The Frog Scientist
by
Pamela S. Turner
Photographs by Andy Comins

Teacher’s Edition
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The Frog Scientist
by Pamela S. Turner

JLG Guide written by Linda Barr

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About the Author

Pamela S. Turner says she writes for “my twelve-year-old self” about the things that interested her back then—and still fascinate her. She never tires of learning more about animals, the environment, and the people who try to help them both. Those people range from a frog scientist, to a gorilla doctor, to an astrobiologist. Her books take readers through swamps, across deserts, deep under the ocean, into outer space, and everywhere in between.

Ms. Turner’s hands-on research and lively writing has won many awards. For example, *A Life in the Wild* won the 2008 Golden Kite for best nonfiction children's book. *Life on Earth—and Beyond* was selected as one of the best children’s books of the year by the Bank Street College of Education.

Like most writers, Ms. Turner loves to read. She learned to write her name at age four just so she could get her first library card. She also loves animals and learned much about them during the year she lived in Africa as a college student. After she married, her family lived in Japan, the Philippines, and other nations. In fact, her three children were each born in a different country!

In addition to writing, Ms. Turner volunteers at a wildlife hospital. Scuba diving allows her to get closer to the animals that live underwater, from sharks to sea slugs.

She and her family now live in California, where Ms. Turner is busy with several books that will be published soon. She also has written many articles about animals and people for *National Geographic Kids, Odyssey, Highlights for Children*, and other magazines. To find out more about Ms. Turner and her books and articles, check out her Web site: www.pamelastrurner.com.
Building Background: The Scientific Method

In this book, scientist Tyrone Hayes uses the scientific method to ask and answer a question. You might have used this same method in science class and elsewhere to figure out how things affect each other. Tyrone designs his experiments to see whether changes in one variable (water, in this case) cause changes in frogs.

These are the steps in the scientific method:

① **Ask a question.**
   For example, you know that pesticides can damage the environment, but you still want to get rid of the bugs on your roses. You might ask, “Does ‘environmentally safe’ pesticide soap work as well as a traditional pesticide?”

② **Form a hypothesis.**
   You have already tried pesticide soap, so you know it kills some of the bugs. You think you know the answer to your question. Your hypothesis is a statement: “Pesticide soap kills about half as many bugs as a traditional pesticide.” Your hypothesis is an educated guess about how things work.

③ **Design an experiment.**
   Now you think of an experiment that will determine whether your hypothesis is correct. You must make sure that only one variable—the bug killer—changes in your experiment. The other variables, such as the number, kind, and health of the bugs, must remain the same. For example, if you try out the pesticide soap on young, healthy bugs but spray the traditional pesticide on old bugs, your results may not tell really you which pesticide works better. If you use more of the pesticide soap than the traditional pesticide, your results will not be about which pesticide works better, but how much more of one you used.

④ **Conduct your experiment.**
   Follow each step in your experiment, carefully recording what happens, including results that you did not expect.

⑤ **Draw conclusions.**
   Review your results. Did the pesticide soap kill half as many bugs as the traditional pesticide? If so, you might have other questions. For example, if you apply pesticide soap twice as often, will it kill twice as many bugs? You might need to plan another experiment!

Think About It

- Why do scientists of all ages use this method?
- What kinds of things could you discover by using the scientific method?
Prereading Activities

Book Summary
As a boy in South Carolina, Tyrone Hayes loved to collect pond creatures, such as frogs, turtles, and snakes. Now he’s a graduate of Harvard University and a professor at the University of California, but he still likes frogs. Just as Tyrone began a serious study of frogs, scientists worldwide became aware that Earth’s frogs were dying. Tyrone has spent years trying to determine why we are losing frogs, focusing on the effect of pesticides on amphibians. This book follows Tyrone and his students as they collect and examine frogs to pinpoint the threats to their health, which also could be threats to human health.

Understanding the Genre: Nonfiction

1. What is the main difference between fiction and nonfiction?

   Fiction is not true; it is made up. Nonfiction is factual, about real people, places, or things.

2. If you were doing research before you wrote a book about frogs, what are some kinds of information sources you would use?

