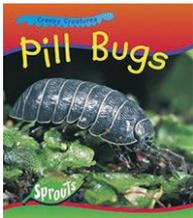


## Roly-Poly Pill Bugs

By *Emily Morgan and Karen Ansberry*

Turn over a rock or rotting log almost anywhere in the United States, and you are likely to find a pill bug. Pill bugs, also called roly-polies, are small terrestrial isopods that are abundant in temperate areas throughout the world. Because they are engaging, harmless, and easily collected, they provide an excellent opportunity for children to learn about invertebrate body parts, behaviors, and information processing. In this month's column, students learn through observation and investigation how a pill bug senses and reacts to its environment.

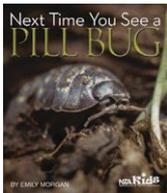
### This Month's Trade Books



*Pill Bugs*  
By Monica Hughes  
ISBN: 978-1-4109-0650-2  
Raintree  
24 pages  
Grades K–2

### Synopsis

Simple text and vivid, up-close photographs introduce children to the life of a pill bug.



*Next Time You See a Pill Bug*  
By Emily Morgan  
ISBN: 978-1-938946-17-2  
NSTA Kids  
32 pages  
Grades 3–5

### Synopsis

This book invites children and adults to interact with these fascinating animals and learn about their extraordinary features.

### Curricular Connections

In this month's K–2 lesson, students begin by observing the structures and behaviors of a familiar and gentle animal—a pill bug. They learn from a nonfiction picture book the names of the structures they observe and some reasons for the pill bugs' behaviors. Students learn about some actual pill bug-inspired technologies and then develop some designs of their own, based on the pill bug's ability to roll its body into and out of a ball. Students then share their designs through sketches and drawings. These activities allow students to experience the *Next Generation Science Standards* (NGSS) science and engineering practice of Designing Solutions, while addressing the crosscutting concept of Structure and Function (NGSS Lead States 2013).

In the lesson for grades 3–5, students participate in a checkpoint lab in which they observe pill pill bugs and design and conduct an investigation about pill bug behavior—specifically, whether pill pill bugs prefer light or dark areas. After the checkpoint lab, students discuss how pill pill bugs sense their environment through receptors on their bodies and how the pill bugs' perceptions guide their reactions. Students also learn about pill bug behavior and structures from a nonfiction read-aloud. Then, students come up with their own questions about pill bug behavior and design investigations to answer their questions. After they complete their investigations, students share their findings with the class, including a model or drawing of a pill bug that demonstrates how it receives information from its senses and responds to it in different ways. This activity provides a step toward reaching a performance expectation outlined for grade 4 stating that students “use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways” (NGSS Lead States 2013, p. 38). ■

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## Grades K–2: Investigating Pill Bug Structures

### Purpose

Students observe pill bug structures and behaviors and read a nonfiction book about pill bugs. They then solve a human problem by designing a device that mimics a pill bug’s ability to roll into a ball.

### Engage

Use sticky notes to hide the cover of *Pill Bugs* by Monica Hughes. Tell students that you are going to remove one sticky note at a time and have them guess what the book is about. (Be sure to have the last sticky note strategically placed over the pill bug’s head.) When students have guessed “pill bugs” or “roly-polies,” show them the entire cover of the book. Ask what they know or are wondering about pill bugs and have them share with a partner or the class. Then open the book to the table of contents and read the titles of the different sections. Point out that a table of contents can give readers a quick idea of what they can learn from the book (CC ELA Connection: Reading – Informational Text, Craft and Structure). However, before they read this informative book about pill bugs, they are going to have the opportunity to observe real, live pill bugs!

### Explore

Give each student a Pill Bug Observation Sheet and a hand lens. Tell students that they will be closely observing pill bugs in order to learn more about the pill bugs’ body parts and behaviors. Give each student a pill bug in a clear plastic container that has a piece of moistened paper towel in it. On the worksheet, they should create a detailed drawing of the bug and describe what behaviors they observe over one minute. Next, they observe and record the pill bug’s reaction to different actions, such as gently touching it, turning it over, or placing a leaf in the cup.

