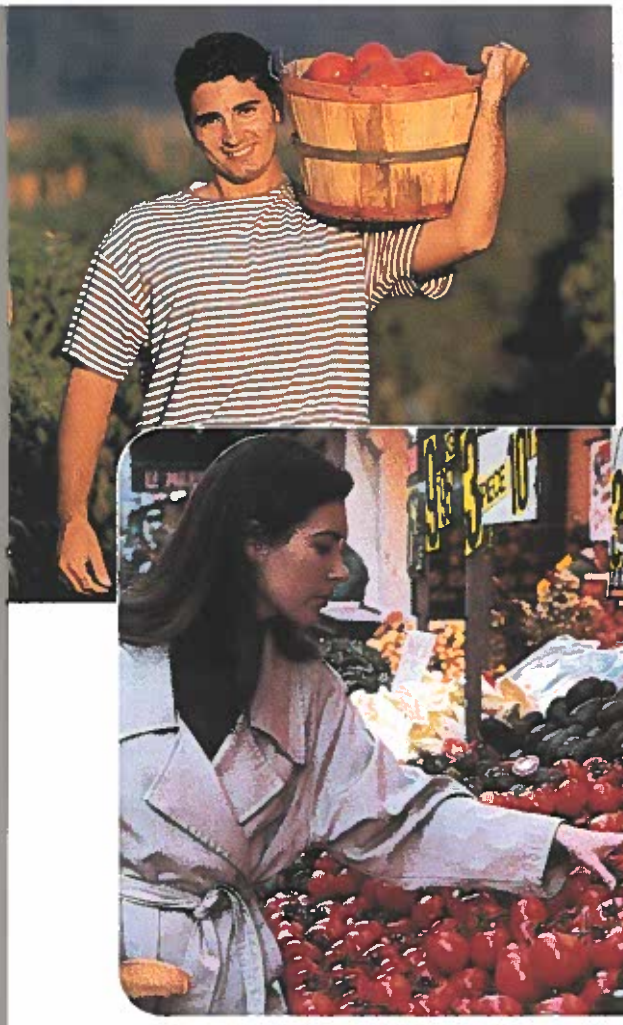
A **gene** is a basic unit of heredity that carries certain information about the development of a plant or animal. What color is your hair? Do you have blue eyes? Are you color-blind? All these traits (characteristics) are determined by your genes. *Genetics* is the study of how traits are passed on from generation to generation.

Genetic Engineering

Genetic engineering is a process of changing the gene structure of a plant or animal to improve it for human use. Fig. 19-7.

How does genetic engineering work? In most cases, a sample of genetic material is taken from a subject and then grown in cell cultures for use. The cells multiply to produce more of the same kinds of cells. This process is used in the manufacture of antibiotic medicines such as penicillin and streptomycin. The production of insulin, a hormone used to treat diabetes, is also produced using genetic engineering techniques.

Fig. 19-7. This scientist is taking samples of sunflower seeds. In what ways do you think a crop of sunflower seeds could be improved?



