# A HEAD START ON LIFE SCIENCE

## Encouraging a Sense of Wonder

William Straits

NSTApress
National Science Teachers Association

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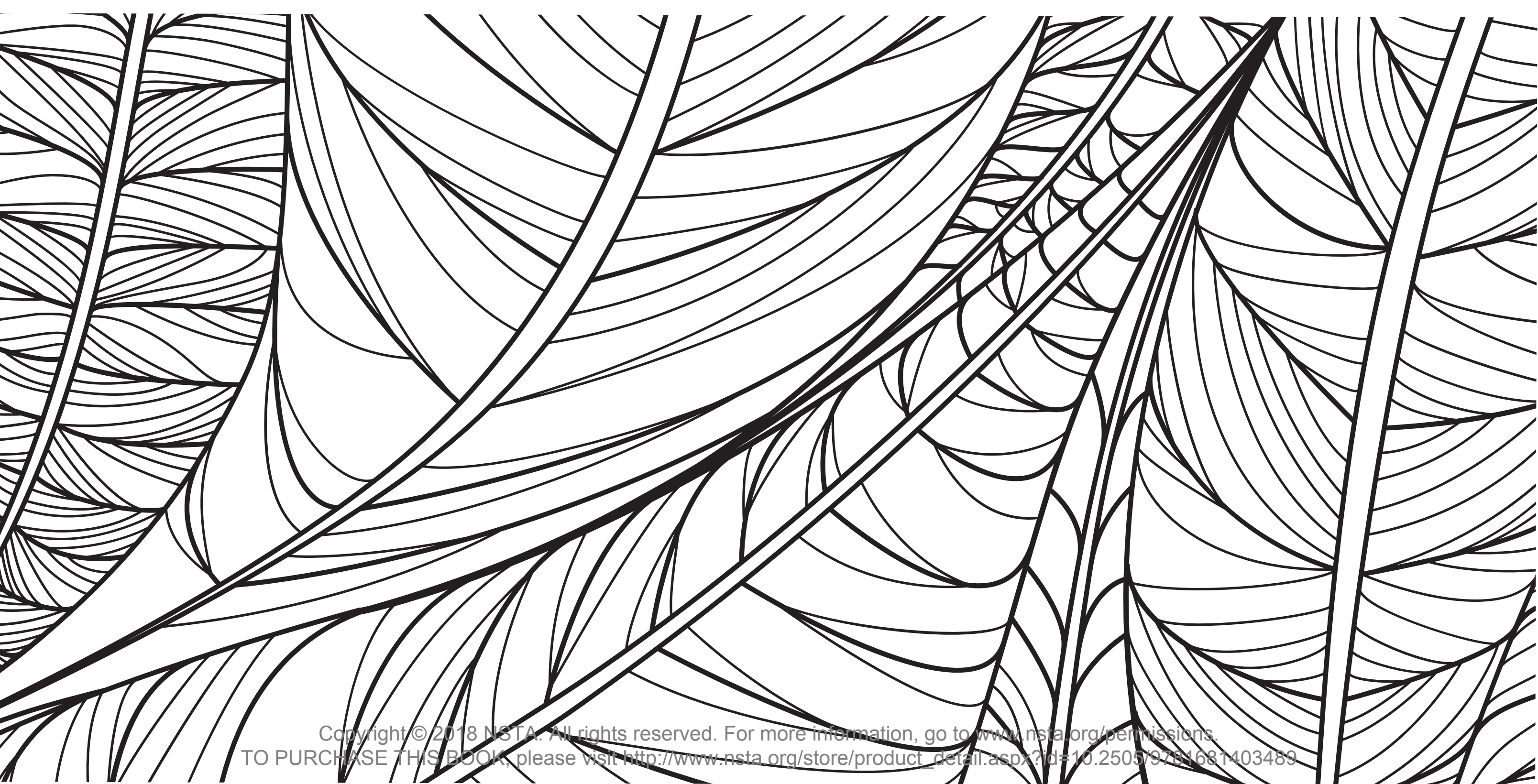