### Explain

Have students share their drawings with a partner and discuss the parts of the pill bug, the pill bug’s behaviors, and any questions they have about pill bugs so far. Have some students share their drawings with the class. Ask if they know the names of any pill bug parts. Next, create a “Behaviors” list on the board and write the behaviors that students observed. Students might have seen their pill bug crawling under the paper towel, stopping on the pa-

### Materials

- Pill Bug Observation Sheet (see NSTA Connection)
- sticky notes
- pill bugs (1 per student)
- clear plastic containers (with sides high enough to contain the pill bugs)
- hand lenses
- paper towels
- clean spray bottles
- drawing supplies

per towel to drink, moving its “feelers” around, rolling up into a ball, and even shedding its skin. For each behavior, ask if anyone else observed the same behavior and share ideas about why the pill bug might have been doing it. Next, reintroduce *Pill Bugs* and tell students that it will help them learn about pill bug parts and behaviors. Read the book aloud, stopping after page 11, “Pill Bug Parts.” Point out the label for *antenna* on page 11. Tell students that when scientists make diagrams, they often use the format pictured—the name of the body part and lines or arrows pointing to the part. Read the rest of this section. Ask students what labels they can now add to their pill bug drawings. Students should be able to label the pill bug’s *legs*, *antenna*, *eyes*, and *segments* on their drawings (CC ELA Connection: Reading – Informational Text, Craft and Structure). As you read the rest of the book, have students listen for pill bug behaviors and the reasons for these behaviors. After the read-aloud, revisit the list of pill bug behaviors. Create a t-chart with “Behaviors” on one side and “Reasons” on the other side. For each behavior, list a reason the pill bug might have been doing it, based on the information in the book. Refer back to the pages where that information is (CC ELA Connection: Reading – Informational Text, Key Ideas and Details). For example:





Behavior	Reason
Moving its antennae around	To sense its surroundings (p. 11)
Hiding under the paper towel	It prefers the dark (pp. 12 and 13)
Shedding its skin	It grows a new shell (exoskeleton) as it grows (pp. 16 and 17)
Rolling into a ball	To protect itself from danger (p. 21)

Next, refer to students' labeled drawings and ask them what parts of a pill bug's body might help it sense its surroundings. For example, how does a pill bug know if it is light or dark (eyes)? How does a pill bug know if danger is near (eyes to see, antennae and feet to feel)? Revisit page 21 of *Pill Bugs*, which shows a pill bug rolled up in a ball and explains that they do this to protect themselves from danger. Ask students what about the pill bug's body allows it to do this. They should see from the picture that it is the segments of the pill bug that allow it to roll up into a tight ball (CC ELA Connection: Reading – Informational Text, Integration of Knowledge and Ideas).



## Elaborate

Explain that engineers often look to nature for solutions to human problems and that the pill bug's ability to use its segments to roll up has inspired some interesting technologies. For example, the "Pill-bot," created by scientists in South Korea, is based on many of the structures and abilities of a pill bug, and the "Firefighting Robot" mimics the pill bug's ability to roll up into a ball. Show students photographs and videos of these pill bug-inspired technologies (see Internet Resources). Discuss how these technologies compare to actual pill bugs (CC ELA Connection: Reading – Informational Text, Integration of Knowledge and Ideas).

Next, ask students to design a solution to a human problem by mimicking how a pill bug uses its body parts to help it survive, specifically its ability to roll up into a ball and unroll. What kinds of human problems might that ability solve? Examples might include an expandable backpack, a device that transports something by rolling up into a ball and then unrolling when it reaches its destination, or a modified soccer ball that rolls up when it is kicked and then unrolls and moves by itself in between kicks to make the game more fun and interesting.



## Evaluate

Have each student select an idea from your discussion or come up with an idea of their own. They should create a labeled illustration that shows the new device and describe how it resembles a pill bug's behavior and structures. They can use the Pill-bot video as an example of how to show the device, along with an inset of the pill bug exhibiting the same behavior. Students should give it a descriptive or catchy name and explain how the new device works, how it mimics a pill bug, and what structures help it roll and unroll (CC ELA Connection: Writing – Text Types and Purposes).

Students should wash their hands with soap and water after handling live organisms. Take care that the pill bugs do not become dehydrated, are not too hot or cold, and are not handled roughly. Remind students that all living things should be handled gently.



## Grades 3–5: Investigating Pill Bug Behavior

### Purpose

Students observe pill bug behavior during a checkpoint lab and associate the behaviors with pill bug sense receptors. Then they design investigations to answer their own questions about pill bug behaviors.

### Engage

Show students the cover of *Next Time You See a Pill Bug*. Ask them if they have ever collected pill bugs or played with them. If so, where did they find them? What did they do with them? Read aloud pages 6 and 7, which encourage students to pick up a pill bug and let it crawl around on their hands, observe it closely, and describe it. Tell students that before you read the rest of the book, they are going to have an opportunity to do just that! Give each student a pill bug in a small plastic container that has a piece of a damp paper towel in it. Encourage students to interact with the pill bug, reminding them to handle it gently. They can pick it up, try to count its legs and segments, place several in one cup and compare their sizes and colors, and so on. Tell students that they will be reading the rest of *Next Time You See a Pill Bug* after they have had some more experiences with the pill bugs.

