Read to Learn

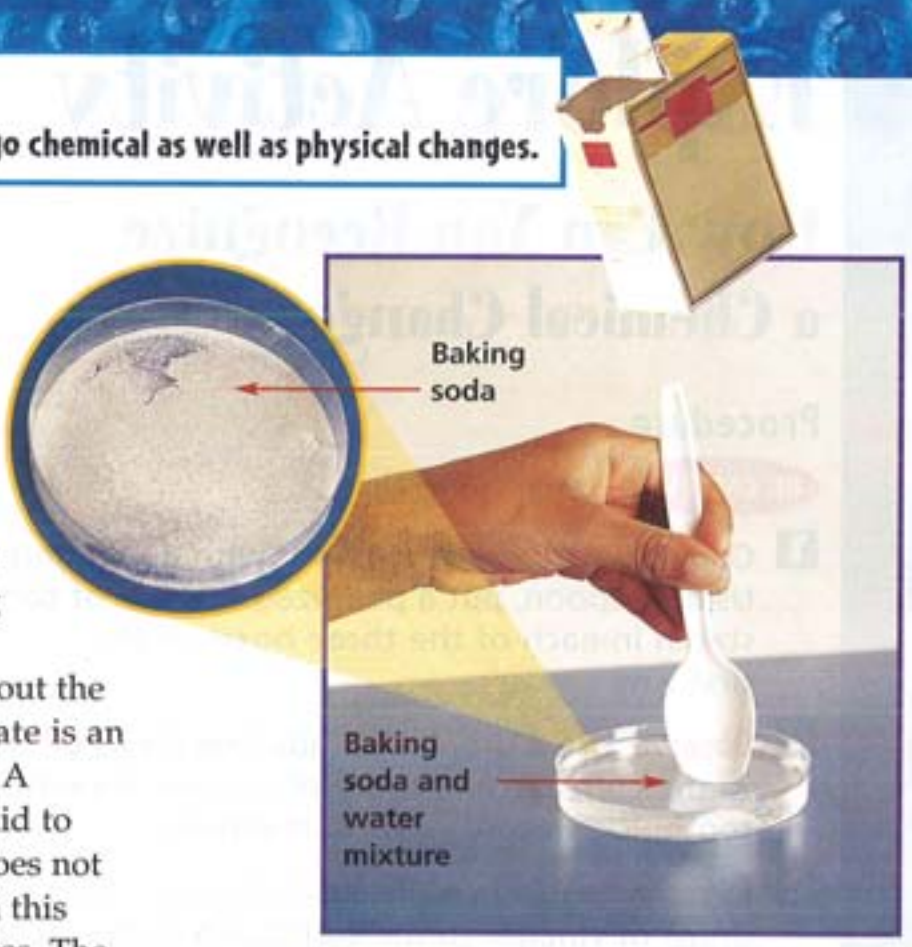
Main Idea **Matter can undergo chemical as well as physical changes.**

What Are Physical and Chemical Changes?

Different kinds of changes are going on all the time. In a **physical change**, matter changes in size, shape, or state without also changing identity.

In Lesson 3 you learned about the states of matter. Change of state is an example of a physical change. A substance can change from solid to liquid to gas. The substance does not change its chemical identity in this process. Its state simply changes. The photograph below shows why a change of state is a physical change.

You also learned in Lesson 4 about mixtures. Combining two substances to form a solution is another example of physical change. The two substances do not lose their identities. They can be physically separated from each other to give back the original substances. The photograph above shows this kind of physical change.



When baking soda mixes with water, the baking soda seems to disappear. However, when the water evaporates, baking soda is left behind. This is a physical change.

A change of state is a physical change. When the steam—gaseous water—hits the dish, it cools and turns back into liquid water.

The photo on page E68 shows a **chemical change**. Chemical changes occur when atoms link together in new ways. The changes cause new compounds to form. The new compounds have properties different from the original substances from which they were formed.