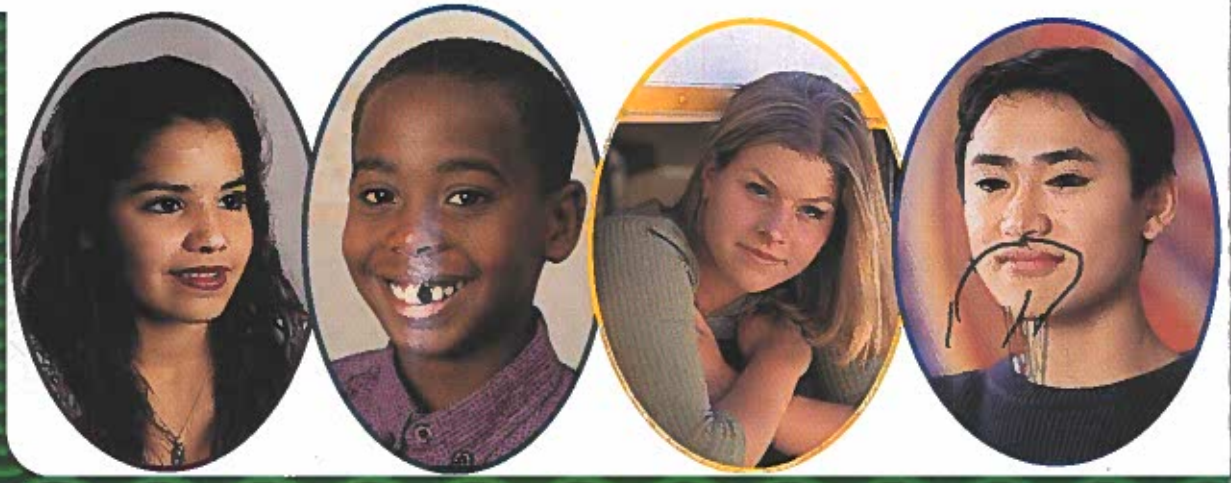
The Uses of Genetic Engineering

Genetic engineering can produce plants with new genes that make them grow faster or be more resistant to disease. Fig. 19-8. Researchers are looking for a way to put a gene into plant cells so plants would not need nitrogen fertilizer. Other researchers are trying to isolate (set apart) genes in people that cause hereditary diseases such as muscular dystrophy. They want to be able to change the gene structure early as a baby develops in its mother's body. That might change how the disease affects the person.

Fig. 19-8. Genetic engineering can produce new varieties of fruits and vegetables. Write a paragraph stating your views on the genetic engineering of our food supply. Give reasons for your opinion.

SCIENCE CONNECTION

DNA—Your Own Special Code



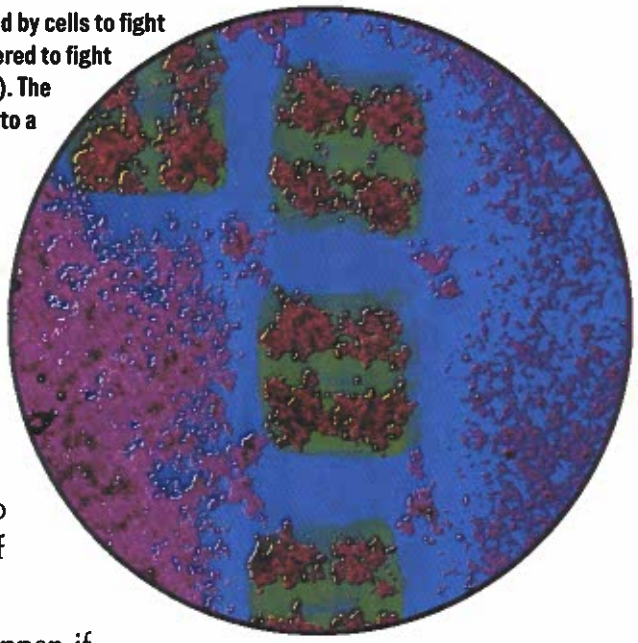


Fig. 19-9. Antibodies are produced by cells to fight foreign substances. These were altered to fight cancer and then cloned (duplicated). The cloned antibodies will be injected into a cancer patient.

Genetic engineering raises many questions. When it is used in the treatment of diseases, you can see its benefits. Fig. 19-9. But whether technologists and scientists should change or improve humans is another issue. What if we could design the "perfect" person by genetic engineering? Who would decide what traits are the best? What if we could *clone*, or duplicate, a person?

Researchers also don't know what might happen if altered microorganisms are released into the environment. Maybe they will end up multiplying too fast and become a pollution problem. Fig. 19-10. What if genetic engineering produces dangerous bacteria and viruses that could be used in war? This problem is one that many countries have tried to prevent through special agreements.

DNA (deoxyribonucleic acid) is the chemical code of instructions found in the nucleus of every living cell.

DNA controls the way plants and animals look and the way their bodies work. The code transmits characteristics from one generation to the next.

DNA is very complex even though only four base compounds—adenine, guanine, cytosine, and thymine—make up its structure. These bases pair up to form a double strand called a double helix. Adenine always pairs with thymine, and guanine with cytosine. Except for identical twins, no two individuals have the same DNA makeup.

ACTIVITY

Assume that A = adenine, G = guanine, C = cytosine, and T = thymine. Make the code for a double strand of DNA if the base pairs of one strand are A A G C T T G G C C C A T T A.