### Explore

Form teams of three or four and tell students they will be learning about how pill bugs react to their environments. Give each student a copy of the Pill Bug Checkpoint Lab. Explain that in the checkpoint lab, they will work as a group and follow the directions on each page. When they reach a “checkpoint,” they should stop and get a checkmark or stamp from the teacher before they move on. As they work, they should keep their green cup on top of their red cup. If they need help or if they are at a checkpoint, they should put their red cup on top. Even though they are working as a team, each member of the group is responsible for recording data and writing responses. Observe and listen to students as they work on the lab, and watch for red cups. Before you give a team a checkmark or stamp, informally evaluate the students by asking probing questions of each team member. Here are some things to look for in each part of the checkpoint lab:

#### Part A: Pill Bug Observations

Students should create a drawing of the pill bug with at least three parts labeled. Pill bugs have 14 legs (two per

### Materials

- pill bugs
- clear plastic containers (with sides high enough to contain the pill bugs)
- paper towels
- Checkpoint Lab Materials (per group of three or four students)
  - Pill Bug Checkpoint Lab (see Internet Resources to download student packets)
  - red and green cups (for signaling the teacher)
  - shallow box
  - hand lens
  - flashlight
  - newspaper
  - 5–10 pill bugs
  - stamp or marker
- Design an Investigation Think Sheet (see NSTA Connection)



segment). Pill bugs react to touch by rolling up into a ball, stopping, or running away. Make sure students realize that the pill bug does react to their touch.

#### Part B: Pill Bug Experiment

Teams should come up with an idea for an experiment and draw it. The experiment should test whether pill bugs prefer light or dark areas. The most common answer is a drawing of the pan or box, one half covered with newspaper and the other half under a flashlight. Encourage students to discuss their ideas with each other and to position the materials while they talk. They will not actually perform the experiment until they get the checkpoint stamped.

#### Part C: Results of the Pill Bug Experiment

Students learn that not all of the experiments will come out the same way. Scientists typically repeat experiments several times and look at the overall results when making a conclusion. Most pill bugs, but not all, will go to the dark area. The question, “What is your evidence?” might be challenging for them. Their evidence is that after looking at their results and the results of five other teams, most of the pill bugs went to the dark area.

#### Part D: A Moth Experiment

Students will use the data table in Julia’s journal to determine that most moths prefer to be in the light.

## Explain

Explain to students that in this checkpoint lab, they had the opportunity to observe various pill bug behaviors, such as rolling into a ball or running away when touched and moving to the dark when they were in light. Ask students to look at the drawings from Part A and think about what parts of the pill bug would help it sense its surroundings. Ask, “How do the pill bugs know you are touching them or sense which areas are light or dark?” Students may say that the pill bugs can feel with their bodies and antennae and see with their eyes. Explain that animals have structures called sense receptors that allow them to sense their environment. The information detected by the receptors is sent to the brain, where it is processed, and then the animal reacts. For example, a pill bug’s eyes are sense receptors. Pill bugs do not have detailed vision but are able to sense light and dark. Ask students how the pill bugs reacted when their eyes detected bright light. (They moved away from it.) This is an example of information processing in an animal. The light was detected by a receptor, signals were sent back and forth through a system of nerves, and then the pill bug responded. Explain that a pill bug’s brain is not like a human brain. All of our thinking is processed inside our brain, and signals to and from our brain are relayed through a complicated system of nerves in our spinal cord and throughout the rest of our body. Pill bugs don’t rely on a central brain to control their entire bodies. Instead, they have a tiny brain behind their eyes and several “minibrains” called ganglia that run along their body, one in each segment. Information from that segment’s sense receptors goes directly to that segment’s ganglion, allowing the pill bug to react quickly with that part of its body. A pill bug’s antennae are also receptors. Pill bugs constantly use their antennae to sense their surroundings. Pill bugs have various other sense receptors throughout their bodies that collect information about their environment and allow the pill bugs to sense danger and find food and water.

Next, ask students whether they have any questions about pill bugs based on the lab. Make a list of some of their wonderings and share some of yours, such as:



- If pill bugs have 14 legs, are they considered insects?
- Do pill bugs lay eggs or give birth to live young?
- Do baby pill bugs look like their parents?
- Why do pill bugs roll up in a ball?
- Why did pill bugs prefer the dark in our experiment?
- How do pill bugs breathe underneath rocks?