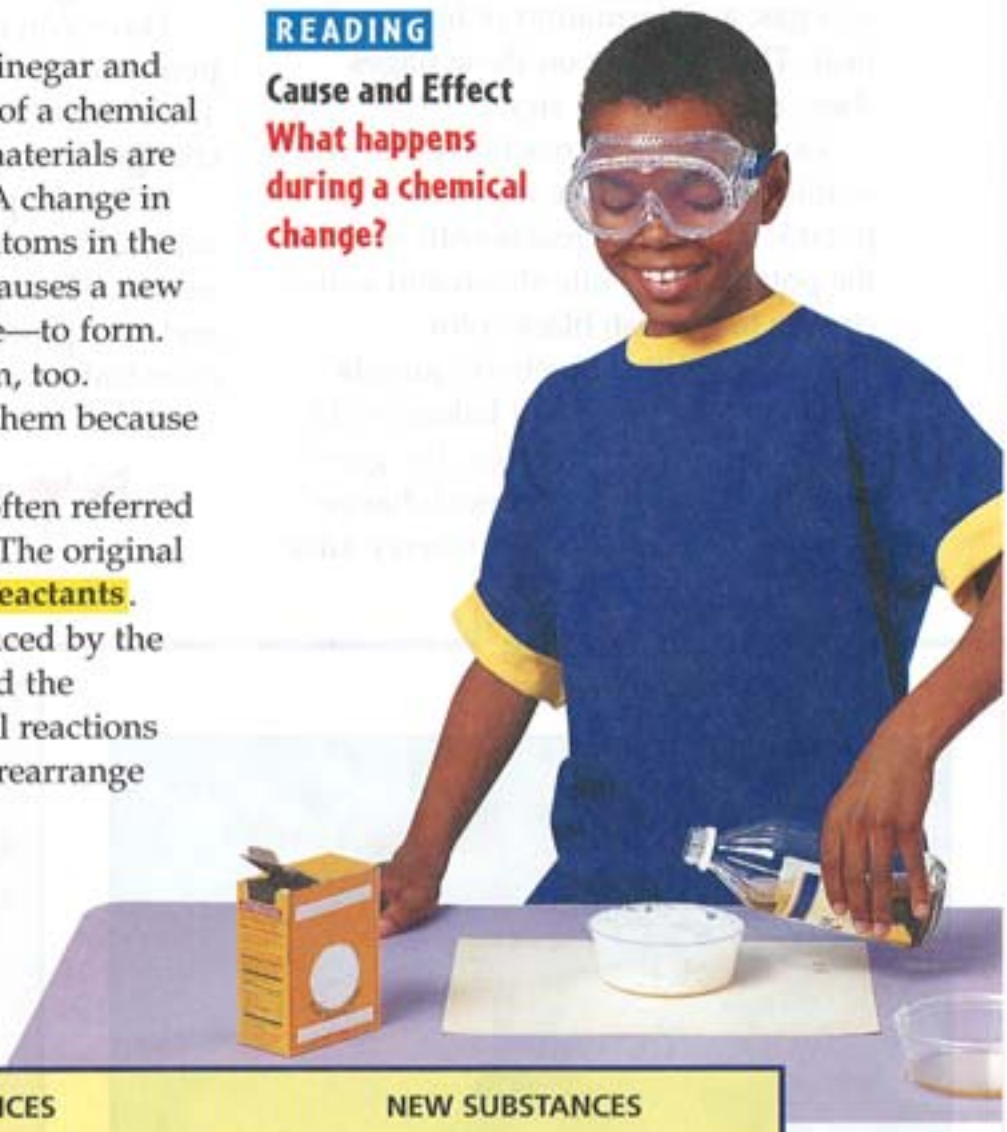
The reaction between vinegar and baking soda is an example of a chemical change. When these two materials are mixed, gas bubbles form. A change in the linking pattern of the atoms in the vinegar and baking soda causes a new substance—carbon dioxide—to form. Other new substances form, too. However, you cannot see them because they remain in the liquid.

Chemical changes are often referred to as **chemical reactions**. The original substances are called the **reactants**. The new substances produced by the chemical reaction are called the **products**. During chemical reactions the atoms in the reactants rearrange to form products with different properties. In the reaction between baking soda and vinegar, the baking soda and the vinegar are the reactants. The carbon dioxide, water, and a chemical called sodium acetate are the products.