   Answers will vary but may include encyclopedias, the Internet, magazines, books, newspapers, interviews, government information, etc. Some students might conduct hands-on research.

3. A book titled *The Frog Scientist* might fall into several genres besides nonfiction. What would you expect from a science-fiction book titled *The Frog Scientist*? From a fantasy book titled *The Frog Scientist*?

   Possible science fiction story: fiction that takes place far in the future or on another planet. Possible fantasy story: fiction with talking animal characters and/or magic.
Prereading Activities

Activating Prior Knowledge
Fill in the first two columns of the KWL chart below to show what you know (K) about frogs and what you want to know (W) about them. Later you will fill in the last column to show what you learned (L).

<table>
<thead>
<tr>
<th>K</th>
<th>What I Know</th>
<th>W</th>
<th>What I Want to Know</th>
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<td>Answers will vary.</td>
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Survey the Book
1. Read the table of contents. Why does this book include the special sections that start on page 52?

The book is nonfiction, so readers might be using it for research. The special sections connect them to additional sources of information.

2. How is the table of contents different from the index?

The TOC lists the titles of the chapters and sections, but the index lists all of the topics mentioned in the book.

3. How is the index different from the glossary?

The index lists the topics mentioned in the book; the glossary defines terms that might be unfamiliar to readers.

4. What are “introduced species”? On which page can you learn more about them?

They are species that are not native to an ecosystem; page 17.
The Frog Squad
pages 1–7

Before You Read
Making Predictions
Look at the photos in this chapter. Who or what do you think the “frog squad” is?

It’s a group of people who catch and study frogs.

After You Read
Mastering Vocabulary
1. You learned on page 2 that the scientific name for mayflies is *Ephemeroptera*, which means “lasting but a day.” If the pleasure of eating a cookie is *ephemeral*, what does that mean?

The pleasure lasts a short time.

2. On page 4, find the words *clutches* and *clutch*. Which word has the familiar meaning? What is that meaning? What does the other word mean? (Look this word up in a dictionary if you cannot define it based on context clues.)

*Clutch* is the familiar word, meaning “to hold onto.” *Clutches* means “nests of eggs.”

3. Also on page 4, find the phrase *break down* in the second long paragraph. Sometimes a car “breaks down” and needs repairs. Someone feeling very sad may “break down” in tears. Use context clues to determine the meaning of *break down* in this sentence.

Here, “break down” means to decompose or lose its strength.

4. On page 6, find the word *feminized*. You are familiar with the word *feminine*, so what does *feminized* mean?

to make feminine; to give a male animal feminine characteristics
Identifying Main Ideas
1. Write the one sentence in this chapter that summarizes the goal of Tyrone’s experiments.

   Page 3: “Tyrone wants to know how pesticides in the environment affect growing frogs.”

2. Why is Tyrone concerned about frogs?

   Frogs are sensitive to water pollution. Polluted water can affect human health, too.

3. Why is Tyrone concerned only about male frogs?

   They are affected by the pesticide atrazine, but the female frogs apparently aren’t.

Understanding Cause and Effect
To identify an effect, you can ask, “What happened?” To identify a cause, you can ask, “Why did that happen?” Often causes and effects form a chain. An effect becomes the cause of another effect. Use what you have learned in this chapter to complete this cause-and-effect chain.
**Drawing Conclusions**

1. Why did Tyrone hike far into the Wyoming hills to find frogs for his experiment?

   He wanted to collect frogs that probably had not been exposed to pesticides.

2. Why did Tyrone take some frog eggs out of the pond before adding a drop of atrazine?

   He needed to have frog eggs that were not exposed to atrazine to compare with eggs that were exposed. The unexposed eggs would be his control group.

3. Since pesticides might harm the environment, why do farmers use them?

   Pesticides are an effective way to protect their crops from insects and weeds.

4. The photo on page 6 shows labels for water samples. Why is this careful record-keeping important?

   Scientists must know exactly where and when the water was collected before they can draw conclusions about how the water might have affected the frogs.

**Making Connections**

Would you enjoy being part of the “frog squad”? Why or why not?

