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SCHOLASTIC

GRADES 6–12

PATHWAYS

TEACHING GUIDE

Science Activities About Regeneration and Research Careers

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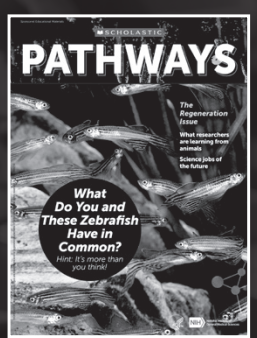
Dear Teacher,

In this guide you'll find:

- ✓ Lesson on regeneration, with tips for reading scientific texts
- ✓ Scaffolded activity sheets for research
- ✓ Class set of student magazines

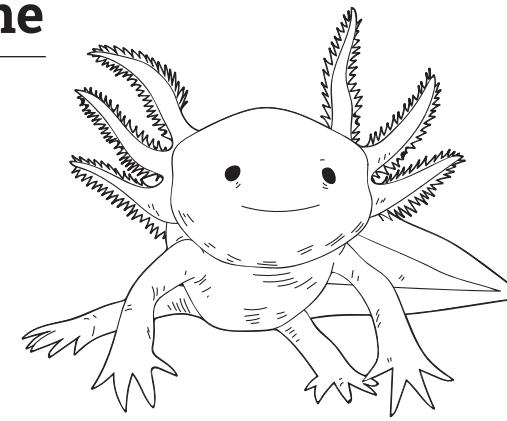


BROUGHT TO YOU BY:

NIH National Institute of General Medical Sciences

Exploring Regenerative Medicine

Help your students imagine the real-world applications of cellular regeneration through experimental design.



Objective

Students will be able to use specific strategies while reading a scientific text in order to demonstrate an understanding of regeneration.

Standards

NGSS Crosscutting Concepts; Structure and Function 6–12
CCSS Reading Standards for Literacy in Science and Technical Subjects 6–12

Time

60–90 minutes

Materials

- *Pathways* magazine
- **Grs. 6–8:** Research the Curious World of Regeneration activity sheet
- **Grs. 9–12:** From Curiosity to Hypothesis activity sheet
- Vocabulary list at scholastic.com/pathways

Directions

1 **Ask** students: *What happens when you get a paper cut? Do you know what happens when a salamander loses its tail?* Help students arrive at a definition of *regeneration* (the process of forming new tissue). Then, have students imagine a world where nothing regenerates. Prompt them to consider what in our world does and does not regenerate, and to what extent (think about buildings, plants, rocks, animals, etc.). Ask: *Is there anything humans can learn from a worm? Why do scientists research regeneration? How could it change lives, or even society?*

2 **Hand out** the student magazine and review tips and tricks for reading informational text as needed.

- If you don't know a word, mark it. If you can't figure out its meaning using context clues, look it up, then reread.
- Use the informational text features (headings, bolded words, captions, sidebars) to help you.
- Annotate: Draw arrows and write your questions/reflections in the margins.
- Challenge yourself to find the main idea and several examples to support it.
- For extra support, break down the passage: Read the first paragraph and annotate the main idea; read the next paragraph and do the same.

3 **Read** the magazine individually or as a class. Discuss, including students' questions and annotations. Ask: *How are mammals similar to organisms like axolotls?* (Like mammals, axolotls have skin, muscles, cartilage, and bones. They also have digestive, circulatory, and nervous systems.) And then ask: *Why can axolotls regrow lost legs and internal organs and we can't?* (Human tissue is much more complex. Scientists are studying axolotls, planarians, and hydras to learn which cell types and genes are essential to regeneration.)

4 **Distribute** the activity sheet. Support students in designing their own experiment, challenging them to draw on the magazine and their grade-level knowledge of experimental design.

5 **Wrap up** by using regeneration as a springboard to discuss the wonders of science. Tell students there are science/lab jobs that can immerse them in fascinating research every day. Encourage them to nurture their curiosity and keep a record of their questions. They just might get to uncover the answers one day!

Supporting All Learners

To increase the challenge
- Have students come up with discussion questions that use each of the vocabulary words.
- Have them research other organisms that regenerate and compare and contrast what these organisms can/can't do.