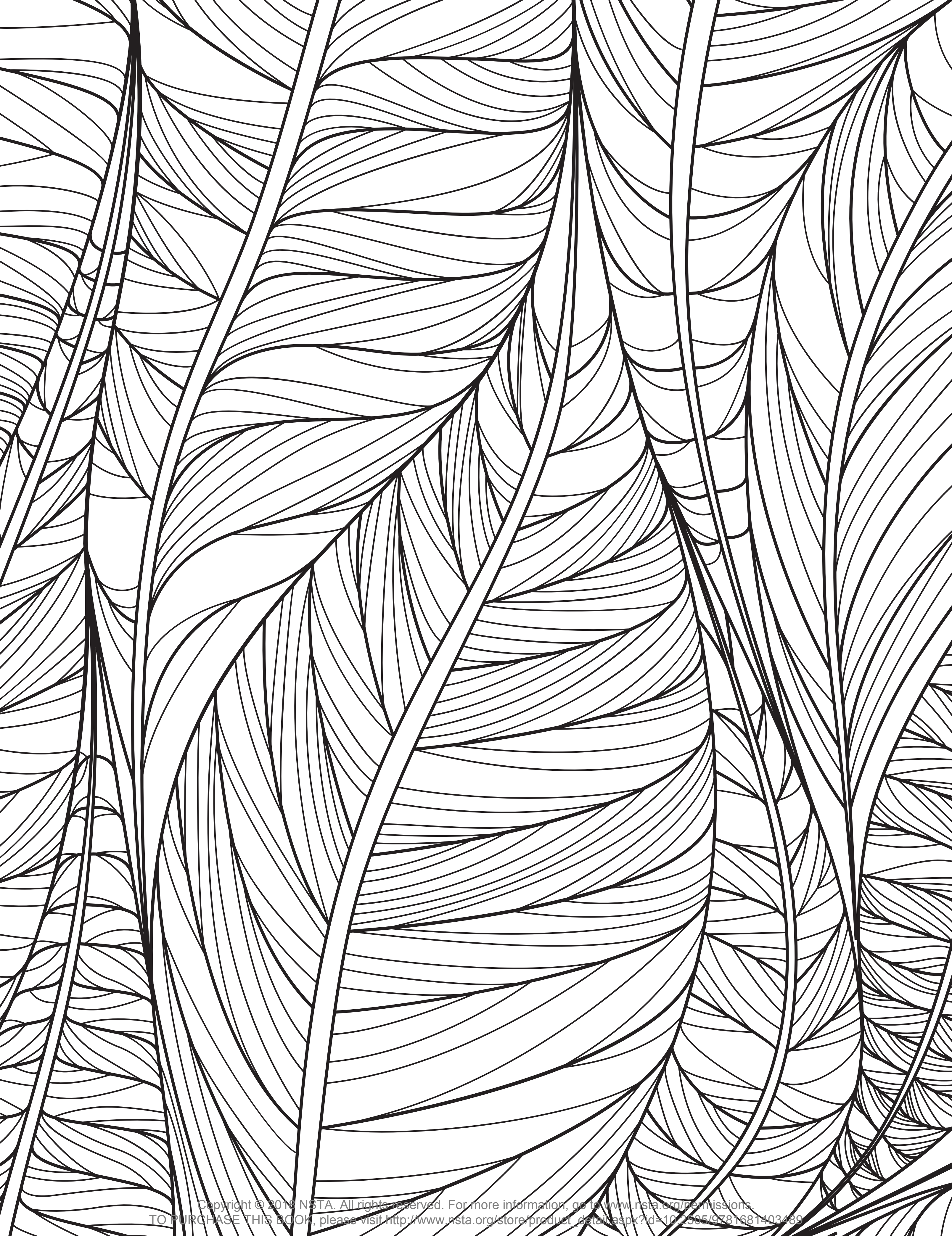

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Arlington, Virginia

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# About the Author

William Straits is a professor of science education at California State University, Long Beach. He earned a bachelor's degree in biological sciences from the University of California at Irvine (1991); master's degrees in biology from California State University Fullerton (1995) and in curriculum and instruction from the University of Texas at Austin (1997); and a PhD in science education also from the University of Texas at Austin (2001). Throughout his career, as a science teacher and as a teacher educator, he has emphasized the natural and important connections between science and language literacies. He currently serves as director of the National Center for Science in Early Childhood and focuses much of his scholarly work on early childhood science education. He is continually amazed by the loving and tireless work of teachers of young children and humbly hopes that this book, in some small way, aids them in their efforts—helping children to heighten and expand their joyful "sense of wonder" about the natural world.

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# 1

# Science for Young Children

## Our Theme

In 1956, marine biologist and conservationist Rachel Carson wrote a book, *The Sense of Wonder,* about the time she spent along the Maine coastline with her young nephew, Roger. From the time Roger was just a baby until he was more than 4 years old, he and Rachel shared adventures in the world of nature. She never set out to "teach" him anything, but rather to have fun and marvel at the plants and animals, the sounds and smells, the rocks and waves they encountered on walks through the woods and along the ocean. Roger, of course, learned a great deal as Rachel explored with him, calling his attention to various things and talking with him about what they observed. Roger learned as the two of them made discoveries *together*.

In *The Sense of Wonder,* Carson wrote, "a child's world is fresh and new and beautiful, full of wonder and excitement. It is our misfortune that for most of us that clear-eyed vision, that true instinct for what is beautiful and awe-inspiring, is dimmed and even lost before we reach adulthood. [I wish that] each child in the world be [given] a sense of wonder so indestructible that it would last throughout life …" (Carson 1956). "Sense of wonder" has become the theme of our *A Head Start on Science* (*HSOS*) program (see Appendix C); we strive to bring teachers of young children the resources and support they need to heighten and expand children's innate curiosity about the natural world. *A Head Start on Life Science* lessons are written to help adults facilitate young children's learning as they work as partners in exploring the natural world. We hope your sense of wonder will be heightened as you engage in science explorations with children, actively following as their curiosity leads them to discoveries about all that they see, hear, smell, and touch.

## High-Quality Early Childhood Science Education

Science learning experiences are important in early childhood education. Early childhood science education (ECSE) engages teachers and children in high-quality interactions that can not only promote children's understanding of science concepts and skills but also can narrow the achievement gap (Cabell et al. 2013) and provide a meaningful context for developing literacy and math skills (Gelman et al. 2009). In fact, compared to other learning contexts (e.g., reading or math instruction), teachers engage in higher-quality teacher–child interactions when they engage in science (Cabell et al. 2013). These high-quality interactions, including supports for concept development, expanding on child ideas, and use of open-ended questions and advanced language, significantly enhance children's cognitive development and thus their academic outcomes (Mashburn et al. 2008). Additionally, ECSE can lead to gains in language achievement for English-language learners, particularly for speaking and listening skills (Gomez Zwiep and Straits 2013).

However, ECSE varies greatly in classroom practice. In the extreme cases, "science" experiences look more like arts and crafts projects (for example, painting pumpkins or gluing feathers on paper birds) that do little to promote children's science learning. At the opposite extreme, ECSE can consist of teacher-directed activities that emphasize academic learning and scientific vocabulary. Although the balance in ECSE has been much debated, this book is written with the belief that the optimal early learning experiences for children lie somewhere between these two extremes. ECSE should not be a series of isolated activities that occupy children but fail to engage them in prolonged investigation or produce long-lasting, meaningful learning. Likewise, ECSE should not consist of experiences that are entirely teacher directed and academic, placing emphasis on the products of learning (e.g., vocabulary) rather than the process; that do not develop children's abilities to engage in science practices; and that fail to foster science dispositions such as persistence, curiosity, questioning, and exploring.

ECSE experiences should address topics relevant to children's everyday experiences that can be experienced firsthand, serve as bases for collaboration and communication among children and adults, and have the potential for meaningful investigation. And, although these high-quality ECSE experiences can take many different forms, they generally have three components at their core: generating and relating to children's interests; facilitating collaborative, child-driven investigation; and providing opportunities for children to reflect on, represent, and apply what they've discovered. The three components are sequential, systematically building children's understanding. Importantly, the three components should be accomplished over days of instruction, in amounts of time consistent with the development and age of your children.

High-quality ECSE experiences begin with children's interest and curiosity. At the beginning of ECSE learning experiences, teachers must tap into children's existing curiosity and generate new interest about the phenomenon to be explored. Aligning with children's curiosity helps to ensure that children are intellectually engaged and sustain interest during a sequence of prolonged and meaningful investigations of science phenomena present in the world around them. Although teacher facilitated, these investigations need to be child driven, emphasizing children's decisions and meaning-making. It is during investigations that children develop their skills in using science practices, such as observing, measuring, comparing, sorting, communicating, and graphing, as well as important language and social skills. Although engaging in science investigations and employing different science and communication skills are important for learning, they alone are insufficient. For meaningful, lasting learning, children also need opportunities to reflect on, represent, and apply their new understandings. This thinking about, sharing, and using new understandings helps children to solidify what they've learned, builds metacognitive skills, and also leads children to new explorations. The lessons in *A Head Start on Life Science* are consistent with this view of learning and are written to help you as the teacher learn to design and implement effective science learning experiences.