Answers will vary.
The Frog Kid
pages 8–11

After You Read
Making Inferences
1. How do you think growing up in the segregated South affected Tyrone?
   Possible response: He probably had to work harder to reach his goals. Others
   might have looked down on him and may not have recognized his potential.

2. Why might someone say that Tyrone graduated from college at just the right time?
   He was fascinated by frogs and ready to help them just when they needed help to
   survive.

3. Reread page 11. What three things will happen to the wood frog population if
   temperatures rise worldwide?
   Wood frogs will develop faster, they will be smaller, and the number of females
   will increase.

Making Connections
1. How was Tyrone’s childhood like yours? How was it different?
   Answers will vary.

2. Which of your hobbies or interests might you continue as an adult? Could you turn
   any of them into a career, as Tyrone did? How?
   Answers will vary.
Asking Questions
If you could, what two questions would you like to ask Tyrone about his childhood or college years? **Answers will vary.**

1. ___________________________________________

2. ___________________________________________

Career Connection
Dr. Hayes is a biologist and herpetologist (a specialist who studies reptiles and amphibians). However, as a boy, he thought that a career in science meant being a doctor.

Look at the types of scientists' jobs below and find out what each one studies:

- marine biologist
- ecologist
- ichthyologist
- meteorologist
- toxicologist
- immunologist
- botanist
- etymologist

Use the Internet to learn more about careers in scientific fields that interest you. Then research colleges, especially those in your state, to find out where you could earn a degree in that career.

Make a chart showing the fields you selected and colleges where you might study them. Post your chart to share what you learn with classmates.
Before You Read
Introducing Vocabulary
Find each word below on the page listed. Infer its meaning from the context of the sentence or paragraph. Then confirm the meaning in a dictionary.

- **gastric** (page 14) *relating to the stomach*
- **brooding** (page 14) *sitting on or incubating eggs*
- **UV radiation** (page 17) *a form of energy found in sunlight*
- **parasite** (page 18) *a living thing that obtains its energy from another living thing*
- **vulnerable** (page 19) *easily harmed*

After You Read
Analyzing Writing
In this chapter, the author uses these two similes:

- “The males . . . were golden orange, like web-footed tangerines.” (page 14)
- “Instead of chasing its prey, the Pac Man sits and waits like a web-footed couch potato.” (page 19)

These similes compare frogs to tangerines and couch potatoes. Choose a frog pictured in this chapter and, using a separate piece of paper, write a short paragraph about it. Do some research to learn about its diet, habitat, and so on so you can include that information in your description. In your paragraph, use a simile that compares your chosen frog to something “unfroglike.” Answers will vary.

Making Inferences
1. Why might the 1989 international conference have saved many amphibians from extinction?

   Scientists shared information and recognized the decline in most amphibians. Now they are working to identify and reduce the causes.
2. Some frogs are born deformed. Why is that a problem?

A deformity can make it harder for a frog to move, so it has trouble catching food and escaping from predators.

3. All amphibians are cold-blooded. How does that affect them?

They must avoid temperature extremes, as their bodies can’t warm up or cool off on their own. They often burrow into the ground during very cold or hot weather.

4. Why are some frogs dark and spotted, while others are brightly colored?

Dark colors and spots help frogs blend into their surroundings, but frogs that are poisonous are brightly colored to warn predators not to eat them.

5. Why do introduced species often become a problem?

They have no natural enemies, so they breed quickly and prey on native species and/or crowd them out.

Making Connections
1. According to this author, what are the five main causes of the frogs’ decline?

habitat loss, fungal disease, introduced species, parasites, pesticides

2. Which of these causes are most likely to affect the frogs in your community?

Habitat loss and pesticides are likely, but other answers are possible.

Math Connection

On page 14, you learned that at least 122 of 5,743 species of amphibians have probably become extinct since 1980. What percentage of amphibians has become extinct? a little more than 2%

At least 1,856 species are now threatened with extinction. What percentage of amphibians falls into this category? about 32%

What percentage of golden toads is now extinct? 100%
The Amphibian Ark
pages 20–21

After You Read
Mastering Vocabulary
1. The word *exotic* has several meanings, including “a species that is not native to the place where it is found” and “different or unusual.” Which meaning of *exotic* is used in the next-to-last paragraph on page 21? Explain your answer.