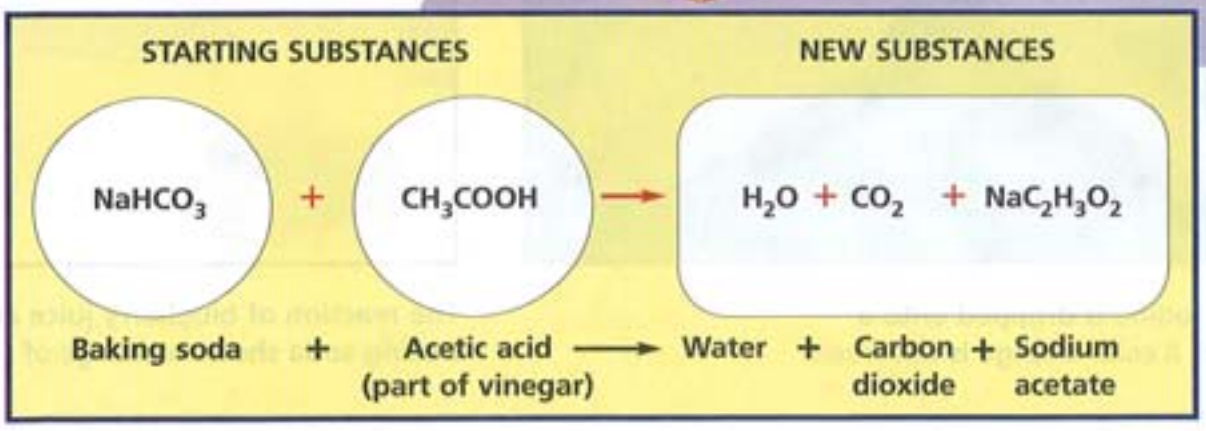
READING

Cause and Effect

What happens during a chemical change?



What happens when baking soda and vinegar mix?



What Are the Signs of a Chemical Change?

Chemical reactions often show one or more signs that a chemical change has occurred. These signs include a color change, formation of a gas, and formation of light and heat. The reactions on these pages show some of these signs.

Does a chemical reaction occur when reddish brown iodine is placed on a potato? The iodine reacts with starch in the potato. The white starch and iodine change to a bluish black color.

When reddish blueberry juice is mixed with a solution of baking soda, it turns to a greenish color. The green color results from a chemical change in the molecules of the blueberry juice.

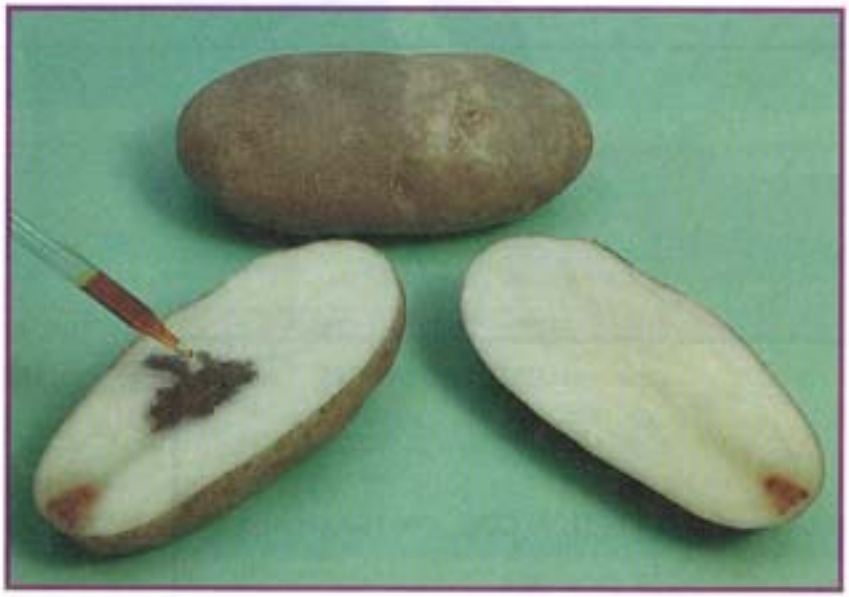
The bubbles you see when lemon juice is added to a solution of baking soda are a sign of a chemical change. Carbon dioxide gas forms by the reaction between acid in the lemon juice and the sodium bicarbonate in the baking soda.

Have you ever put hydrogen peroxide on a cut to kill germs? The bubbles tell you that a chemical change is occurring.