## Our Beliefs About Science for Young Children

Central to our understanding of young children is the idea that a sense of wonder is innate; children are naturally awestruck by and curious about the natural world. Further, the exploration of this amazing natural world is natural for young learners. We believe that a sense of wonder is part of all children's experience and that children are intrinsically motivated to explore the natural world. Therefore, it is important that *all* children have access to culturally relevant science experiences that are of value in learners' everyday worlds. Formal science education settings must tap into this natural interest in science by providing authentic materials, allowing a degree of child autonomy, and celebrating each child's success. Additionally, science education for young learners must utilize play and emphasize free exploration as a means for learning, provide opportunities to teach and learn from peers, recognize that trial and error are natural parts of the scientific learning experience, and emphasize the importance of process over right and wrong answers.

Teachers charged with facilitating science education for young learners face a great challenge. Teachers must abandon the traditional view of the teacher as disseminator of information and adopt roles as facilitators of learning. Consistent with this, a primary role of the early childhood science teacher is to provide an appropriate learning environment and opportunities for children to explore, represent, and share their discoveries. Teachers need to model excitement and enthusiasm when involved in science exploration and when planning and anticipating discoveries. Throughout the design of learning experiences, teachers need to recognize that the process of discovery and the science practices children engage in are more important than learning science facts and that science experiences can be highlighted at all times and in all parts of the classroom and outdoors, not just during "science time" or at the "science center." As children engage in science investigations, adults should observe children's actions and listen to children's conversations so that they can follow children's leads; child-initiated learning is of great importance and should be encouraged and supported. Additionally, effective early childhood teachers must be effective parent educators and involve families in their children's science activities.

Throughout our work with children we must all emphasize the exciting process of discovery over science information. Rather than understanding science as the learning of already-known answers, our children should see science as the exploration of a vast and wondrous world of infinite mysteries. The experience is the objective; instead of telling children science facts, nurture their curiosity, interest, and joy. These attitudes and foundational experiences can serve as a basis for a lifelong love of science.

We firmly believe that children enrolled in the types of early childhood programs described here, where active learning and children's exploration are central, where teachers emphasize science practices and child-initiated investigation, and where teachers and families are actively involved in children's science learning, are more likely to succeed in school, and in life, than children who are denied these important learning experiences.

## Developmentally Appropriate Science

The lessons in *A Head Start on Life Science* were created with these beliefs in mind and designed for developmentally appropriate use in early childhood education settings. Inspired by and adapted from the activities in NSTA's *A Head Start on Science: Encouraging a Sense of Wonder,* edited by the founder of our project, William Ritz, each lesson has as its basis active, hands-on involvement of children and focuses not on teaching children "science facts," but rather on nurturing children's innate curiosity about the natural world and encouraging children to make discoveries on their own. Teachers familiar with the activities in the original book will find the lessons here to be useful models for expanding science activities into integrated inquiry lessons. The lessons are intended to help teachers to expand children's thinking in an area of interest and are designed to help teachers to come to understand a method for sequencing learning opportunities that promotes understanding. In ECSE, children's interest and prior knowledge are key—developmentally appropriate science meets children where they are and allows children to participate at their own level. These lessons provide experiences that are hands-on, concrete, and relevant and allow children to learn through play and social interaction. *A Head Start on Life Science* integrates learning across domains, allowing for science learning throughout a child's school day as well as at home with his or her family. The learning situations across all lessons and activities are flexible, allowing teachers to follow children's interests and questions. And throughout all the lessons we emphasize children's thinking and use of science practices rather than focus on factual knowledge or right or wrong answers.

## Lesson Overview

### Introduction

Each lesson in *A Head Start on Life Science* provides teachers with introductory information to help prepare for the learning experience. The information includes a brief description of the lesson and a listing of the learning objectives, required materials, and safety considerations. This information is here to assist you in preparing your lesson and deciding where in your unit of study this lesson would best fit. Additionally, for each lesson we provide relevant teacher content background. In our many years of working with early childhood educators, we have often heard teachers express a desire for more science content. We are providing it in this revised version. However, we emphasize that this information is for teachers' knowledge only and is there to assist you in your own learning. This information should NOT be directly taught to young children. Studies have shown that formal, teacher-directed instruction is at best ineffective and at worst detrimental to children's long-term growth as learners. Our goal is not for children to acquire "facts," but to be active explorers, reveling in the process of discovering more about the natural world around them. In addition to the teacher content background, we provide a list of key science terms for teachers to be aware of as they prepare for the lesson. Keep in mind that vocabulary acquisition is not our primary intent. Capitalize on opportunities for vocabulary development when they arise naturally during your conversations with children, but do not feel compelled to force vocabulary into these learning situations. In all situations, our primary goal is to enhance children's sense of wonder—their innate curiosity about and appreciation for the natural world all around them. Following the introductory material, the procedure for each science lesson is described.

## Procedure

Aligned with high-quality ECSE and inspired by the learning cycle[1] (Atkin and Karplus 1962), we've designed lessons where children are first, oriented toward the topic to be investigated; second, given a chance to explore and develop an understanding of concept; and third, supported in formalizing that understanding by explaining or applying. Subsequently, the procedure for each lesson is divided into three sections: *Getting Started*, *Investigating*, and *Making Sense*, each of these sections serving an important purpose in the development of new knowledge. Although there is broad consistency across lessons, the specific ways that children are oriented toward a topic, explore and develop an understanding, and formalize that understanding can vary from lesson to lesson. We have been intentional in our effort to highlight these alternatives across the lessons provided here, and these options are described below and in the model in Figure 1.1, on page 6.

In all learning, it is important to give children an introduction before engaging in teacher-structured explorations. We call this introduction *Getting Started* and encourage teachers to use this time to allow children to play with materials, share what they already know about a topic, and ask questions. Only after this introduction are children ready for directed exploration. *Getting Started* helps prepare children to learn by activating prior knowledge, allowing free exploration of materials, generating interest, and giving purpose to their investigations. What you choose to do with children can vary from lesson to lesson, but for all lessons children need an opportunity to orient to the topic before structured learning experiences can occur. There are five categories of teacher actions in the *Getting Started* section; most lessons employ two or three of these. The teacher actions are