   The meaning used is “different or unusual.” The author is not suggesting that Panamanian frogs have been found where they are not native. Instead, they are a different or unusual kind of frog.

2. Why does that paragraph also discuss Houston toads?

   They author is contrasting a familiar, American amphibian with the more exotic Panamanian frogs.

Summarizing Information
1. What is the purpose of the Amphibian Ark?

   It was formed to rescue and breed amphibian species that may become extinct.

2. Why must the staff of the Amphibian Ark work quickly?

   The chytrid fungus and other threats are killing off amphibian species right now.

Art Connections

Study the frog photos in the chapters you have read so far. Think about why each frog has its name. Then draw a new kind of frog and give it a name. (You can trace this frog for an outline if you wish.) Use colored pencils to indicate its color or markings. Add a sentence or two that explains why the name you chose suits your frog.
Follow the Water
pages 22–27

After You Read
Identifying Main Ideas and Details
Complete each main idea below. Then write two details that support the main idea.

1. It’s important to study atrazine because 75 million pounds of it enter our environment each year.
   
   Detail: Possible detail: Atrazine breaks down in a few months, but farmers apply more of it each spring.

   Detail: Possible details: Atrazine is used on corn, the largest crop in the United States; atrazine is the top-selling chemical in the world.

2. After experimenting with African clawed frogs, Tyrone decided to study leopard frogs.

   Detail: Possible detail: He wondered whether atrazine feminizes other kinds of frogs.

   Detail: Possible detail: Leopard frogs are easy to find and are often used in experiments.

Understanding Cause and Effect
As you know, an effect can become the cause of another effect. Use what you have learned to complete this cause-and-effect chain.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Effect</th>
<th>Cause</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine causes male frogs to grow eggs instead of sperm.</td>
<td>The male frogs cannot reproduce.</td>
<td>The frog population declines.</td>
<td></td>
</tr>
</tbody>
</table>
Drawing Conclusions

1. Why didn’t Syngenta allow Tyrone to publish his results?

   The company did not want people to know that the chemical is harmful because then its sales might drop.

2. Why would about 33 percent of male frogs in some places be feminized, while more than 90 percent of males in other places were feminized?

   The number of frogs that are feminized might depend on the amount of atrazine in the water.

3. Why does the author mention that our drinking water is considered safe if it contains three parts per billion of atrazine?

   That amount is 30 times the amount needed to feminize frogs. That amount might be enough to affect human health, too.

---

Atrazine seems to disrupt a frog’s endocrine system. How might it affect humans? Use your health textbook or another source to answer these questions:

1. How is a frog’s endocrine system similar to yours?
   Both systems include the hormones testosterone in males and estrogen in females.

2. Where are testosterone and estrogen produced in the human body?
   Most of the testosterone is males in produced in the testes. Estrogen is produced in the ovaries.

3. What might happen if a boy’s testosterone was changed into estrogen?
   He might not fully develop into a man and be unable to reproduce when he is older.
Tyrone’s Question
pages 28–37

Before You Read
Predicting
Think about the title of this chapter. What do you think is Tyrone’s question?

How does atrazine affect frogs?

After You Read
Identifying Main Ideas
1. Scientists set up experiments with carefully controlled variables. What is the manipulated (changing) variable in Tyrone’s experiment?

The amount of atrazine in the water is the variable.

2. What are variables that do not change during this experiment?

Possible answers: the kind of frogs used, the location where the frog eggs were laid, the temperature of the water during the experiment, the food given to the frogs, how often the frogs' water is changed

3. Why does Tyrone very carefully mix the water for his experiment?

He must know exactly how much atrazine is in the water for each group of growing frogs.

4. Why is Tyrone the only person who mixes the water?

He’s the only one who knows exactly how much atrazine is in the water for each group of growing frogs.
Making Inferences

1. Why was it unlikely that Dugway Pond had already been contaminated with atrazine?

   The pond is far away from farms where atrazine might be used.

2. What if Dugway Pond had already contained atrazine? How would that have affected this experiment?

   Tyrone could not have used eggs from that pond, as he would have no control group from the same location growing up in uncontaminated water.

