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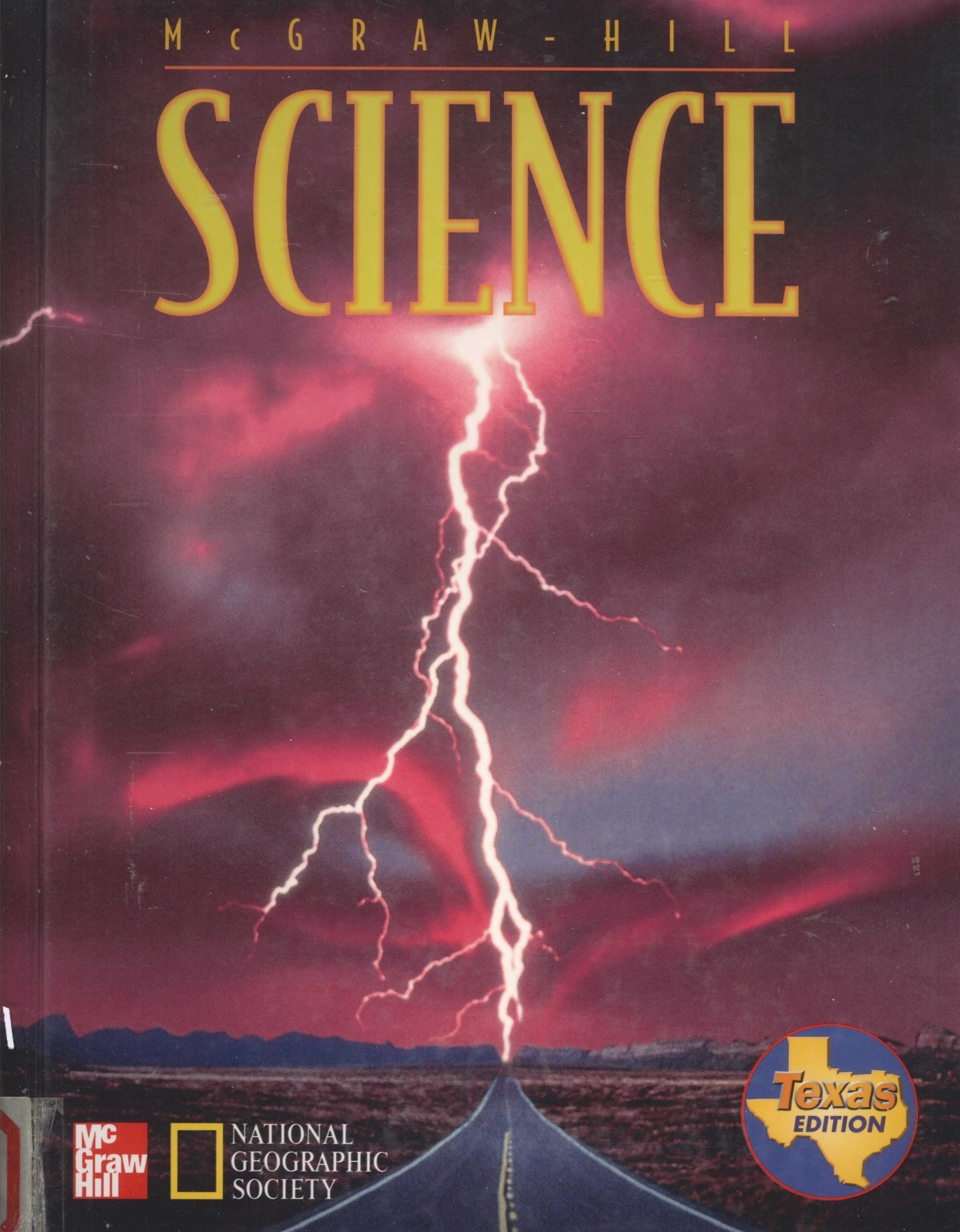