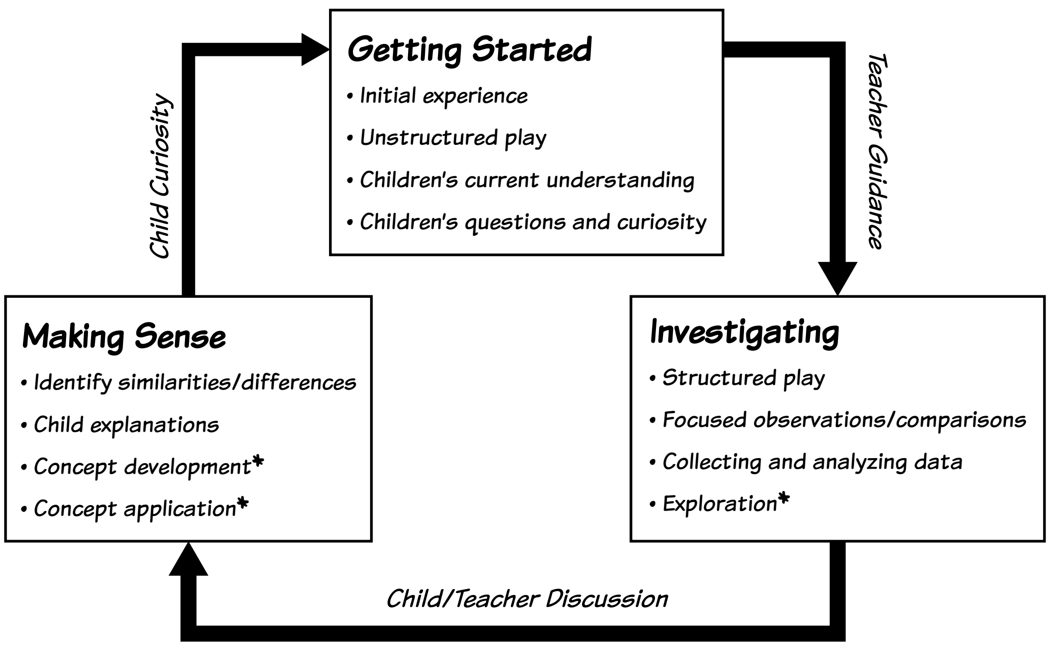
1. **Prior knowledge.** Show or describe an example of the topic of interest and use questioning to probe children's prior knowledge about the topic. (For example, "What do you know about elephants?")
2. **Introduction.** Introduce phenomena or materials to children to explore, asking children to describe them. (For example, "Look closely at these seeds and share what you notice.")
3. **Child questions and curiosity.** Ask what they know about the phenomenon and what questions they have about it. (For example, "What questions do you have about fish?")
4. **Prompting questions.** After children have gotten a chance to explore and wonder themselves, introduce a question. (For example, "How have the seeds changed?")
5. **Initial explanations.** Ask children to explain the reasoning behind their initial answers to your prompting questions and record their responses. (For example, "Why do you think it will move or change that way?")

1 The learning cycle is a three-part teaching model. The first phase, "exploration," has students engaged in teacher-facilitated experiences; in the second phase, "concept development," teachers guide students in understanding the concept(s) related to their explorations; and finally, in "concept application," the teacher presents a situation for students to use their new understanding(s). In this book, you'll find parallels between "exploration" and the *Investigating* of many lessons, as well as between the "concept development" and "concept application" phases and some aspects of *Making Sense*.

*Figure 1.1*

## Lesson Model

*Model demonstrating the three-phase lesson sequence used for each of the A Head Start on Life Science lessons and the components that can be included in each of the three phases.*




** Denotes connections to the learning cycle (Atkin and Karplus 1962)*

All five do not need to be in each lesson, but high-quality science lessons nearly always begin with one (or more) of these actions.

*Investigating* provides an opportunity for children to actively work with materials to generate new understandings of and appreciation for some natural phenomenon. Capitalize on opportunities to discuss new science concepts and vocabulary, but use a light touch. With our young children, the experience is our primary objective. Let children's interests shape the direction and outcomes of your science explorations. The *Investigating* descriptions (like all of the descriptions) provided in each lesson are intended as guides, suggesting one set of possibilities. You do not need to adhere strictly to them. Let your children's curiosity take you and your lesson in new directions. Throughout this time, use questioning to encourage children to observe details, make comparisons, and notice differences that might otherwise have been overlooked. Keep in mind that your aim in this questioning (and in questioning throughout the lesson) is to be conversational; be a learner with your children. Share ideas, insights, excitement, and questions. Model for your children what enthusiastic science learning looks like. Whether you are a preschooler or a professional scientist, there are two important parts to investigating:

1. **Collecting data.** This includes experimenting, observing, measuring, and documenting and can be encouraged by the teacher by asking prompting questions such as "How can we test that idea? What do you notice? How big is it? How could we keep track of these ideas?"
2. **Analyzing data.** This includes comparing and sorting (across objects and processes as well as across children's ideas and findings), encouraged by prompting questions such as "Which of these are similar? Which are different? How are these alike? In what ways are these different? Can you put these in order from smallest to largest?"

In the *Investigating,* phase children take center stage as they actively explore phenomena. However, teachers play a very important role in these investigations, including providing appropriate materials and supports; sequencing activities so that they build understanding and curiosity; and being active participants, engaging in explorations with children. The conversations and questions you have with children will help them to better understand and appreciate the science topic being explored. [Note: Sometimes lessons have two separate but related activities that take place during the *Investigating* section. When this occurs, the individual activities are designed to be experienced sequentially and are referred to as *Investigating 1* and *2*.]

*Making Sense* provides children with an opportunity to represent and share results and to apply, sum up, think about, and discuss what they discovered during their investigations. To develop critical thinking skills and a more lasting understanding of what they learn, learners need to be given the opportunity to reflect on their investigations. This reflection may mean the discussion of similarities or differences or the identification and generalization of patterns discovered during the *Investigating* section. Teacher questioning and guidance are important to facilitate this sense making. Throughout the *Making Sense,* section, remember that child explanations, based on discoveries made during their Investigating, are more important than the "correct" scientific explanation. There are four important processes in *Making Sense:*

1. **Describing findings.** Articulating our thoughts helps us to clarify and reinforce our understandings; this is true for children as well as adults. Communicating about the outcome of an exploration is important for learning and can be part of the investigation itself or the sense making that follows. In *Making Sense,* encourage children to describe and represent (through drawings, text, graphs, etc.) what they've learned and how different phenomena compare. For example, while making sense of an investigation, children might state, "The spiny seed sticks to things, but the smooth seed doesn't" or "All of these birds have feathers."
2. **Generating explanations and identifying patterns.** Here, learners, just like scientists, take an investigation one step further, going beyond simply stating the results to explaining the meaning of the results or the trend across multiple results. In these efforts, children use (and further develop) their reasoning and critical-thinking skills as they engage in concept development. For example, after exploring the insides of several fruits, a child may be able to tell you that (or ask you if) all fruits have seeds. Although developmentally, many of our younger children may not be ready to make these leaps, as a part of science investigations they should still have opportunities to explain their thinking at a level appropriate

for each individual child. The correct explanation is not our goal; our goal is to provide children with opportunities to explain their thinking and develop their reasoning skills.