3. Why was it important that all of the frog eggs come from Dugway Pond?

   That controls one variable: the source of the eggs.

4. How would the experiment be affected if the eggs came from different ponds?

   Uncontrolled variables, such as other contaminants in the water, might have changed the results.

5. When the students collected frogs from Dugway Pond, why did they collect water from where the frogs were living, too?

   Later they measured the amount of atrazine in that water. Then they could compare those frogs with frogs grown in the lab in water with the same amount of atrazine.

6. This experiment examines the effect of atrazine on growing male frogs. How might this same pesticide affect growing female frogs? Explain your response.

   Possible response: Atrazine changes testosterone into estrogen, so it might cause the females to be “extra-female,” perhaps producing more eggs.
Synthesizing Information
1. What scientific skills are Tyrone’s students learning as they carry out this experiment?
   
   Possible responses: how to carry out the steps in a scientific experiment; how to follow directions, measure accurately, and keep careful records.

2. What personal skills are Tyrone’s students learning?
   
   Possible responses: They are learning how to work in a group; they are becoming more self-confident.

Making Connections
1. How do you know that Tyrone cares about his students?
   
   He supports them in their studies and provides a feeling of family for kids who might be a long way from home.

2. Why do you think many students struggle in their first year of college?
   
   They are not used to living on their own, setting their own schedules, and solving their own problems. Some may not have learned good study habits in high school. Many are homesick.

Checking Predictions
Review your prediction on page 14 of this study guide. Were you correct? What was Tyrone’s question?

Possible response: How does atrazine affect male frogs?
Applying Knowledge
You are planning an experiment on plant growth. Some people think that coffee grounds help plants grow. You want to find out if that is true.

1. What is your hypothesis? Remember that a hypothesis is a statement, not a question. You are predicting the results of your experiment.

   Plants grown in soil mixed with coffee grounds grow faster than (or slower than or at the same rate as) plants grown in soil without coffee grounds.

2. What is your manipulated variable? coffee grounds in the soil

3. What is your control group? plants grown without coffee grounds in the soil

4. What are three of your controlled variables? Remember that controlled variables do not change from one group to the next.

   Possible answers: the kind and age of the plants, the soil, the pots, the kind and age of the coffee grounds, the amount of water and sunlight given to the plants, the temperature where the plants are grown

5. Tyrone and his students grew frogs in water with different amounts of atrazine. How could you use this same approach in your experiment?

   by growing plants in soil with different amounts of coffee grounds

6. On the back of this page, draw the setup for your experiment. Add notes to help explain it.

   Students should show pots of identical plants growing under identical conditions. Some pots should be labeled “control” or “without coffee grounds.” Some might be labeled with the amount of coffee grounds in the soil.
Before You Read
Making Predictions
Now you know Tyrone’s question. How do you think nature will answer it?

Answers will vary.

After You Read
Drawing Conclusions
Reread the quote from Isaac Asimov on page 39.

1. Why is “Hmmm . . . that’s funny . . .” the most exciting phrase to hear in science?

   It shows that the scientist has made a new discovery. However, the meaning of this discovery might not be clear yet.

2. Why do few true scientists shout “I found it!”?

   They often do not immediately realize what they have discovered.

Evaluating and Synthesizing Information
1. What is the most likely reason why the cells of the lab-raised frogs were less developed than the cells of the wild-caught frogs?

   The lab-raised frogs were younger when they were dissected.

2. If Tyrone were to repeat this experiment, what should he do?

   Wait a little longer to kill and dissect the lab-raised frogs.

3. What other variable, in addition to the amount of atrazine in the water, was not controlled in Tyrone’s experiment?

   The age of the wild-caught frogs was not the same.

4. This experiment did not completely support Tyrone’s hypothesis. Was the experiment a waste of time? Explain your answer.

   No, because it added to his knowledge about the effects of atrazine
5. Why didn’t the results of this experiment shake Tyrone’s conviction that atrazine feminizes male frogs?

He has been examining frogs from that pond for years, and the males that grew up in contaminated water were feminized.

Responding to the Text
1. The frogs raised by the students were all killed so their internal organs could be examined. Do you think killing these frogs was justified? Explain your answer.