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NATIONAL GEOGRAPHIC SOCIETY

Texas EDITION

McGRAW-HILL

SCIENCE

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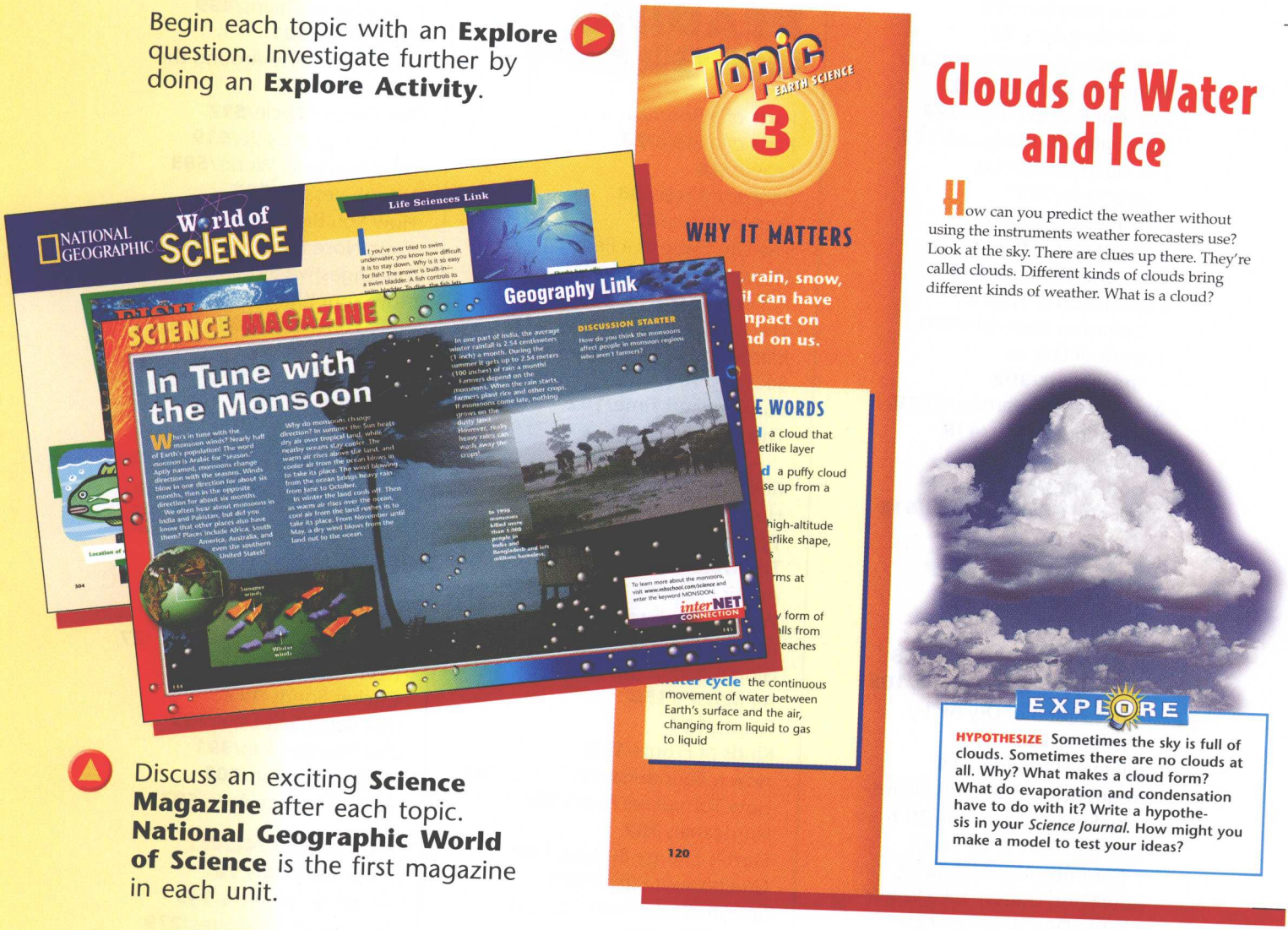
YOUR TEXTBOOK at a Glance

Begin each topic with an **Explore** question. Investigate further by doing an **Explore Activity**.



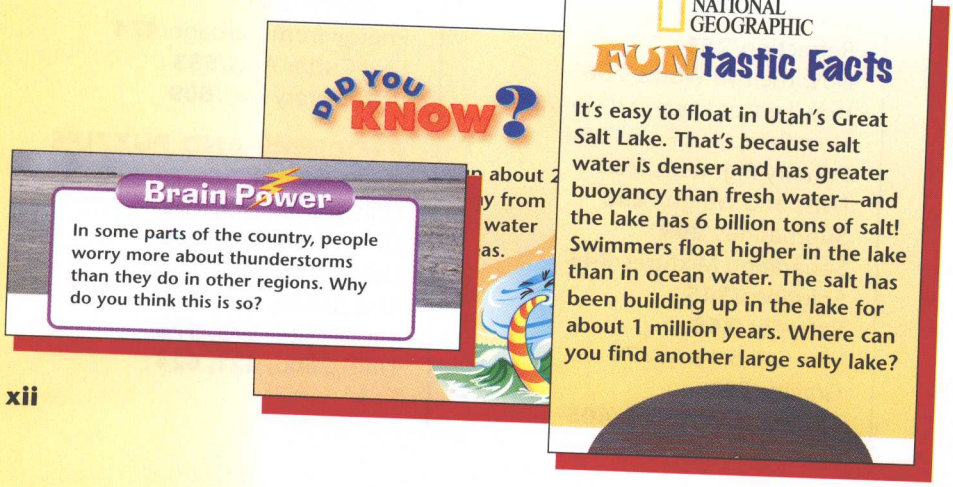
Discuss an exciting **Science Magazine** after each topic. **National Geographic World of Science** is the first magazine in each unit.