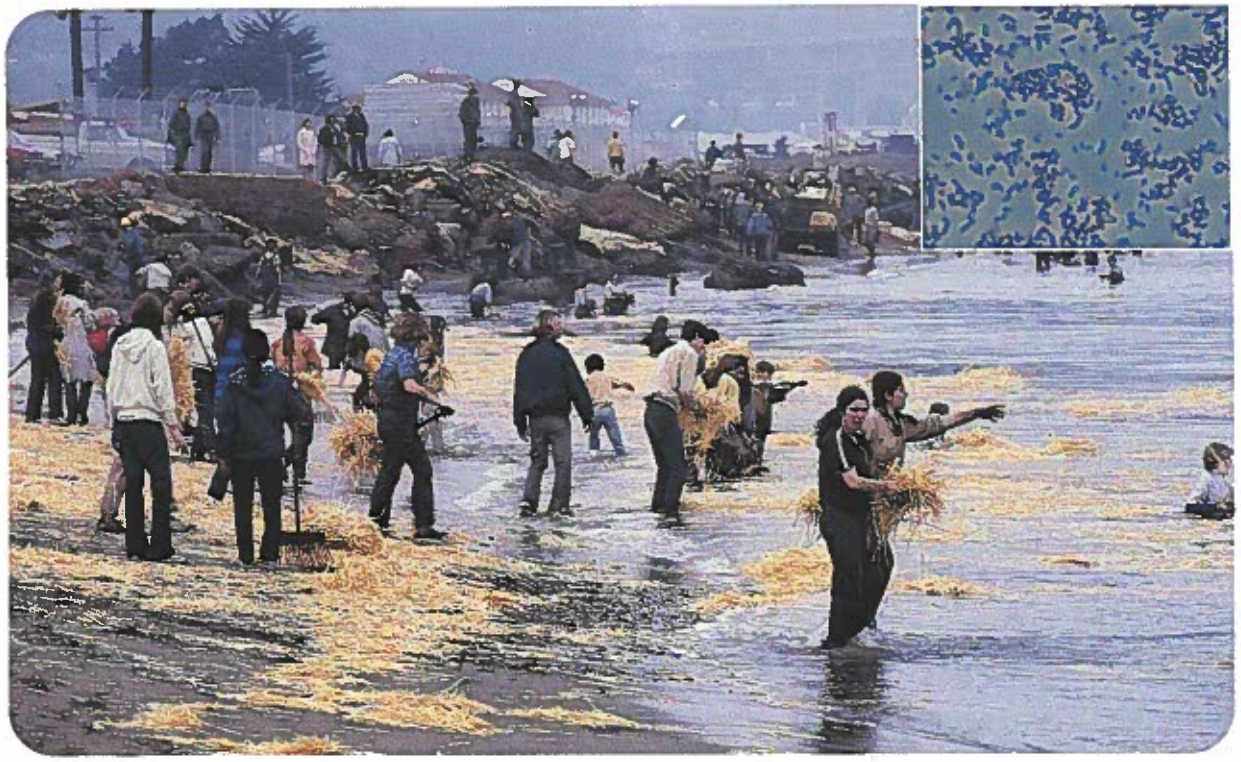


Fig. 19-10. Cleaning up after an oil spill, like this one in San Francisco, is very difficult. Many animals die in the meantime. But genetically altered bacteria (see inset, above) can eat the oil quickly. What do you think could go wrong with using bacteria in this way?

TechnoFact

IMPROVING CROPS

Corn has been improved to make it higher in nutritional value, more resistant to disease, and able to grow in colder climates. Scientists hope to try the same processes on other key crops such as wheat and rice.

The Law of Dominance

To improve plants for human use, geneticists must find out which plant traits determined by genes are *dominant* (producing traits that show) or *recessive* (producing traits that show only if no dominant gene is present). Each trait requires two genes to express it, one from each parent.

Gregor Mendel (1822-1884), an Austrian monk, was the first person to study how traits are carried from one generation of living things to the next generation. After many experiments with pea plants, Mendel stated the **Law of Dominance**. A dominant gene will always mask, or hide, a recessive gene when they occur together. Dominant and recessive genes make up the **genotype** (what actual genes the organism has) and the **phenotype** (what an organism looks like). Geneticists can use this information to change life forms.