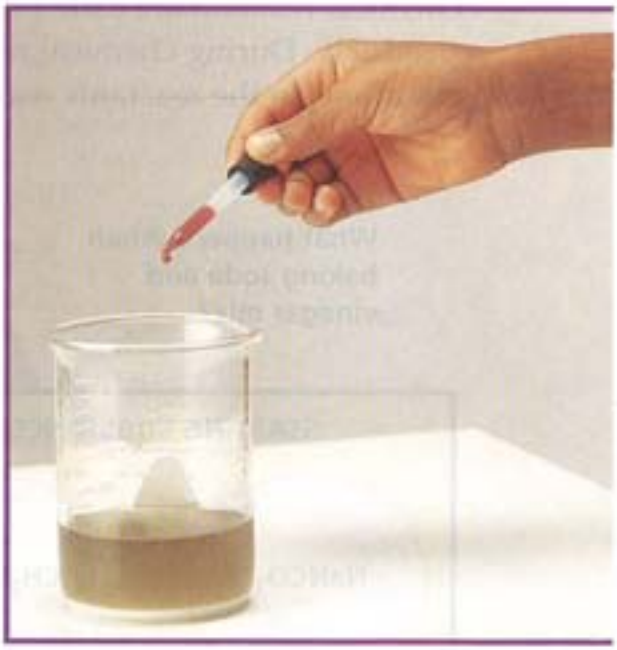
What happens when propane gas is released from a tank and ignited? It reacts with oxygen in the air. The light and heat produced are signs of this chemical reaction.

What are three signs of a chemical change?

Color Change



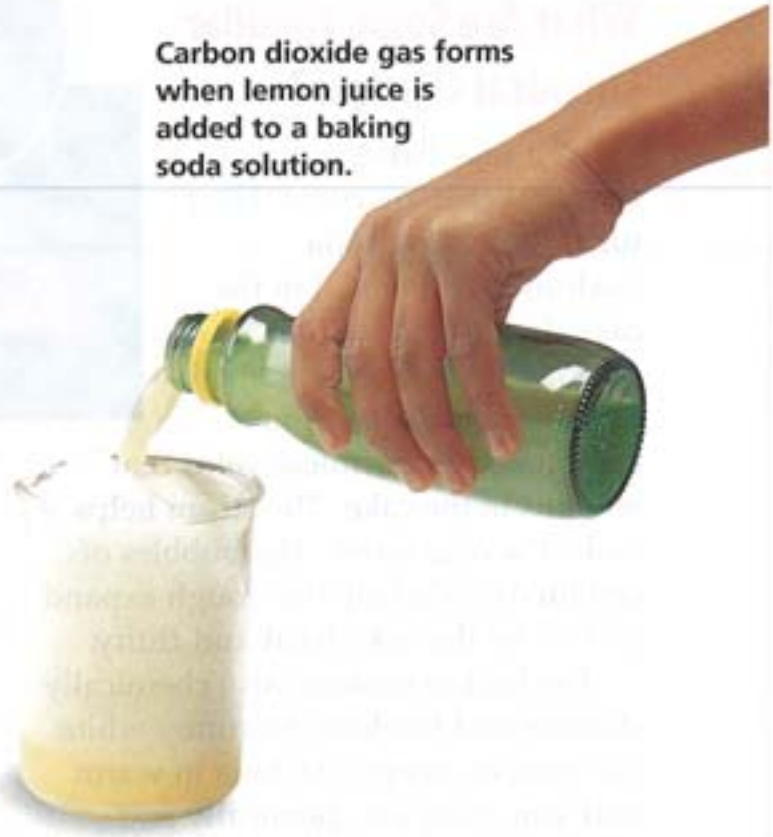
When iodine is dropped onto a potato, a color change is observed.



The reaction of blueberry juice and baking soda shows a change of color.

Formation of a Gas

When hydrogen peroxide comes into contact with bodily fluids, it reacts and gives off pure oxygen gas. The oxygen gas, in turn, kills germs in the cut and guards against infection.



Carbon dioxide gas forms when lemon juice is added to a baking soda solution.

Formation of Light and Heat

When propane burns in air, it chemically reacts with oxygen.

When you light a match, it gives off light and heat all on its own. This tells you that a chemical change is occurring.

What Are Some Familiar Chemical Changes?

As a cake bakes, several chemical changes occur. Heat turns the baking soda (sodium bicarbonate) in the cake dough into sodium carbonate, steam, and carbon dioxide gas. The sodium carbonate is a harmless solid that remains in the cake. The steam helps make the cake moist. The bubbles of carbon dioxide help the dough expand and make the cake light and fluffy.