Clouds of Water and Ice

How can you predict the weather without using the instruments weather forecasters use? Look at the sky. There are clues up there. They're called clouds. Different kinds of clouds bring different kinds of weather. What is a cloud?

EXPLORE

HYPOTHESIZE Sometimes the sky is full of clouds. Sometimes there are no clouds at all. Why? What makes a cloud form? What do evaporation and condensation have to do with it? Write a hypothesis in your *Science Journal*. How might you make a model to test your ideas?



Flex your brain with questions about real-world facts.

NATIONAL GEOGRAPHIC

INVITATION TO SCIENCE

Nurturing strangler fig seedlings is part of Laman's research.

Safely strapped in, Laman works high above the rain forest floor.

EXPLORE ACTIVITY

Investigate Why Clouds Form

Watch what can happen when you cool off some air.

MATERIALS
- hot tap water
- 2 identical clear containers
- mug
- 3 ice cubes
- food coloring
- refrigerator or freezer
- *Science Journal*

PROCEDURES

SAFETY Be careful handling the hot water. Use the handle to hold the mug. Do not burn yourself.

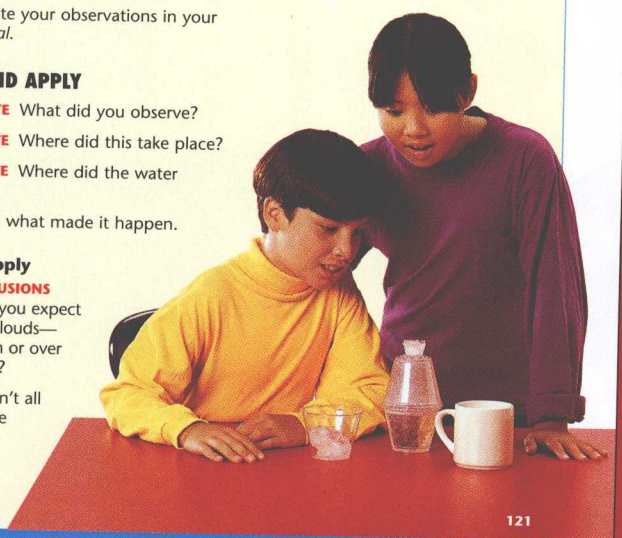
1. Chill container 1 by putting it in a refrigerator or on ice for about ten minutes.
2. Fill a mug with hot tap water.
3. **MAKE A MODEL** Fill container 2 with hot water. Place empty cold container 1 upside down on top of container 2 with the water. Fit the mouths together carefully. Place the ice cubes on top of container 1.
4. **OBSERVE** Write your observations in your *Science Journal*.

CONCLUDE AND APPLY

1. **COMMUNICATE** What did you observe?
2. **COMMUNICATE** Where did this take place?
3. **COMMUNICATE** Where did the water come from?
4. **INFER** Explain what made it happen.

GO FURTHER: Apply

5. **DRAW CONCLUSIONS** Where would you expect to find more clouds—over the ocean or over a desert? Why?
6. **INFER** Why don't all clouds look the same?