Tell students that you have a nonfiction book that will answer some of their questions and help them understand some of the behaviors they observed in the lab. As you read the book aloud, stop when answers are provided to the questions on your list. For example, page 11 explains that pill bugs are crustaceans, page 13 explains that pill bugs lay their eggs in a pouch and that baby pill bugs look much like their parents, and page 15 shows how pill bugs roll up as a defense against danger (CC ELA Connection: Reading – Informational Text, Key Ideas and Details).

## Elaborate

Tell students that they are now going to design their own investigation based on a question they have about pill bug behavior. Before students come up with their questions, have a discussion about humane treatment of pill bugs, including handling them gently, being sure they don’t dry out, and keeping them away from long periods of direct sunlight. Then, divide students into teams of 2–4 and ask them to brainstorm questions together, such as:

- Do pill bugs prefer wet or dry areas?
- Do pill bugs react to smells?
- Can pill bugs navigate a maze to find food?
- Do pill bugs prefer soil or sand?

Once students have selected a question, they must get your approval before they move on. Check to make sure that students’ investigations are safe (for them and for the pill bug), their question is testable, and that they have a clear plan. Once approved, they can use the Design an Investigation Think Sheet to create a list of materials and write or draw their plan. Encourage students to organize their data in a table, do multiple trials, and control variables.

## Evaluate

When teams have completed their investigations, have them create a poster to share their findings. The poster should include their question, conclusion, and evidence. They should also include a drawing or model of a pill bug with structures labeled, such as antennae, feet, and eyes,

as well as an explanation about how those structures help the pill bug sense and react to its environment. Encourage students to include data tables, photographs, and other graphics to illustrate their findings. Students can present their findings at a poster session or gallery walk (CC ELA Connection: Writing, Research to Build and Present Knowledge).

### Internet Resources

The Firefighting Robot

- [www.popsci.com/scitech/article/2008-03/firefighting-robot](http://www.popsci.com/scitech/article/2008-03/firefighting-robot)
- [www.engadget.com/2007/08/12/ole-pill-bug-robot-concept-](http://www.engadget.com/2007/08/12/ole-pill-bug-robot-concept-could-fight-forest-fires)

*could-fight-forest-fires*

The Pill-bot

[www.youtube.com/watch?v=vi-5PisiDY](http://www.youtube.com/watch?v=vi-5PisiDY)

Pill Bug Checkpoint Lab Instructions and Student Packets

[www.nexttimeyousee.com/resources/Pill-Bug-Checkpoint-Lab.pdf](http://www.nexttimeyousee.com/resources/Pill-Bug-Checkpoint-Lab.pdf)

### NSTA Connection

Download the Pill Bug Observation Sheet and Design an Investigation Think Sheet at [www.nsta.org/SC1603](http://www.nsta.org/SC1603).

## Connecting to the *Next Generation Science Standards (NGSS Lead States 2013)*:

### 1-LS1.D Information Processing

[www.nextgenscience.org/1s1-molecules-organisms-structures-processes](http://www.nextgenscience.org/1s1-molecules-organisms-structures-processes)

### K-2-ETS-2 Engineering Design

[www.nextgenscience.org/k-2ets1-engineering-design](http://www.nextgenscience.org/k-2ets1-engineering-design)

The chart below makes one set of connections between the instruction outlined in this article and the NGSS. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities. The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectations listed below.

Performance Expectation	Connections to Classroom Activity <i>Students:</i>
1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. K-2-ETS-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	<ul style="list-style-type: none"> <li>design a solution to a human problem by mimicking the ability of a pill bug to roll up into a ball.</li> <li>create a sketch of a device that mimics a pill bug's ability to roll up into a ball and explain how the parts of the device allow it to work.</li> </ul>
<b>Science and Engineering Practice</b>	
Designing Solutions	<ul style="list-style-type: none"> <li>design a solution to a human problem.</li> </ul>
<b>Disciplinary Core Ideas</b>	
LS1.D Information Processing <ul style="list-style-type: none"> <li>Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive.</li> </ul> ETS1.B Developing Possible Solutions <ul style="list-style-type: none"> <li>Designs can be conveyed through sketches, drawings, or physical models. These representations are useful to compare and test designs.</li> </ul>	<ul style="list-style-type: none"> <li>observe pill bug behaviors, explain reasons for these behaviors, and identify the body parts that help the bugs sense their surroundings and behave the way they do.</li> <li>create a sketch of a device that mimics a pill bug's ability to roll up into a ball and explain how the parts of the device allow it to work.</li> </ul>
<b>Crosscutting Concept</b>	
Structure and Function	<ul style="list-style-type: none"> <li>identify pill bug structures and recognize their functions.</li> <li>explain how a device that mimics a pill bug has structures that aid its functions.</li> </ul>