

## Heads and Tails Planaria Curriculum

This unit will help elementary children learn about regeneration in living things by observing planaria—both as whole living things and after they've been cut. They'll be able to observe how the planaria are able to regenerate their heads and tails after they've been cut off.

### OBJECTIVE

To clarify concepts of regenerative medicine science and provide lab experience of objective, replicable evidence for regeneration.

### WHY?

This invention was the first crucial step toward public acceptance of key scientific concepts of the reality of the dinosaurian fauna, fossils, extinction and a radical new theory of the day: Evolution.

### LEARNING GOALS

#### Benchmarks for Science Literacy

##### 1A The Nature of Science: The Scientific Worldview (3-5) #2

Science is a process of trying to figure out how the world works by making careful observations and trying to make sense of those observations.

##### 1B The Nature of Science: Scientific Inquiry (3-5) #1

Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.

##### 5C The Living Environment: Cells (3-5) #1

Some living things consist of a single cell. Like familiar organisms, they need food, water, and air; a way to dispose of waste; and an environment they can live in.

##### 5C The Living Environment: Cells (3-5) #2a

Microscopes make it possible to see that living things are made mostly of cells.

##### 8F The Designed World: Health Technology (3-5) #2

Technology has made it possible to repair and replace some body parts.

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**National Science Education Standards**

## Science as Inquiry: Abilities Necessary To Do Scientific Inquiry (K-4) #1

Ask questions about objects, organisms, and events in the environment.

## Science as Inquiry: Abilities Necessary To Do Scientific Inquiry (K-4) #2

Plan and conduct a simple investigation.

## Science as Inquiry: Abilities Necessary To Do Scientific Inquiry (K-4) #3

Employ simple equipment and tools to gather data and extend the senses.

## Science as Inquiry: Understandings About Scientific Inquiry (K-4) #3

Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses.

## Science as Inquiry: Understandings About Scientific Inquiry (K-4) #4

Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations.

## Life Science: The Characteristics of Organisms (K-4) #2

Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.

**Next Generation Science Standards**

K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. [Clarification Statement: Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.]

K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. [Clarification Statement: Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.]

- Planaria Information Sheet
- What Are Planaria? Worksheet
- Regeneration Information Sheet for teachers
- What Happens When Planaria Are Cut? Student Sheet
- What Happens When Planaria Are Cut? Teacher Sheet
- Regeneration Student Sheet
- *Ice Cream & Fish* by Linnea Ljosenvor and Iris Works
- Planaria – these can be obtained from the Carolina Biological Company
- Digital microscopes (if available)
- Microscopes
- Microscope slides
- Petri dishes
- Bottled water
- Pipettes
- Plastic coverslips
- Scalpel (for educator to use when working with young children)
- Rulers
- Cotton swabs

## CONTEXT:

Regenerative medicine has long been a topic of much speculation and it has even been part of science fiction stories from *Frankenstein* to *The Fifth Element*. However, what was once mere speculation is becoming more and more of a reality in the realms of science and medicine. Over the past ten years, scientists have been making great strides in regenerative medicine—the development of therapies and techniques to help replace, engineer, or regenerate human cells, tissues, or organs to restore or establish normal function.

The activities in this unit introduce elementary age children to the concept of regeneration and regenerative medicine by using the simple planarian, a flatworm that lives in many parts of the world, in both saltwater and freshwater ponds and rivers. Some species are terrestrial and are found under logs, in or on the soil, and on plants in humid areas.

Planaria are used here because they are known to be able to regenerate lost body parts. For example, a planarian split lengthwise or crosswise will regenerate into two separate individuals.

In these activities, children observe planaria over a period of several weeks and watch as the organisms regenerate lost body parts. As they work their way through this unit, they engage in several activities to help them learn about the organisms and regeneration.

As you go through the activities with your group, you should be aware of some of the misconceptions children in this age group have about living things and about the work that scientists perform.

It is important to recognize that when working with young children, they may have difficulty understanding that a living thing as small as a planaria is really alive. They may have trouble understanding that it is indeed an animal, since some children often have very narrow definitions for what an animal is. They can, however, be introduced to the variety of shapes and sizes of living things. One book that could help you introduce this concept to kids is *Many: The Diversity of Life on Earth* by Nicola Davies with illustrations by Emily Sutton.

Some research indicates that in second grade there is a shift in children's understanding of organisms from representations based on perceptual and behavioral

features to representations in which central principles of biological theory are most important. Children at this age can begin to understand that animals of the same species have similar internal parts and offspring.

Young children also hold a much more restricted meaning than biologists for the word “animal” (Mintzes et al., 1991). For example, most students list only vertebrates as animals. They use such criteria as number of legs, body covering, and habitat to decide whether things are animals. They also may have difficulty understanding that an organism can be classified in more than one category, such as being a bird and animal.