The heat of cooking also chemically changes and hardens the runny white and yolk of an egg. Bacteria in warm milk can change it chemically and turn it sour.

The red powder covering the wheelbarrow above is iron oxide. Iron oxide is commonly known as rust. Rust forms when iron atoms in steel react with oxygen from the air. The reaction is very complex and needs moisture to occur. Steel objects are most likely to rust if they get wet and are not dried right away.

Rocket engines use chemical reactions to produce lots of heat. This space shuttle's main engines are fueled by liquid hydrogen and liquid oxygen. The two react together to make water vapor and the energy the shuttle needs. The shuttle also uses launch boosters containing a solid fuel, aluminum powder. When it burns, it changes to aluminum oxide.

Rust

Tarnish

The silver spoon in the photo is partly covered with a tarnish of silver sulfide. The silver sulfide forms when silver reacts with sulfur or hydrogen sulfide in foods or the air. You can even tarnish silver by wrapping it with a rubber band. Sulfur added to strengthen the rubber causes the tarnish to form. Polishes can be used to remove the tarnish and restore the silver's shiny appearance.

What are three examples of chemical changes?

Inquiry Skill BUILDER

SKILL Experiment

Preventing Rust

You've learned that steel forms rust when exposed to oxygen and moisture. Rusting can ruin metal objects. Can you find a way to stop or slow rusting? In this activity you will experiment to try to find the answer. In order to experiment, you need to do the following things. Form a hypothesis. Design a control. Carry out your experiment. Analyze and communicate your results.

Materials

- steel nails
- sand paper
- paper cups
- dilute salt water
- goggles

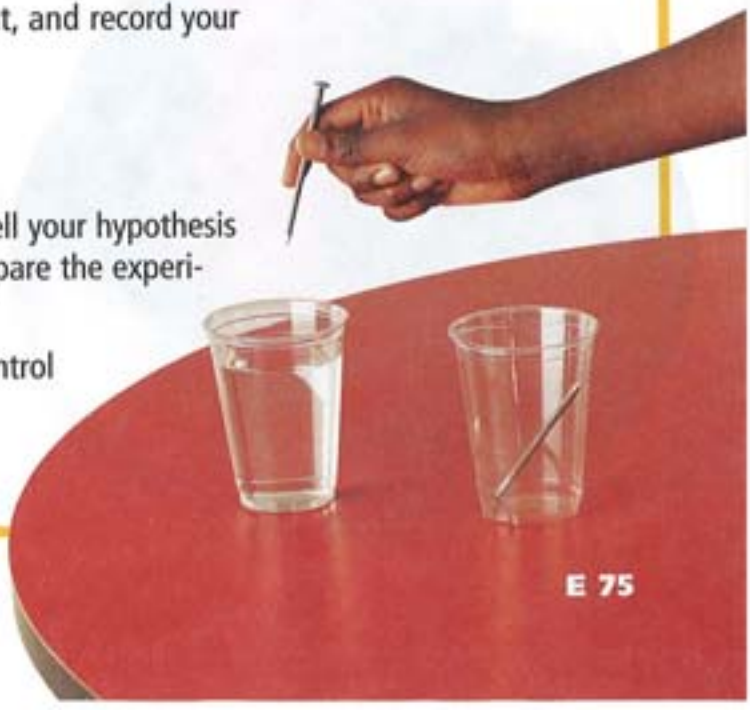
Procedure

BE CAREFUL! Wear goggles.

1. **Hypothesize** The photograph shows a method for making a steel nail rust. Think of a way to protect a steel nail from rusting under such conditions. Write down an explanation of why you think your method will work.
2. **Experiment** To test your method of rust protection, you need a control nail kept under normal conditions. Each experimental nail will have just one condition (variable) change. For example, what if you wanted to make a nail rust? You might leave one nail in a clean, empty jar (the control). You might put another in water. You might put a third in lemon juice. The amount of rusting that occurs is called the *dependent variable*. Write out how you will set up the experimental and control nails for your experiment.
3. **Experiment** Carry out your experiment, and record your observations.

Drawing Conclusions

1. **Infer** Write out a description of how well your hypothesis agreed with your results. Be sure to compare the experimental nail with the control nail.
2. **Communicate** Why did you need a control in this experiment?



Which Are Easier to Reverse – Chemical or Physical Changes?