3. **Application.** Opportunities to apply new knowledge are important for long-term learning. In *Application* children are asked to use what they discovered during the investigation(s) to explore a different, yet similar, phenomenon. For example, after developing the skill of sorting using beans, children could use this new skill to sort buttons; after studying a goldfish, children could observe other fish to see if they too have fins, gills, tails, and so on.

4. **Curiosity**. Science investigations often lead to new ideas and new investigations. This continued exploration is one of the aspects of science that most interests scientists and motivates them to devote their lives to scientific study. We want to help nuture this same passionate curiosity in our children by encouraging them to identify what questions they have about the phenomenon studied and what they'd like to explore next. Let their interests determine your next *Getting Started* experience.

Each lesson encourages children to engage in one or more of these four processes. And very often, these processes will prompt the exploration of new topics or questions; a successful lesson is one that inspires further learning. [Note: As in the *Investigating* section, on occasion there are two parts to this final section. When this happens, the parts are referred to as *Making Sense 1* and *2*.]

## Beyond the Lesson

After the lesson, we provide ideas for extending the science learning in a section called *What's Next?* We first provide an extension activity that describes one or more science activities related to the topic explored during the lesson. It's our hope that these extension activities link to the *Making Sense* section by connecting to children's curiosity and offering additional opportunities for children to apply what they've learned. The ideas provided in the extension activity are not as detailed as in the lesson; it's up to the teacher to structure these activities in a manner consistent with the *Getting Started*, *Investigating*, and *Making Sense* format.

It's important to remember that science need not be a stand-alone subject limited to science time or relegated to a dusty science table. Science naturally connects to math and language arts. Ideas for making these connections are provided in the *Integration to Other Content Areas* section. In *Other Connections*, we present still more ideas for connecting the science lesson to other parts of the school day. Examples for increasing the relevance of the science lesson in the child's life are given, as are ideas for the art, sensory, and dramatic play centers. Additionally, the Family Activities section provides ideas for how families might interact with their child; these are provided in English and Spanish and are written with parents and guardians in mind.

*What to Look For* and *Standards* are the final sections provided. The *What to Look For* section lists questions that teachers can ask themselves in an attempt to gauge children's progress toward learning goals. After each question, the academic skills that may be demonstrated by children as they respond are briefly indicated. These academic skills are based on indicators included in several preschool and primary grade frameworks and assessments,including HighScope's *Preschool Child Observation Record* (2015), *Teaching Strategies GOLD: Objectives for Development and Learning* (Burts et al. 2016), *Head Start Early Learning*

*Outcomes Framework* (U.S. Department of Health and Human Services, 2015), NAEYC Early Childhood Program Standards and Accreditation Criteria (2015), and the *Next Generation Science Standards (NGSS)* Science and Engineering Practices (2013). Use children's responses to these questions to make decisions about your next steps in instruction, providing additional experiences for children who have yet to demonstrate mastery of each goal. Be sure to consider each child's age and development to ensure that the tasks related to each goal are appropriate. Finally, for each lesson we provide the most relevant standards from the Head Start Early Learning Outcomes Framework, the science and engineering practices (SEP) of the *NGSS* (NGSS Lead States 2013), and the kindergarten or first-grade *Common Core State Standards for Mathematics and English Language Arts* (NGAC and CCSSO 2010). Although each lesson has multiple points of alignment with these different standards documents, only the primary standard addressed in each is noted and detailed at the end of each lesson. [Note: These different standards documents point out an important consideration for teachers using the lessons presented here. *A Head Start on Life Science* is written for teachers of children ages 3–7. This is an enormous span considering the development of children. You will have to be a critical reader of these lessons, making sure that the suggestions are developmentally appropriate and applicable to your setting. Each component of each lesson, while striving to adhere to the same general format, is written to present varied tasks to children. Pick and choose from among them and adapt them as necessary to design the optimal learning experiences for your children. For example, Head Start teachers may want to design lessons that emphasize the Cognitive (Science and Math) or Literacy Domains as suggested in the Head Start Early Learning Outcomes Framework (see Appendix A for a guide). Elementary teachers may want to make their science lessons two- or three-dimensional, aligning with a combination of the SEPs, disciplinary core ideas, and cross-cutting concepts of the *NGSS* (see Appendix B for a guide). Providing for each of our many different audiences *within* all aspects of each lesson is not practical, so instead we offer ideas for pre-K and Elementary (and for rural, urban, and suburban settings, Spanish- and English-speaking families, etc.) *across* the lessons. Our hope is that as a whole the lessons here are "educative," and that as you read and try the lessons you'll learn more about what makes for appropriate, high-quality science for children.]

## Planning for a Lesson

Our lessons include several components. These are provided so that you may provide multiple and different opportunities for students to explore each science phenomenon. However, it is not our intention that these lessons be necessarily taught in full or all at once. Depending on the development of your children, a different number of activities, each of a different duration, may be most appropriate. As you plan learning activities for your children, consider the sample weeklong plans provided in Tables 1.1 and 1.2 (p. 10).

## Planning for Safety

With hands-on, process- and inquiry-based classroom and field activities, the teaching and learning of science can be both effective and exciting. However, successful science teaching must always address potential safety issues. Teachers should review and follow local polices and protocols used at their school site and within their school district or agency (e.g., Board of Education safety policies, field trip policies, etc.). Additional applicable standard operating procedures can be found in the National Science Teacher Association's

*Table 1.1*

## Weekly Plans for Children Ages 3 to 5

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| • Getting Started<br>• Book From Reading Connection<br>• Centers | • Investigation<br>• Book From Reading Connection<br>• Centers | • Making Sense<br>• Book From Reading Connection<br>• Centers | • Extension Activity<br>• Book From Reading Connection<br>• Centers | • Math and/ or Writing Connections<br>• Centers<br>• Send Home Family Activity |

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| • Getting Started<br>• Centers | • Investigation<br>• Centers | • Making Sense<br>• Book From Reading Connection | • Extension Activity<br>• Book From Reading Connection | • Math and/ or Writing Connections<br>• Send Home Family Activity |

*Table 1.2*

## Weekly Plans for Children Ages 5 to 7

| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| • Science Lesson<br>• Book From Reading Connection<br>• Send Home Family Activity | • Lesson Review<br>• Vocabulary Review (if appropriate)<br>• Book From Reading Connection | • Extension Activity<br>• Book From Reading Connection | • Math and Writing Connections | • Centers |