## PREPARATION

### Care and Feeding of Planaria

- Collect or order your planaria to arrive a few days before starting the activity with students. This will allow the animals to acclimate to their new environment.
- Keep the planaria in a container in a cool area that is dark or dimly lit.
  - A wide, shallow container is better than a narrow, deep one, because the larger surface area of the wide container allows for more aeration.
  - Leave the lid of the container loose or ajar to allow airflow.
- Culture the planaria in bottled water or unpolluted pond/stream water, or as directed in the instructions that accompany the planaria. Do not use tap, salt, or distilled water. (Tap water often contains chlorine. There could be metal ions that can harm planaria. Distilled water may lack minerals and nutrients that planaria need to survive.)
- Change the water in the container two or three times a week. First, make sure no planaria are floating in the water. If any planaria are floating, carefully make them sink with a plastic pipette. Next, carefully remove most of the water using the pipette, leaving the planaria in place. You can also slowly pour off the water, as the planaria typically stick to the bottom of the dish. Finally, gently add new bottled water.

- Feed the planaria at least once a week. They can be given small pieces of hard-boiled egg yolk or liver, cut to the size of a grain of rice or small pea (one piece of food per dish). Let them eat undisturbed for an hour, or until they stop feeding and swim away from the food.
- Do NOT feed planaria for 2–3 days before they are to be cut (for regeneration lab), and do NOT feed any planaria after being cut, until they have fully regenerated (about 2–3 weeks).

### Preparing Microscope Slides

- Depending on the number of children you expect or are in your class, you could set up one table with a microscope/digital microscope and slides so that children can observe planaria.
- To set up a slide, simply dab a small amount of the planaria water on the slide. You can use a cotton swab to do this. Then carefully roll a planaria onto the cotton swab and place it in the drop of water.

### Setting Up Digital Microscope

- Set-up the digital microscope before you start to carry out these activities. Make sure that the camera is working, and you can view the images on your computer screen or mobile device.

### Setting Up Activity Area

#### DAY 1

Set up a table to help introduce children to planaria. They should learn that they are living things. Students should use the Planaria Information Sheet and the What Are Planaria? Worksheet at this station.

There should be a digital microscope (if available) or microscope and slides on this table. There also should be a computer monitor to show images from the digital microscope.

#### DAYS 3-21

This table should help students learn what regeneration is and how some living things can regenerate while others can't.

Before students engage in the regeneration activity, they should be asked to form hypotheses about what they think will happen once the planaria are cut in half.

You or the students can cut the planaria in half. Each half should be placed in a petri dish that contains the liquid that is appropriate for the planaria. Children should observe the planaria that have been cut in half under the microscope. They should record their observations.

Table 3: This is where the dishes with the regenerated planaria could be stationed. Students can use this table to do the wrap-up activity for this project.

## BACKGROUND INFORMATION ABOUT REGENERATION

If you think that you need some background information about regeneration before you attempt this unit with your students, you can read Regeneration (<https://www.nigms.nih.gov/education/fact-sheets/Pages/regeneration.aspx>) from the National Institute of General Medical Sciences. This resource talks about regeneration, the types of organisms that can regenerate, and regenerative medicine in general.

## ACTIVITIES

### DAY 1: INTRODUCTION TO PLANARIA

To begin this set of activities, tell your group that they will get a chance to observe some living things they may not have seen before. Ask them:

- Have you seen worms before?
- If so, what kind of worms have you seen?
- Is a worm an animal?

Student answers here may vary. Encourage students to explain their answers. As students explain their answers, look for any misconceptions students may have about living things and worms in particular. Elementary students hold a more restricted understanding of living things than scientists. They often don't view invertebrates like worms as animals. So, the last question above is important to help you determine if your students do indeed view worms as animals.

In addition, you should be sure to drive home two key points with this questioning and students' answers:

1. Planaria are very different than most worms children have seen.

2. They are different because they are born with the special power to regrow body parts—called regeneration. Tell students that, “We will talk about where these special regenerative powers come from later in the lesson.”

Explain to your group that in this activity they will be introduced to flatworms called planaria. You can explain to them that planaria are found in many different places around the world. Provide your group with the Planaria Information Sheet. You can go over the information on there as a group.

Now, ask your group to come up to the table you set up beforehand to see the objects you have on there. Ask them:

- Do you know what the things are that are on this table? If so, what are they?

Your group of children may not know the objects, so you should take time to explain what they are. Children will most likely know what a microscope is, but they may not have seen a digital microscope before. Explain what it is. Also explain the Petri dishes, microscope slides, pipettes, etc. Be sure to point out to the group that there are planaria in the Petri dishes.

Now that the children are familiar with these instruments, divide them into groups of three to four students. Provide them with the What Are Planaria? worksheet. Tell them that they should observe the planaria found in the Petri dishes. They should try to measure them, observe what they look like, and watch them as they move around.

Once students have had a chance to observe the planaria, they can work together to fill out their worksheets.

Then the children should observe the planaria under the microscope. They should note the differences in how the planaria look when they observe them without the microscope as compared to what they look like with the microscope. There is space on the worksheet for them to write and/or draw what they see in both instances.

Once the children have finished filling out their worksheets, you can bring them back together to go over the sheets as a group.

To wrap up this section, you could have your group act like the planaria they’ve observed. If you have room, allow the children to get down on the floor and wriggle around like planaria!