To decrease the challenge
- Have students work (or read) in groups of varying abilities.
- For experimental design, review terms like dependent and independent variables, constant, control group, and repeated trials.

To support English language learners
- Emphasize the Latin roots of scientific terms. Examples: "re" (again or back), "gener" (create), "ation" (noun suffix).
- Assign a color to word types (e.g., action words = circle in red).

Name _____

Research the Curious World of Regeneration

Find out what we know so far about regeneration, then think like a scientist and come up with your own research questions.

Planarian

Type of organism: Flatworm
Regenerative abilities: It can regrow its entire body—including its head—from a tiny bit of tissue. If one planarian is cut into 20 pieces, in three weeks you'll have 20 planarians. Cells called neoblasts are activated and re-create missing tissue, including nerves, guts, and muscles.

Axolotl

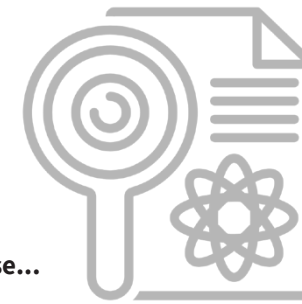
Type of organism: Aquatic salamander
Regenerative abilities: It can regenerate its tail, limbs, heart, spinal cord, pancreas, and kidney. The cells near the damaged spot transform to stem cells, which then form bones, skin, and tissue. Researchers study axolotls to investigate whether humans can one day regenerate in similar ways.

Human

Type of organism: Mammal
Regenerative abilities: Humans have limited regenerative capabilities. We can usually regrow lost hair. Our skin, bone marrow, liver, and the insides of our intestines can grow back when they're damaged, but our limbs can't. Researchers have helped develop ways to grow back fingertips.

Idea Starters for Research Questions

Brainstorm good investigative questions by asking yourself:



How does...

What would happen if...

What is the difference between...

What conditions would cause...

Now Build Your Own Questions

Brainstorm a research question you want to ask about each organism.

1. Planarian

2. Axolotl

3. Human

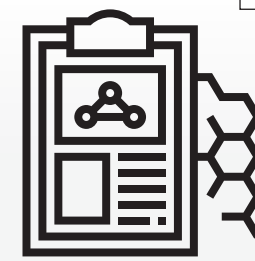
Extra Credit

BUILD YOUR EXPERIMENT Choose one of your research questions and design an experiment to find out more. (You may have to narrow your question's focus when you form and test your hypothesis.) As you summarize your experiment on the back of this sheet, be sure to isolate your variable (what will you change? will you have a control?) and explain how you will measure and collect data.

Name _____

From Curiosity to Hypothesis

Go out on a limb to develop a research hypothesis about regeneration, animal behavior, disease, or something else you're curious about!



CREATING A HYPOTHESIS

1 On separate paper, brainstorm or research a few organisms that regenerate (or some other topic that you are interested in knowing more about). Circle the one you are most curious about.

2 Imagine you are going to conduct research on this organism/topic. Consider what you already know vs. what you want to know. Write down ideas for narrowing your focus. Circle your favorite.

3 Set a main objective for your research. Then write it as a hypothesis you can test:

I hypothesize that if _____

_____,

then _____

_____.

REFLECTING & REVISING

- Could my hypothesis help me learn something I didn't know before?
- Is it testable? Consider independent and dependent variables. Will I be able to observe and measure a change?
- Am I using math to measure my outcomes? (Example: percent of change over time, how many _____, by how much did _____ change?)

4 Based on the reflections above, revise your hypothesis to:

I hypothesize that if _____

_____,

then _____

_____.

CHALLENGE ZONE

On separate paper, develop a summary of the steps needed to test your hypothesis. Be sure to consider:

- independent and dependent variables
- constant(s)
- control group
- repeated trials
- experimental conditions/setting
- data collection

Predict the outcomes: Imagine your hypothesis was disproved. What happened, and what could you learn from that? If you made observations consistent with your hypothesis, what would you expect to find out?

What's another question you could study to go further, after you have found out the results of your initial hypothesis?