"Safety in the Science Classroom, Laboratory, or Field Sites" document, available online at *www.nsta.org/docs/SafetyInTheScienceClassroomLabAndField.pdf*. Remember that children with allergies or immune-system illnesses will need additional consideration. Always check with parents and guardians and the school nurse ahead of time. Field studies need to be given special consideration. As with all field trips, scout out the area before you take children there. During all science activities, but especially during field studies, make sure there is appropriate student supervision by adults. For information on field trip safety, read the NSTA Safety Advisory Board paper "Field Trip Safety." It can be found at *static.nsta.org/pdfs/FieldTripSafety.pdf*. [Note: The safety precautions provided in each lesson are based in part on use of the recommended materials and instructions, legal safety standards and better professional practices. Selection of alternative materials or procedures for these activities may jeopardize the level of safety and therefore is at the user's own risk. Ultimately, teachers are responsible for the materials and procedures they opt to use in their classrooms and for the safety and well-being of their children.]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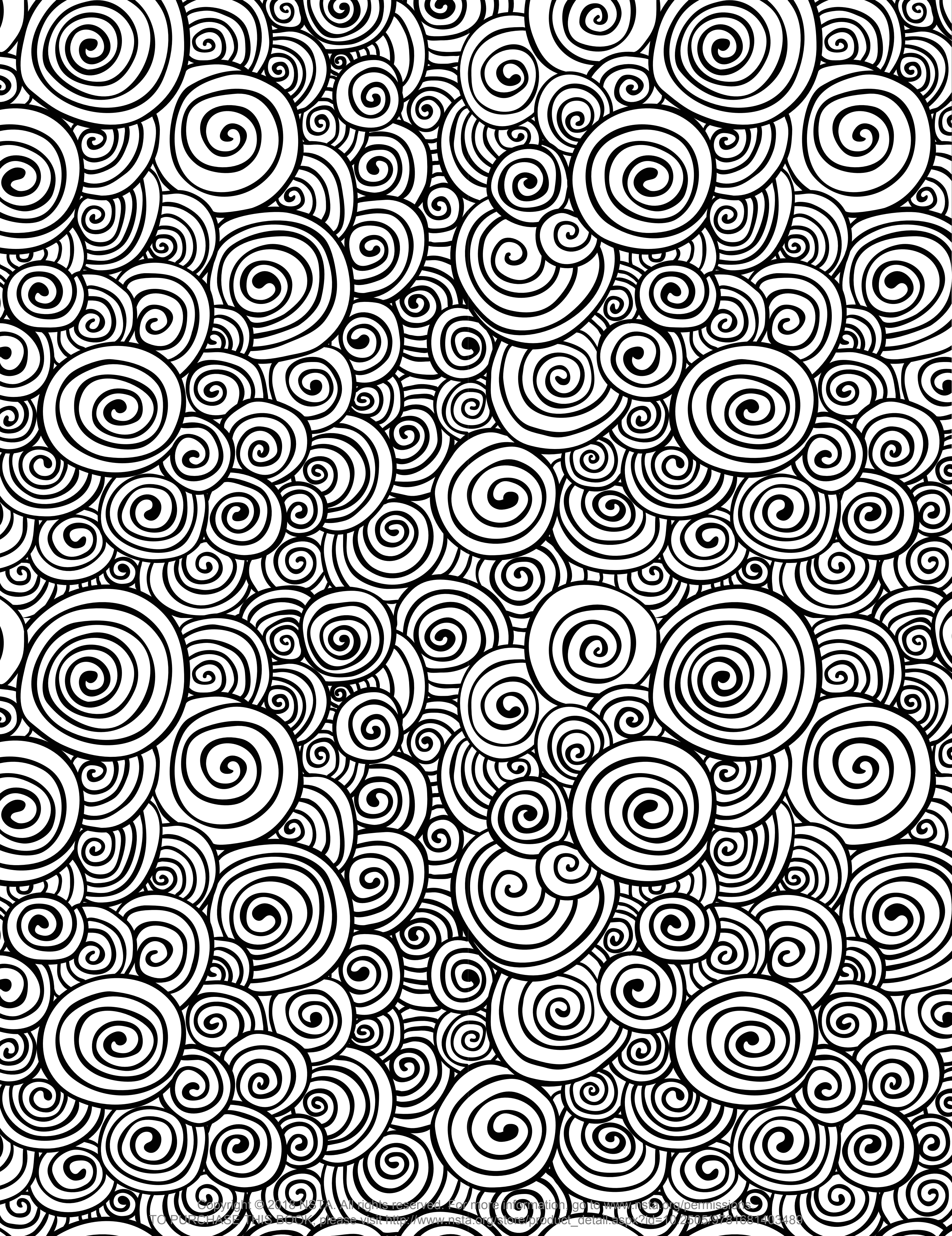
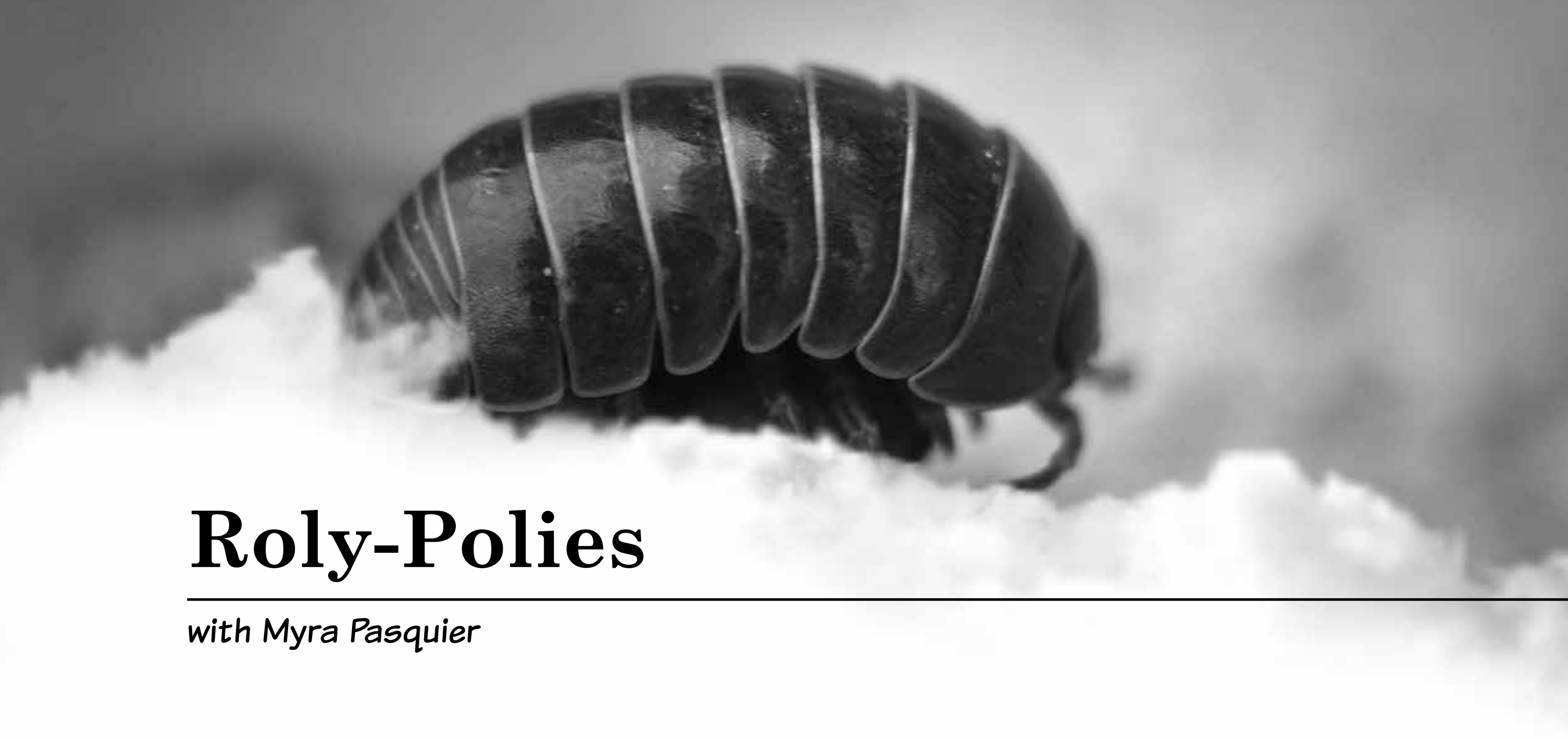
# Animals