You would probably agree that turning carbon dioxide gas, water, and sodium acetate back into baking soda and vinegar would be difficult. Simply stirring the three ingredients together would not give you baking soda and vinegar. In general, chemical changes are difficult to reverse. Imagine trying to "unburn" toast or "unspoil" milk!

On the other hand, physical changes can sometimes be easily reversed. Although this is not always true. For example, melting an ice cube can easily be reversed by cooling it until it freezes again. Stirring sugar into water can be reversed by letting the water evaporate.

What changes occur when toast burns? What happens when a candle burns?

However, it would not be so easy to put pieces of paper back together after cutting them from a single page. Still, if a change seems very easy to reverse, it is more likely to be a physical change.

The photograph of a burning candle shows that many changes are happening. Wax melts, runs down the side, and turns solid again. However, some of the wax turns into carbon dioxide gas and steam when it combines with oxygen in the air. This change releases enough heat to make the candle flame you see.

Why are chemical changes more difficult to reverse than physical changes?

Why It Matters

Chemical changes harden the yolk and white of your cooked egg. They make cake and bread rise and bake. Chemical changes turn milk sour. They turn fuels into heat to warm your home. Chemical changes even turn the food you eat into energy to keep you going. In what other ways are chemical changes important to you?

e-Journal Visit our Web site **www.science.mmhschool.com** to do a research project on chemical changes.

Think and Write

1. Is the rusting of a nail a chemical or a physical change?
2. Is the melting of ice a chemical or a physical change? Why?
3. When a match burns, what evidence is there that a chemical change is occurring?
4. **FURTHER INQUIRY** **Experiment** What if you wanted to find out if a cake bakes better with baking soda or baking powder? Design an experiment to test your ideas. Why might you want to use a control?
5. **Critical Thinking** What could you do to protect a bike from rusting?

L·I·N·K·S

LITERATURE LINK

Read *Let's Go Spelunking!* to learn about a trip to Howe Caverns. Try the activities at the end of the book.

WRITING LINK

Expository Writing The Statue of Liberty is a famous statue in New York Harbor. What is it made of? How does it look today? How did it look 100 years ago? What could have caused the statue's appearance to change? Research this topic and write a cause-and-effect essay.

MATH LINK

Solve this problem. A car uses fuel at a rate of 25 miles per gallon. How much fuel is consumed after traveling 100 miles?

TECHNOLOGY LINK

LOG ON Visit **www.science.mmhschool.com** for more links.

Can Chemical Reactions Make Food Safe or Unsafe?

Why do mold and bacteria grow in foods and spoil them? Are the foods unsafe to eat? What can be done to prevent microorganisms like molds and bacteria from spoiling foods? All the answers involve chemical reactions.

Like all living organisms, molds and bacteria require food. They can "eat" the same foods we eat and multiply in the food. They cause chemical reactions to occur in food, making it spoil.

In some cases, molds and bacteria can be harmful, perhaps even deadly, to people who eat foods in which these microorganisms have grown. Bacteria from contaminated food can multiply in the digestive tract of a person, causing vomiting, diarrhea, and intestinal bleeding. Hamburger, for example, may be contaminated with a bacterium known as *E. coli* O157:H7. Each year, *E. coli* O157:H7 causes about 73,000 illnesses and about 60 deaths in the United States.

To help prevent bacteria and molds from spoiling foods, food manufacturers may add chemicals to kill microorganisms. Sodium propionate, for example, is a chemical often added to cheeses and baked goods to keep molds from growing. Manufacturers also package foods in airtight containers and bags to prevent spoiling.

While food manufacturers take steps to keep the foods you eat safe, what can you do at home? Chemical reactions slow down as the temperature is lowered. Keeping foods in the refrigerator or freezer is a primary means of preventing the growth of bacteria and molds. The cold temperatures slow down the chemical reactions that make food spoil. Foods such as lunch meats and potato salads should not be kept out of the refrigerator for a long time.

The cheese in the photograph has spots of mold growing on it.

and Society

Vacuum-sealed containers prevent bacteria from contaminating food.

LOG ON Visit www.science.mmhschool.com to learn more about bacteria and mold.

Write ABOUT IT

1. How can molds and bacteria cause food to spoil?
2. What are some harmful effects of eating food contaminated with bacteria such as *E. coli*?