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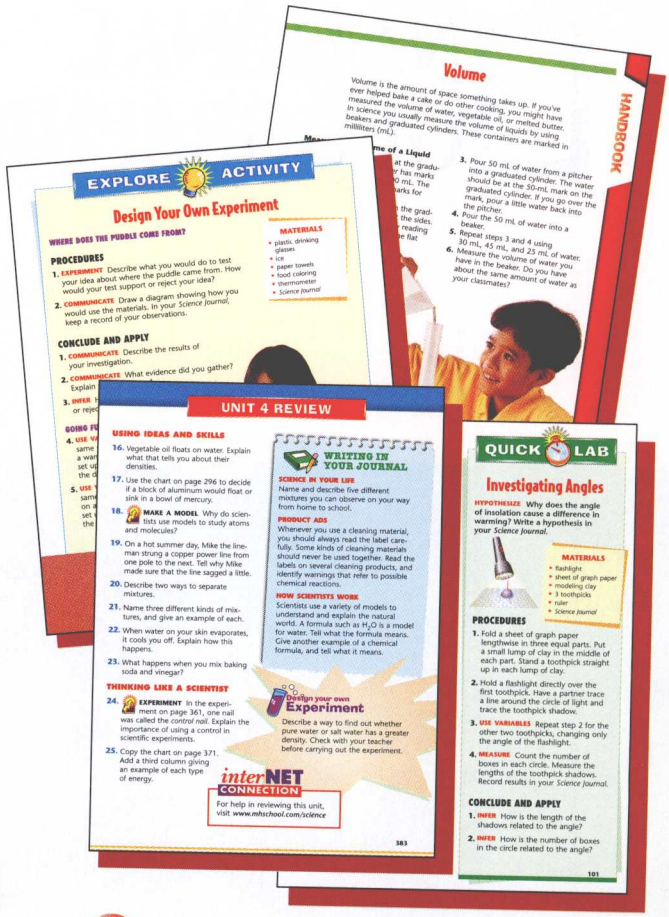
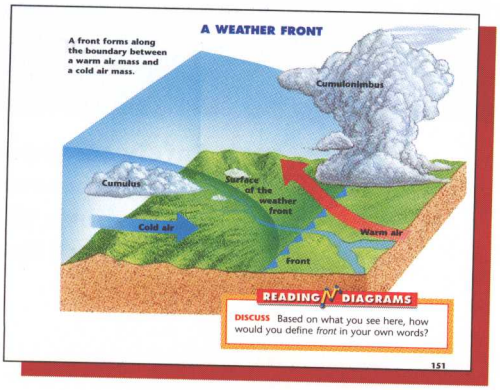


Design Your Own Experiments, do **Quick Labs**, use **Internet Connections**, and try **Writing in Your Journal**. Use the **Handbook** for help.

Reading Graphs, Diagrams, Maps, and **Charts** help you learn by using what you see.

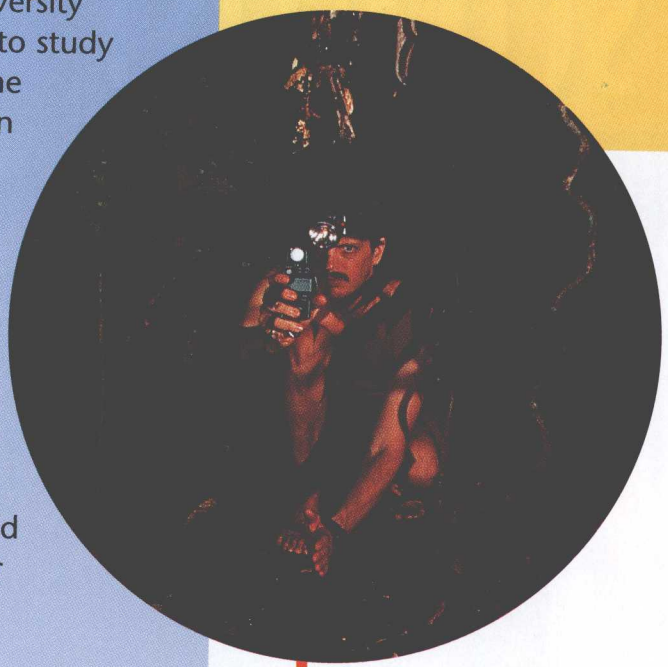


Build your skills with **Skill Builders** and **Problems and Puzzles**.

Tim Laman

Tim Laman's research takes him up into the sky-high rain forest canopy of Indonesia's Gunung Palung National Park. The Harvard University biologist climbs trees in the rain forest to study strangler figs. The figs sprout high in the trees and send their roots snaking down to the ground. Eventually the roots circle the host tree, cutting off growth.

Laman is a careful observer. Sometimes an observation pays off dramatically. One day when he was collecting samples high in a tree, Laman noticed tiny ants carrying fig seeds. "As I followed the trail of ants to their tree-crotch nest site, I realized I had discovered a new player in the strangler fig's seed dispersal."



For observing at night, Laman uses an infrared camera.

Laman had already discovered that birds play a major role in spreading strangler fig seeds. Birds eat the figs and then scatter the seeds throughout the rain forest. The seeds most likely to sprout are the ones that fall in decayed leaves high in the clefts of tree branches.

Measuring the growth of strangler fig seedlings is another part of Laman's work. High above the forest floor, he has planted more than 6,000 strangler fig seeds in the crowns of 45 trees.

Laman calls the pristine Indonesian rain forest a "biological frontier where there is much to discover."

Birds like this rhinoceros hornbill help spread the fig seeds through the rain forest.

BE A SCIENTIST

SCIENTIFIC METHODS

A fully grown giant sequoia can grow 100 meters (300 feet) tall!