## DAY 2: INTRODUCTION TO REGENERATION

In this part of the lesson, students are introduced to the term regeneration and what it is. Explain to your students that regeneration means that a living thing regrows a lost body part so that the original function is restored. To help students understand this concept, go over page 2 of Pathways Regeneration Issue: <https://www.scholastic.com/pathways/pdfs/Regeneration-StudentMag.pdf>. As you go through this resource with your students, ask them these questions and record their answers on a blackboard or large sheet of paper:

- What is regeneration? (It is the process of regrowing a lost body part.)
- Why are scientists studying regeneration in other living things? (They are studying regeneration to learn how regeneration works and to help them map out a blueprint for getting humans to do the same thing.)
- What are some living things discussed in this resource that can regenerate lost body parts? (They include the axolotl, hemichordates, and hydras.)

Explain to your students that for human beings, we can regrow body parts such as skin cells and the liver. However, we are not able to regrow whole body parts like limbs or other major organs.

On the other hand, some other living things, like planaria, the axolotl, deer with antlers, and sea stars, can regenerate whole parts of their bodies. As a class, watch the “These Spiny Creatures Can Regrow Lost Body Parts” (<https://video.nationalgeographic.com/video/til/0000015a-f787-d979-adfa-ffa728890000>) from National Geographic. Ask your students to write down their answers to the questions on the Regeneration student sheet as they watch the video. You’ll discuss these questions as a class:

- What creature throws up its whole stomach? Why? (The sea cucumber throws up its stomach to chase off predators.)

- How can the sea cucumber throw up its stomach and still live? (It can regenerate its entire stomach after it has thrown up its old one.)
- What does the sticky star do to get away from predators? (It will drop off a limb if its being held to get away from predators.)
- What happens to the sticky star’s limb after it has lost it? (The sticky star regenerates that limb.)
- How does the star regrow its limb? (It generates new cells and creates a blastema. From this, the limb regrows in just a few weeks.)

## DAYS 3–21: WHAT HAPPENS WHEN PLANARIA ARE CUT?

In this section, students get the opportunity to develop a hypothesis about what they think will happen when planaria are cut and then observe what happens under microscopes. They also should record their observations and then, if necessary, revise their hypotheses based on their observations.

To help students form their hypotheses, they can use the What Happens When Planaria Are Cut? student sheet. The sheet guides them through the process of developing a hypothesis in Part 1 of the sheet. As students are working on their hypotheses, you may want to walk around the room and be available to answer any questions they may have or to help them if they are stuck.

In addition, you should guide students in forming their hypotheses in light of what they have learned so far about the science of regeneration.

Once students have their hypotheses completed, they should carry out the activity described below using the items set up at the station/table for days 3–21 of this lesson.

### Day 3 Procedure

1. Divide your class into groups of 3–5.
2. Working in their groups, your students should cut the planaria in half (you could opt to cut the planaria in half for the students—depending on their abilities).

3. Place each half in a petri dish that contains the liquid that is appropriate for the planaria.
4. Students should observe the planaria that have been cut in half under the microscope.
5. Students should record their observations in the space on their student sheet.

### Days 4–21 Procedure

1. For the following 17 days, your students to observe the planaria under the microscopes each day.
2. They should be sure to record what they observe on their What Happens When Planaria Are Cut? student sheets.

As students carry out this activity over the course of the 17 days, you should help them think about what is happening in terms of regeneration using these key teaching points and prompts from the Biology Background materials supplied.

Once all of the groups have finished filling out their student sheets and recorded their observations, they should meet as a group to go over what they discovered. They should reflect and revise their hypotheses using Part 2 of their student sheet. Then, each group should create a poster or infographic that you can display in the classroom. The poster/infographic should have five slides with these elements:

- Title slide
- Introduction to planaria
- Explanation of regeneration
- What happened when planaria was cut in half
- What the planaria looked like after 17 days

Each slide should have an image and text with information about it.

You can grade your students’ posters/infographics using the What Happens When Planaria Are Cut? teacher sheet.

### Roundup/Evaluation

In order to bring this unit to a close and evaluate student understanding of the concepts covered in it, students should use what they’ve learned about

planaria and regeneration to create new details for, or add entire new features to, the “Lily’s Wild Ride” section of the *Ice Cream & Fish* book by Linnea Ljosenvor and Iris Works. You can find this resource on The Story Laboratory website (<https://www.thestorylaboratory.com/>). As you evaluate the students’ work, you should keep in mind these points:

- Does the student show a good understanding of the topic?
- Is the student able to clearly explain what a planaria is?
- Is the student able to clearly explain what regeneration is?

## GOING FURTHER

You can help students link the study of regeneration in planaria to the potential of regenerative medicine in humans providing them with this information:

Students can visit the Tissue Regeneration Science Update (<http://sciencenetlinks.com/science-news/science-updates/tissue-regeneration/>) to learn more about the regeneration of mammalian tissue.

You can also have your students color in the Planaria Mandala to further reinforce their understanding of planaria and regeneration.