The components of the natural world that children often find most fascinating are animals. This interest, coupled with their great diversity and their prominence in our communities and cultures, makes animals the ideal topic for exploration with young children. As you investigate animals together, keep in mind that children have been fascinated by and thinking about animals long before they came to your classroom. In all of your lessons, make time for children to share what they know about animals and what they wonder about animals. Listen to your children and follow their leads. The lessons in this chapter will give you and your children opportunities to explore several animals and to learn about animal structures and their functions, adaptations such as camouflage, and the diversity of life.

Throughout your explorations with animals, always keep safety in mind—both the safety of your children and the safety of the animals! Familiarize yourself with NSTA's guidelines for the responsible use of animals in the classroom, found online at *www.nsta.org/about/positions/animals.aspx*. After each lesson, return animals to their rightful place. If you collected animals from your yard, return them to your yard. If you purchased them from a pet store, return them to the pet store. Animals obtained from stores should never be released outside. In many cases, these non-native species can cause great harm to native species and existing natural systems as well as to crops and gardens. During lessons, engage children in conversations about the appropriate handling and treatment of animals and encourage your children to be kind to animals. Remember that throughout these lessons, your gentle and respectful treatment of animals will serve as an important model for our young children.





# Roly-Polies

*with Myra Pasquier*

**Lesson:** Observing and comparing roly-polies to other animals

**Learning Objectives:** Children will use observation skills to describe the physical features of roly-polies. They will make comparisons with other animals to identify similarities and differences to infer which animal roly-polies are most like.

**Materials:** Roly-polies, magnifiers, writing and drawing materials, clear plastic plates or tubs, ants and pictures and diagrams of ants, crayfish and pictures and diagrams of crayfish. [Note: Crayfish are most commonly available in the spring; if they are unavailable at the time of your lesson, you can use shrimp instead.]

**Safety:** Remind children not to put their fingers in their mouth or nose while handling roly-polies or other animals. Make sure children thoroughly wash their hands with soap and water before and after the activity. Students with allergies or immune-system illnesses should not handle the roly-polies or the other animals used in this lesson. Make sure any spilled water is wiped up to prevent slipping hazards. Remind children to keep away from electrical outlets when working with water.

**Teacher Content Background:** Roly-polies, pill bugs, potato bugs, and doodle bugs are all names for the animal scientists know as *Armadillidium vulgare* (although in different regions of the United States these common names are often given to different animals). We'll call them roly-polies; partly because it's more fun to say but also because bugs are insects and, contrary to popular belief, roly-polies are not insects. They belong to the group of animals called crustaceans and are relatives of crabs, shrimp, and lobsters. Like their crustacean relatives, they have many legs and a body enclosed in a hard, segmented exoskeleton. However, unlike most of their crustacean relatives, roly-polies live on land and are found in almost all areas of the United States, except for deserts—which makes sense, as roly-polies have gills and breathe oxygen dissolved in water and therefore prefer moist environments. The females carry their young in a little pouch under their bellies until the more than 100 young roly-polies are ready to fend for themselves. Roly-polies play a very important role in soil ecosystems, both because they are a food source for many insects and because they are detritivores (they eat, and therefore help to break down, dead and decaying material). Of course, roly-polies are best known for their characteristic defense mechanism of


**Searching for roly-polies**

curling up into tight little balls, a trick that their relative the sow bug cannot accomplish.

Science terms that may be helpful for teachers to know during this lesson include *observe*, *compare*, (body) *segments*, *antennae*, *legs*, and *environment*.

## Procedure

### Getting Started

***Introduction:*** Before bringing out the roly-polies, have a discussion with children about being gentle with animals and being sure to not hurt them. Show the children how to handle the roly-polies—demonstrate holding your hand flat and letting a roly-poly uncurl and walk freely across your hand. For children who would prefer not to hold the roly-poly, provide a roly-poly on a clear plastic plate (a clear plate will allow children to see the underside of the roly-poly). Ask children to observe their roly-poly and to describe what it looks and feels like. Encourage children to use a magnifier to get a closer look. Prompt them to notice different parts of the roly-poly body. Ask, "What color is it? Is the top of it the same color as underneath? How do you think it moves? How many legs does it have? Which end is the front? How can you tell?" And ask the children if they have seen these animals before and if they know what they are called. [Note: Remember that roly-polies have several different names, each of which is acceptable. If most of your children already call them potato bugs or pill bugs or doodle bugs, use that name throughout the lesson.]