Have you ever watched a tree grow from a tiny seed? Trees can grow taller than any other living things. Giant sequoias can grow taller than a 20-story sky-scraper and weigh about 13 times more than the heaviest dinosaur that ever lived! **Mass** (mas) is what scientists use to measure the amount of matter in an object. Giant sequoias started as small seeds. How did they gain so much mass?

Think of a heavy log burning in a fireplace. After several hours there is nothing left but a few ounces of ash. What happened to the rest of the log?

EXPLORE

Where do plants get their mass? Write some possible explanations in your *Science Journal*. How might you test your explanations?

EXPLORE ACTIVITY

Investigate Where Plants Get Their Mass

MATH LINK

Where do you think the extra mass comes from as a plant grows?

Think of a hypothesis about this question. A hypothesis is a statement in answer to a question. You must be able to test the statement in an experiment.

MATERIALS

- package of lima bean seeds
- 4 paper cups
- soil
- balance
- ruler
- water
- *Science Journal*

PROCEDURES

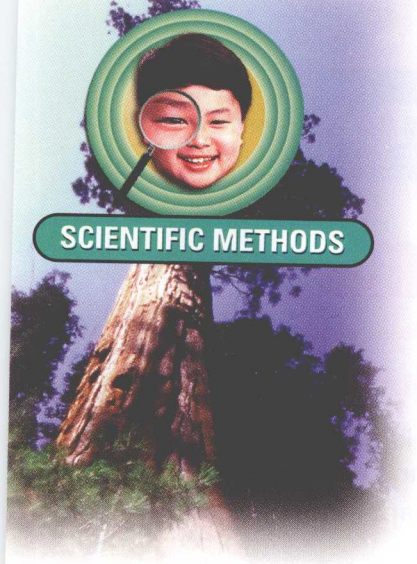
1. Fill the paper cups with a premeasured amount of soil. Use the same amount for each cup. Record the mass of the soil and the date in your *Science Journal.*
2. Find the mass of the seed. Record it and the date. Plant one lima bean seed in each cup.
3. Place the cups where they will get sunlight. Water the soil the same amount each week.
4. **OBSERVE** After three months, measure the plant height with the ruler and record your findings. Carefully remove the plant and root from the soil. Find the mass of the plant, and record it. Find the mass of the soil again, and record it.
5. **INTERPRET DATA** Compare the mass of the plant and soil now to the start of the experiment.

Sample data

	September	December
Plant height	7.6 cm (3 in.)	25.4 cm (10 in.)
Mass of plant	2 g	68 g
Mass of soil	225 g	223 g

CONCLUDE AND APPLY

1. **DRAW CONCLUSIONS** How much mass did the plant gain in three months?
2. Do you think the added mass of the plant came from the soil? Why? Do you think it came from the water you added? Explain.



Where Do Plants Get Their Mass?

All around us things are changing their properties due to chemical changes. A **chemical change** is a change of matter that occurs when atoms link together in a new way, creating a new substance different from the original substances.

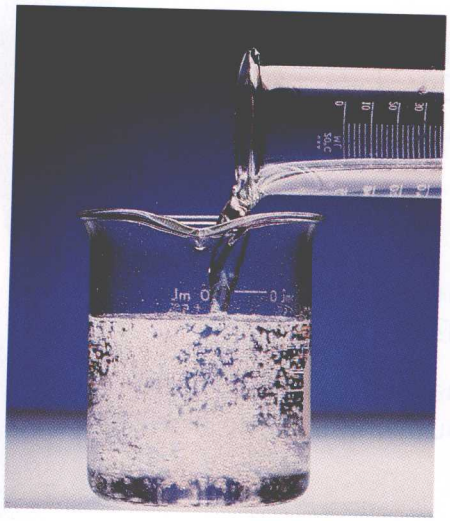
The Explore Activity showed that a chemical change took place when the seed was planted in the soil. Plants use energy from the Sun, water, nutrients from the soil, and air to make their own food and grow. The food-making process in green plants that uses sunlight is called **photosynthesis**

There are many types of chemical changes. Fire (1) causes a chemical change in burning wood. As the wood burns, the chemical energy stored in it is changed to light and heat. Some of the chemicals in the wood produce gas as they burn. Smoke is formed when the gas mixes with tiny particles of the burnt wood. The only solid material left behind is the ash, which has much less mass than the log.

Vinegar and baking soda (2) combine to form a gas. The gas is so light it rises into the air. Metals (3) turn to rust after being exposed to air for a long time.