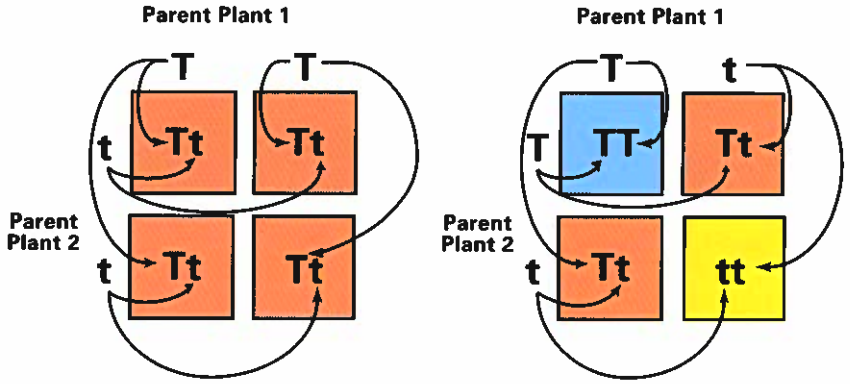


Fig. 19-11. In these Punnett squares, T indicates the gene for tallness and t indicates the gene for shortness. Which is the dominant gene?

A grid called a **Punnett square** is often used to show possible gene combinations in offspring (next generation). Figure 19-11 shows the offspring of two plants. The four boxes show the genotypes and the phenotypes of the trait for tallness. The upper-case letter T indicates the dominant gene for tallness and the lower-case t indicates the recessive gene for shortness. Will the plants be tall or short? You can tell just by looking to see if a dominant T appears in the box. If one or both genes are T, then the offspring will be tall. Are there any short plants in this generation? The second Punnett square shows the possible plant sizes if two parent plants with different genes (Tt) are crossed. Are all the plants tall?

TechnoFact

TONGUE TWISTERS

Can you roll your tongue into a distinct U shape? That's a dominant trait in many people. Can you twist your tongue into an S shape? That trait is recessive. Check your classmates for these traits!

SECTION 4 TechCHECK

1. What is genetic engineering?
2. How might genetic engineering help us?
3. What is the Law of Dominance?
4. **Apply Your Knowledge.** Find out more about Gregor Mendel and his plant studies. Make a report to your class.

ACTION ACTIVITY

Recessive or Dominant?

Be sure to fill out your TechNotes and place them in your portfolio.

Real World Connection

Researchers use Punnett squares to show possible gene combinations. In this activity, you will experiment with a Punnett square to show how dominant and recessive genes express themselves.

Design Brief

Use a Punnett square to determine possible gene combinations from crossing parent plants with different traits. A parent plant might be tall and have smooth seeds (TW), tall and have wrinkled seeds (Tw), short and have smooth seeds (tW), or short and have wrinkled seeds (tw). Fig. A.

Materials/Equipment

- 3" x 5" cards (at least 64)
- pencil and paper
- cardboard or tagboard
- colored pencils or markers
- PTC paper (optional)
- computer with graphics software (optional)

SAFETY FIRST

Follow the safety rules listed on pages 42-43 and the specific rules provided by your teacher for tools and machines.