Answers will vary.

2. Atrazine seems to have some negative effects on male frogs. What else would you need to know before deciding whether this pesticide should be banned from use in the United States?

Possible responses: how it affects other living things, especially humans; how a ban on its use would affect agriculture

Checking Predictions
Review your prediction on page 18 of this study guide. Were you correct? How did nature answer Tyrone’s question?

Possible response: The results did not completely support Tyrone’s hypothesis that atrazine feminizes male frogs.
Independence, Persistence, Prudence, . . . and Balance
pages 46–51

After You Read
Summarizing
1. What did piercing his ears four times symbolize for Tyrone? Explain the reason for each piercing.

The first piercing symbolized independence from his family; the second one, persistence in carrying out his experiment; the third one, prudence after he botched piercing his daughter’s ears; the fourth piercing added balance with two piercings on each side.

2. Why might the price of cheap food include a pond without frogs?

Pesticides kill bugs and weeds cheaply, making it cheaper to grow crops. However, pesticides also might kill frogs in waterways near where the crops are growing.

Making Comparisons
1. Use the Venn diagram to show how leopard frogs and spadefoot toads are alike and different. (Be sure to read the note on page 53.)
2. Why might spadefoot toads be more resistant to pesticides?

   Possible response: They do not spend most of their lives in water, so they would not absorb as much pesticide from contaminated water as other kinds of frogs.

Evaluating and Synthesizing Information

1. Look at the photo on page 51. How was the tadpole on the right able to grow bigger? Why is that both a good and not-so-good thing?

   This bullfrog tadpole grew bigger in clean water, but bullfrogs are crowding out native frog species.

2. Why is studying the effects of pesticides complicated?

   Possible response: It’s difficult to separate out and identify the effects of each pesticide. In addition, their effects might change when they are combined.

3. Why is Tyrone now more concerned about the effects of a combination of pesticides rather than the effects of atrazine?

   Some frogs can survive atrazine, but not a mix of pesticides.

4. Why does atrazine in the water affect humans differently than it affects frogs?

   Frogs grow up and live in water, so they absorb atrazine through their skin.
   Humans do not have that much contact with contaminated water. Also, frogs are much smaller than humans, so less atrazine can affect them.

5. How do we know that humans can absorb atrazine?

   Farm workers who apply atrazine to crops have high levels of this pesticide in their urine.
6. On page 51, why does Tyrone say, “Environmental health and human health are one and the same”?

   If the environment includes harmful substances, they will end up in our bodies and affect our health.

7. What are the possible long-term benefits of Tyrone’s experiments?

   He is helping us understand how water pollution can affect our health.

**Understanding Cause and Effect**

Use what you have learned in this chapter to complete this cause-and-effect chain.

- **Cause**
  - Farmers use different kinds of pesticides on their crops.

- **Effect**
  - Rain washes the pesticides into waterways.

- **Effect**
  - Frogs and amphibians in that water grow and develop in a pesticide soup.

- **Effects**
  - Possible responses: The combination of pesticides has a more harmful effect than just one pesticide; it’s difficult to determine which pesticide causes which effect.

**Making Connections**

You are not a frog or a frog scientist, so how does the information in this book relate to your life?

Our health depends on a healthy environment. We need to know how contaminated water might affect our hormones and the rest of our bodies.
Wrap-up

Analyzing the List of Resources

1. Look at the sources listed on pages 54–55 of *The Frog Scientist*. How do they help establish Tyrone Hayes as an expert on pesticides and frogs?

   **Tyrone wrote many of the sources listed, and references to his work are included in several others. This shows that other scientists respect his work.**

2. Would it be helpful for this book to list all of the sources that Tyrone consulted before and during this experiment? Explain your answer.

   **No, because most readers, even most adult readers, would not understand highly technical information.**

Discussing the Issues

1. Should scientists raise frogs to use in experiments? Should they collect frogs in the wild and use them? Give details to explain your answer.

   **Answers will vary.**

2. In another study, Tyrone discovered that the growth of tadpoles was affected when their water contained contaminants 50 times lower than the level permitted in our drinking water. Should frogs be used as a low-cost way to detect contamination in our water sources? Why or why not?