1

2



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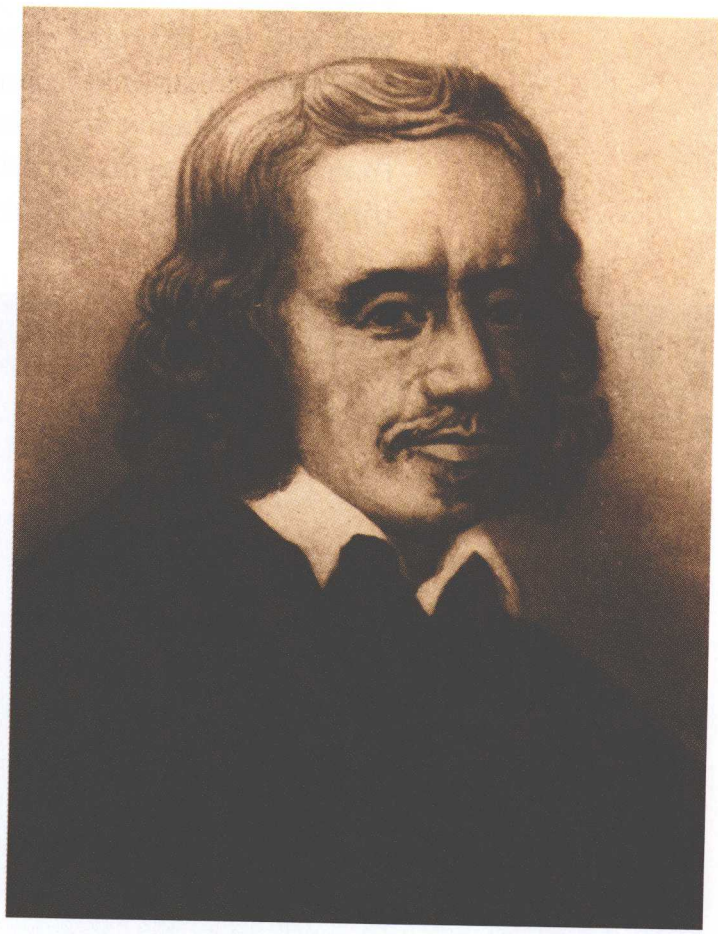
How Do Scientists Begin?

For hundreds of years, scientists have studied the chemical changes that make green plants grow. At one time it seemed reasonable to think that plants got their food by absorbing soil through their roots. A scientist named Jan Baptista van Helmont helped change that view over 300 years ago.

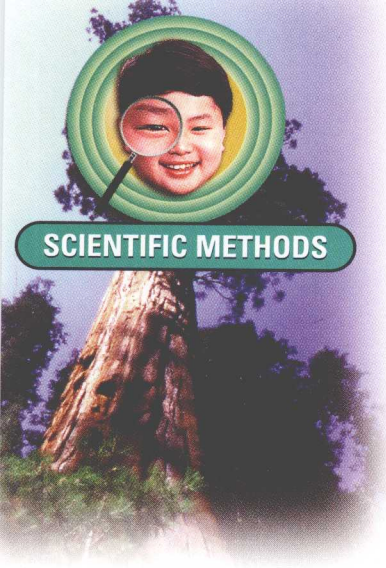
Scientists are curious about the world around them. This curiosity causes them to ask questions about things they don't understand. Sometimes they question the explanations accepted by others. This was the case with Helmont. He wondered whether plants really absorbed soil as others thought. He wondered whether anyone had ever actually tested the idea. He thought about how he could test this idea himself.

Does the mass of a tree come from absorbing the soil it grows in? He concluded that if a tree uses up soil to get its food, then the soil around it should get lighter. Helmont conducted an experiment to test his hypothesis. His findings changed the way scientists thought about how green plants grow.

Scientists need to think of ways to control as many parts of an experiment as they can. This helps determine what is or what isn't causing the change they are investigating. To investigate whether plants were absorbing the soil around them for food, Helmont decided to measure it.



Jan Baptista von Helmont was a doctor and chemist.



How Do Scientists Learn from the Work of Others?

Helmont planted a young willow tree that weighed 5 pounds in a tub that contained 200 pounds of soil. Then he carefully studied the tree and the soil for five years, recording all the changes that occurred. During this period his measurements showed that the tree grew to a weight of 169 pounds. In all that time, the soil lost only 2 ounces! The evidence showed that the tree had not gained all its mass directly from the soil. In fact it gained very little of its added mass from the soil!

The experiment answered one question, but it raised another question! How did the tree increase its mass?

After his experiment Helmont guessed that water provided everything a plant needed to grow. Now we know he was only partly right. Plants do need water to increase their mass, but most of all, green plants need sunlight. Thanks to the work of many scientists since Helmont's day, we know that few organisms can survive without receiving energy directly or indirectly from the Sun. Green plants use photosynthesis to mix energy from the Sun with water, air, and soil nutrients to make a kind of sugar. The sugar is used by the plant to grow its stems, its roots, its seeds, and all its other parts.