	TW	Tw	tW	tw
TW	TTWW			
Tw				
tW				
tw				

Fig. A

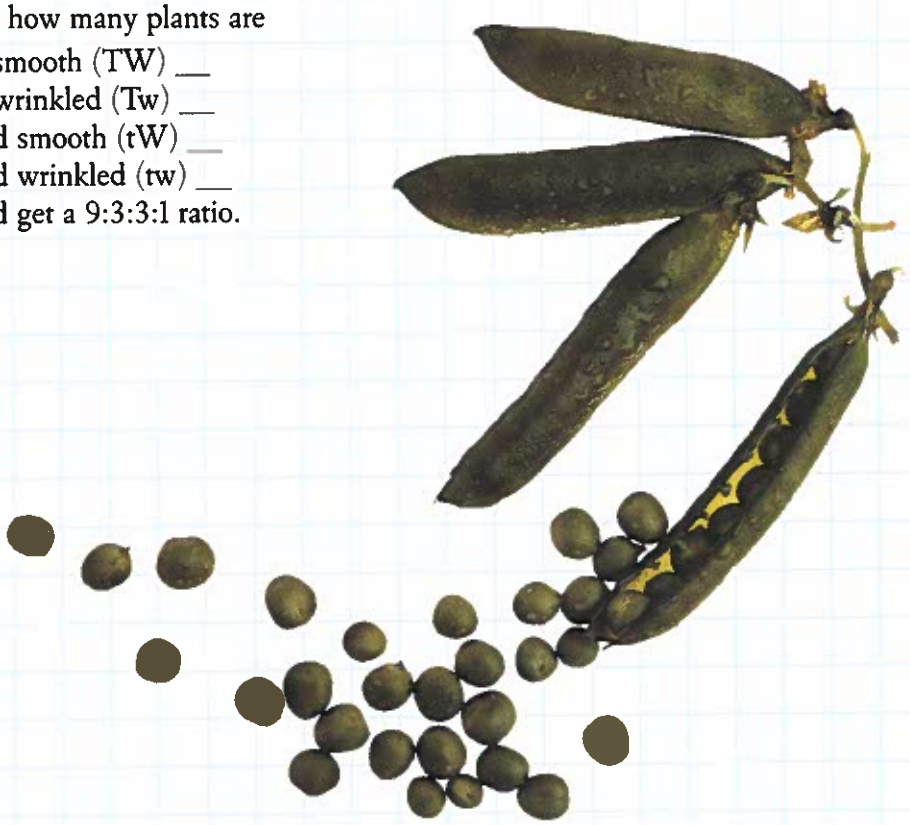
Procedure

1. Work in groups of four students. Each group should make up the following 3" x 5" cards to represent genes:
   - 16 cards with a large T to stand for dominant tallness
   - 16 cards with a small t for recessive shortness
   - 16 cards with a large W for dominant smooth pea seed
   - 16 cards with a small w for recessive wrinkled pea seed
2. Put all the cards together in a deck.
3. Make a large 16-box Punnett square to show plant combinations from a cross of two different traits.
4. Each student should draw a card from the deck and place it in the appropriate box on the Punnett square. Refer to the chart in Fig. A.
5. Determine how many plants are
   - tall and smooth (TW) ___
   - tall and wrinkled (Tw) ___
   - short and smooth (tW) ___
   - short and wrinkled (tw) ___

   You should get a 9:3:3:1 ratio.

Evaluation

1. Did you get a 9:3:3:1 ratio? If not, try again. This is a ratio of dominance for two traits determined by Gregor Mendel.
2. Is a dominant gene necessarily better than a recessive gene? What is the real difference?
3. **Going Beyond.** Research some genetic diseases such as sickle-cell anemia, cystic fibrosis, or Tay-Sachs disease. Find out if they result from dominant genes or recessive genes.
4. **Going Beyond.** Brainstorm ideas about how food crops or animals could be altered to make food production better. Evaluate the possible advantages of crossing a tomato and a watermelon.



CHAPTER 19

REVIEW &

CHAPTER SUMMARY

SECTION 1

- Bio-related technology includes technologies related to living things, such as genetic engineering, bionics, bioprocessing, hydroponics, and aquaculture.
- Chemical and bio-related technologies also deal with pesticides, waste management, biomaterials, hazardous wastes, and other environmental concerns.
- Bio-related technologies raise ethical questions about how we should use them.

SECTION 2

- Distillation can change salt water into fresh water. The process separates substances by their different boiling points.
- Fermentation uses microorganisms to turn grain into alcohols.
- Biofuels, such as ethanol and methanol, are made from fermentation.

SECTION 3

- Scientists study the flow of fluids to understand, control, and improve many natural and industrial processes.

SECTION 4

- Genetic engineering is a process of changing the gene structure of a plant or animal to improve it for human use.
- Genetics is the study of how traits are passed on from generation to generation.

REVIEW QUESTIONS

1. What is bionics?
2. Name two biofuels.
3. Name two types of fluids.
4. What is a gene?
5. Why would people want to alter genes in plants or animals?

CRITICAL THINKING

1. Research the many uses of soybeans as food substitutes for meats and other products. Do a survey to see if people can tell from taste and texture when soybeans are substituted for meat.
2. What effects do you think genetic engineering will have on the future? List three possible changes in your lifetime.
3. If you wanted to develop a plant that would resist a certain disease, would you try to make that trait dominant or recessive? Why?
4. Why were the *Apollo* astronauts kept away from other people for two weeks after their return to Earth? Was this precaution needed?
5. Research the operation of an artificial leg or hand. Draw a diagram of the prosthesis.