   **Answers will vary.**

3. Should the use of atrazine be banned in the United States, as it is in Europe? Why or why not?

   **Answers will vary.**
Asking Questions
List at least three questions you have after reading this book. They might be related to frogs, frog scientists, college students, the use of pesticides, or the environment in general. Suggest how you might find the answer to each question.
Questions will vary.
1. ______________________________________________________________

2. ______________________________________________________________

3. ______________________________________________________________

Completing Your KWL Chart
Look back at the chart you started on page 5 of this guide. Now it’s time to complete the last section of it. Explain what you have learned about frogs from this book.

Making Connections
1. How has reading this book affected your opinions about the use of pesticides?

   Answers will vary.

   ________________________________________________________________

2. Has reading this book increased your interest in working in a scientific field when you are older? Explain your answer.

   Answers will vary.

   ________________________________________________________________

Economics Connection
Farming is a business. Farmers must be able to raise and sell enough food to make a profit, or they cannot buy seeds, tractors, and the other equipment they need to grow more food. They also cannot pay their workers or even buy water and electricity.

Working with a partner, imagine that you have a large farm where you grow corn, tomatoes, and other vegetables. Decide whether to use the pesticide atrazine to control weeds. Bear in mind that a study by Syngenta, producer of atrazine, shows that farmers who use this product harvest from 4.3 to 10.8 bushels more of a crop per acre. Also decide how you will know how much pesticide is enough—and how much is too harmful. Share your decisions with the other “farmers” in your class.
Library Applications

Choosing a Research Topic
“Frogs” is a very general topic to research, but “frogs and the environment” is a more specific topic. In the index on page 58, you will see even more specific topics that are discussed in this book. If you were to write a research report, which three topics from the index would you choose? Why?

1. Answers will vary.

2. 

3. 

Learning More about Your Own Community
How safe are the water you drink and the air you breathe? Go to www.epa.gov/ and find out.

Enter your zip code in the My Environment field on the left side of the EPA home page. You will be linked to information about your local air quality index, cancer risks, water contaminants, and other data. This site also identifies local industries that must report to the EPA.

Study the information here, do some research to understand the terms used if necessary, and report what you learned about your community to your class.

Understanding Different Viewpoints
What do farmers, including organic farmers, think about the use of pesticides? Perhaps you live in or near a farming community and can interview people who depend on the use of pesticides to make a living—or people who have decided not to use pesticides. Even if you live in a city, you can use the Internet to gather information from farmers’ points of view. In addition, many city dwellers manage to keep a small garden and must deal with weeds and other pests.

Remember, though, that one farmer or gardener does not represent all farmers and gardeners. You must interview a number of people or access many sites to
obtain a fair sampling of opinions. Even then, you cannot assume that all farmers or all gardeners agree with those opinions.

Here are possible questions to ask or research:

• Do you use herbicides or insecticides on your farm? Why or why not?

• For organic farmers/gardeners:
  ✔ How does the lack of use of pesticides affect your harvest?
  ✔ What other means do you use to control insects and weeds?
  ✔ How effective are these approaches? How practical are they, cost wise? Which ones would you recommend to others?

• For other farmers/gardeners:
  ✔ How does the use of pesticides affect your harvest?
  ✔ How much do you know about the effects of these pesticides on other living things, such as honeybees and frogs?
  ✔ Does rainwater from your fields run into a waterway? Has this water been tested for contaminants?

Find a way to share what you learn with others in your school and community. If you have a school or community garden, find out if insecticides are used on it. If so, perhaps you can convince the gardeners to try the more natural ways to control pests that you have discovered during your research.
Suggestions for Further Reading

Be sure to check pages 54-55 in *The Frog Scientist* for more resources!

**Nonfiction books about frogs:**


**Nonfiction books about pesticides and the environment:**


**Language Arts Connection**

Read one of the books above or another book on the same topic. Write a report that includes:

- A summary of the book
- The author’s main point
- A critique of the book (whether you agree with the author, whether the author's arguments were supported by current, credible research and logical reasoning, whether the author offered practical solutions to problems, etc.)
- A short biography of the author
### Correlations to National Standards

**For Grades 6–8**

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