Helmont studied the growth of a willow tree to explore where plants get their mass.

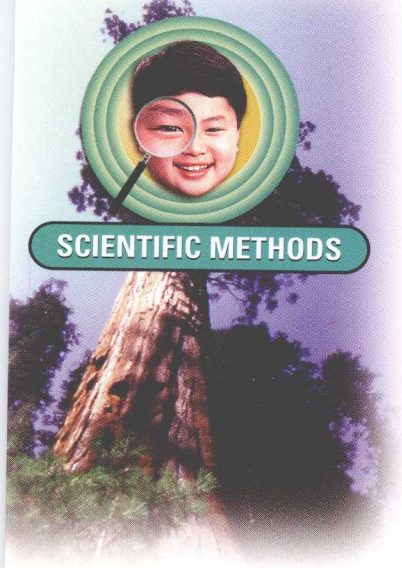
How Do Scientists Know What Questions to Ask?

Scientists today understand much about photosynthesis, but not everything. They still can't make it happen in a laboratory experiment. We *have* learned that the relationship between plants and soil is much more complicated than what was believed in Helmont's time.

One scientist who studies the way trees grow is Roy Renkin. Renkin is a **biologist** (bī ol'ə jist) who works for the National Park Service at Yellowstone National Park in Wyoming. A biologist is a scientist who studies plant and animal life. Thanks to the work of Helmont, Renkin learned that the trees he studies don't absorb much soil to increase their mass. When scientists answer one question, it often leads to more questions. Renkin had two questions. What makes forests grow? When a forest dies, how does it grow back?

In August 1988 a huge forest fire raged at Yellowstone National Park. Winds tore through the park at 112 kilometers (70 miles) per hour. Flames soared 110 meters (360 feet) into the sky. When it was over, more square miles of Yellowstone Park had burned during one

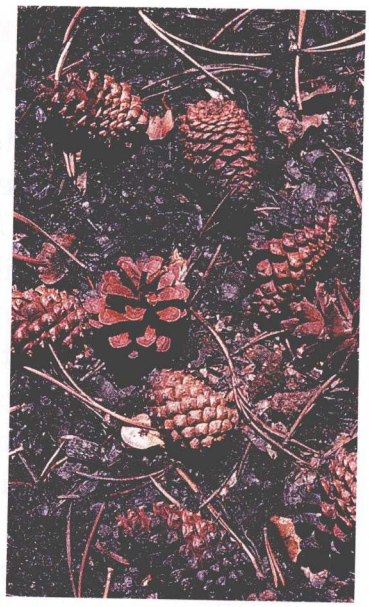
Roy Renkin is a biologist for Yellowstone National Park.



week than during any ten-year period since 1872! The fire burned nearly 1 million acres of forest, an area larger than the entire state of Rhode Island!

The fire seemed to be a great tragedy, but for Roy Renkin it was also the chance of a lifetime. It gave him the chance to investigate the questions he had about how forests begin to grow.

Scientists once believed that intense forest fires destroyed the roots and soil nutrients that plants need to grow. The Yellowstone fire helped show that that was not true.



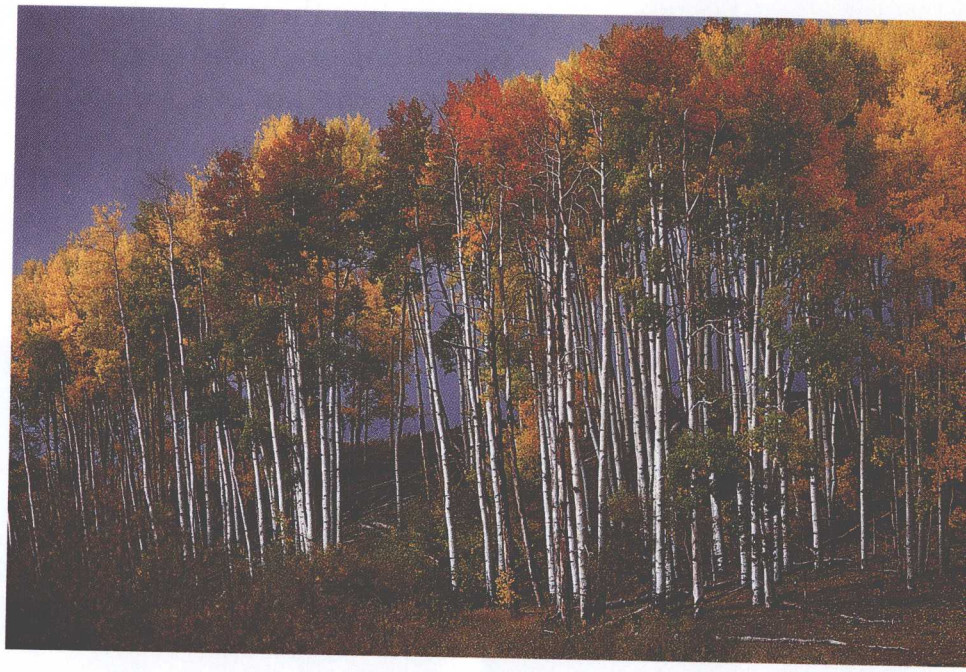
Some lodgepole pine cones open only after a fire.

Some trees use a forest fire to help them reproduce. Some of the pine cones dropped by a lodgepole pine evergreen tree open to release their seeds only after they have been burned! After the Yellowstone fire, Renkin and other scientists found as many as one million or more lodgepole pine seeds per acre. Renkin also discovered that the ash from the fire made the soil's nutrient levels increase for the first year or two after the fire. Within five years after the fire, he found the forest ground was covered with new growth.

The 1988 Yellowstone fire destroyed nearly 1 million acres of forest!

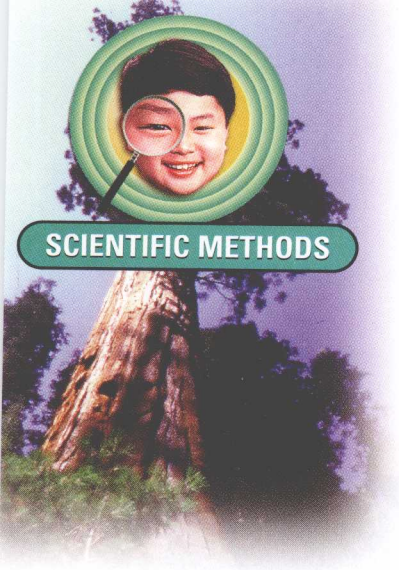
Renkin also investigated the park's aspen trees after the fire and made an important discovery. He discovered that a forest fire is one the best things that can happen to aspens.

Aspens grow mostly in the western areas of North America. Scientists know that groups of aspens are connected underground through a large root system. Scientists used to think that new aspen trees grew only as shoots from the underground root system of the older aspens. After the Yellowstone fire, Renkin discovered aspens growing from seedlings. He also discovered they were growing from seeds because the fire changed the forest soil. The change in the soil's nutrients and moisture content because of the fire created the conditions in which the aspen seedlings could grow on their own!



Aspen trees often share one huge root system.

Renkin has helped us understand that fire can be a natural process that helps a forest. As forests age, dead timber builds up on the ground. Fires become more likely. Careless people cause many forest fires, but lightning can also start one. Lightning striking a new forest may have little effect, but if it strikes the downed, dry timber of an old forest, it can spark a widespread fire. Some trees, like the lodgepole pine and the aspen, have developed ways to use the new conditions to their benefit.



How Can I Be Like a Scientist?

Scientists start with curiosity! They **look carefully** at things around them and **ask questions**. How can trees grow so tall? How can heavy, burning logs turn into lightweight ashes? Do forest fires prevent new young trees from growing, or do they help them? You may have observed things around you that made you wonder.

Thinking like a scientist means trying to find answers to questions like these. Sometimes it means not believing the explanations of others. Helmont conducted his experiment because he did not believe the conclusions of the scientists before him.

Try picking a favorite tree and learning what you can by observing it over the course of a year. See if your observations lead to another hypothesis you might be able to test.

A deciduous tree changes with the seasons.

Now let's go back and look at how you thought like a scientist when you did the Explore Activity on the increase in mass during plant growth.

YOU ASKED YOURSELF QUESTIONS

To be a scientist means asking questions about the world around you.

When you thought about tall trees growing from tiny seeds, you wondered where their mass came from. You asked yourself: How can I test my ideas to answer my questions?

YOU SET UP AN INVESTIGATION

At the beginning of the Explore Activity, you thought about a **hypothesis**. It was an idea or a guess about what would happen that you could test. You then **planned your experiment** and planted your seeds.

You **measured** the materials and **started your observations**. You **recorded** and **organized** the information to help you understand it better. You **shared your observations** with others in the class. Just as later scientists learned from Helmont, you learned by looking at the data of the other students.

YOU USED THE RESULTS OF YOUR INVESTIGATION TO ANSWER QUESTIONS

To be a scientist, you need to observe the process of your experiment closely. You also need to **analyze the results** and **draw conclusions**. After you studied the measurements of the experiment, it was clear the gain