## Investigating

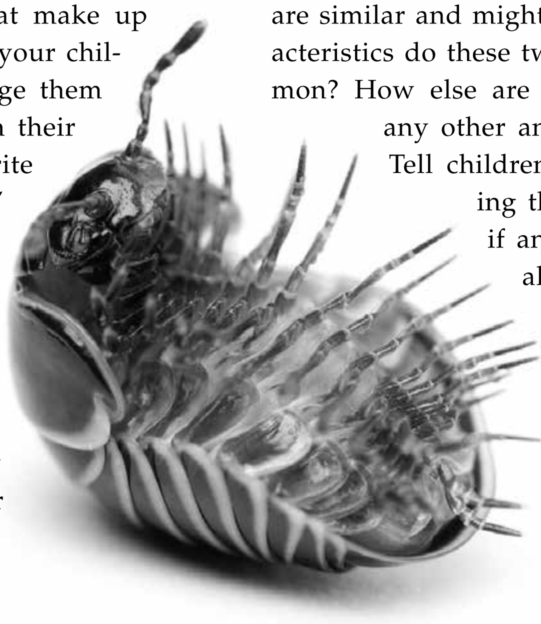
***Observing and Documenting:*** After children have had an opportunity to observe freely, provide some structure to their observations. Ask children to draw their roly-polies and guide them to include as many details as possible, emphasizing the body segments, legs, and antennae. (Alternatively, you can have children take photographs of their roly-polies. Print these for them, and encourage them to circle or label different body parts on their photograph.) Have children pay attention to the roly-poly's segmented body structure and numerous legs. Ask children to point to what they think might be the head of the roly-poly (the head has two antennae and is usually in front as the roly-poly moves). Sum up children's observations of roly-polies by asking them to count and decide how many body segments the roly-polies have. Do the same for the number of legs. After children have observed, it is helpful if you make a (larger) drawing of your own. Let children instruct you as you draw their observations for them and use questioning to encourage children to provide you detailed instructions (e.g., "What did you observe about the roly-poly? Oh, you saw a head? What shape was it? When I draw an oval for the head, is this how I should draw it? Did your roly-poly look like this?") This type of teacher demonstration will sharpen children's observation skills and help them to create detailed drawings of their own.

**Observing roly-polies**

***Comparing:*** Bring out the crayfish and ask the children to identify any differences and similarities they might notice between the crayfish and the roly-polies. Share real crayfish (from the seafood section of your local market or, even better, *live* crayfish from a bait shop), as well as downloaded pictures and drawings or diagrams of the crayfish. As simplified representations of the animals, drawings and diagrams will help children to see similarities and differences as they compare. After some initial time for observing this new animal, direct children to analyze their crayfish, focusing on determining the number of body segments and the number of legs. As children direct you, create a drawing of a crayfish that shows the body segments and legs, or have children create a drawing of their own. Repeat this process for ants, drawing three body segments and six legs. By the end of the investigation, children should have drawings of roly-polies, crayfish, and ants to analyze.

## Making Sense

***Describing Findings:*** Revisit the drawings and focus the children on the body segments of the animals. Ask them to count the number of parts or segments that make up each animal's body. Support your children as they count. Encourage them to record this information on their drawings and help them to write "7" or "seven segments." Next, direct children toward the animals' legs, asking, "What do you notice about their legs? How many does it have? How many do you see in each part of the body?" Again, support them as they count and record the number of legs.



***Generating Explanations:*** It may be wise to start by helping children to understand the concept of *similar*, explaining that when two things are almost the same, but not exactly the same, we call them similar. Referencing drawings, diagrams, or pictures of the three animals, ask the children which two animals have similar numbers of body segments and which one animal is different. Repeat this comparison for the legs. Explain to your children that "scientists analyze animals the way that we did to find out which animals are related. Animals that have many similarities are often related; these roly-polies and the crayfish have a lot in common. Do you think they're related? Why do you think they are related?" [Note: If you choose to, you can now inform children that roly-polies are not bugs or insects but instead are a type of animal called crustaceans. But much more important than this factoid is the idea that children, just like scientists, can observe animals and find out which ones are similar and which are different.]

***Application:*** Engage children in a discussion of other animals they know that they think are similar and might be related. "What characteristics do these two animals have in common? How else are they similar? Are there any other animals that are similar?" Tell children that it's not just looking the same that determines if animals are related; it can also be sounding similar or acting similar. "Can you think of two animals that sound similar? Can you think of two animals that act similar—that eat similar foods or that live in similar places?" Download pictures of animals to support this discussion; use pairs of closely-related animals, such as zebra–horse, coyote–wolf, kangaroo–wallaby, llama–vicuña, and ostrich–rhea. Be sure to label the pictures so children can see that the names of the animals are different.

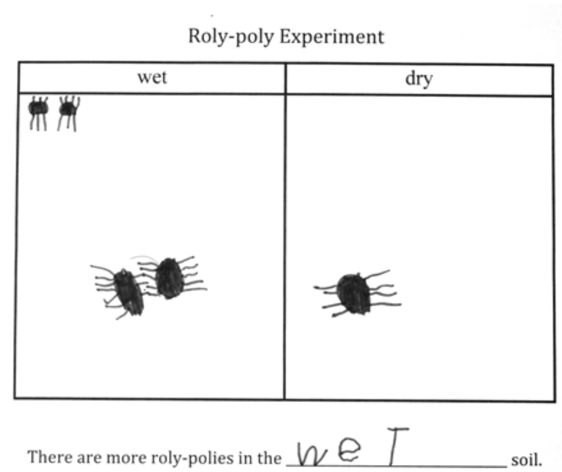
## What's Next?

### Extension Activity

In this activity, children will investigate whether the roly-polies have a preference for wet or dry environments. Ask children, "How can we test to see whether roly-polies prefer wet or dry environments?" Encourage children to ask questions and to explain possible ways to conduct this test. Use a clear tub roughly the size of a shoebox. Have the children place their roly-polies in the center of the tub; there should be about 10 to 20 roly-polies in the tub to make this investigation reliable. Students can wet a napkin (a paper towel or cloth will also work), wring the excess water from it, and then place the wet napkin on one side of the tub; on the other side children can place a dry napkin. The bottom of the tub, and the roly-polies, should be completely covered. Show the tub to the children and let them tell you what is different about the two sides of the tub. Discuss the experiment, asking children to explain how it's set up, what it's designed to investigate, and what results they anticipate. After 15 to 20 minutes, hold the tub up so that children can view the roly-polies from below. Have children describe the movement and placement of the roly-polies they observe. Students can record their data, drawing the roly-polies found on each side (see Figure 2.1, Roly-Poly Data Sheet). Based on the results of the investigation, children can determine if their roly-polies have a preference for wet or dry environments.

*Figure 2.1*

**Roly-Poly Data Sheet**




**A full-size version of this figure is available at *www.nsta.org/startlifesci.***

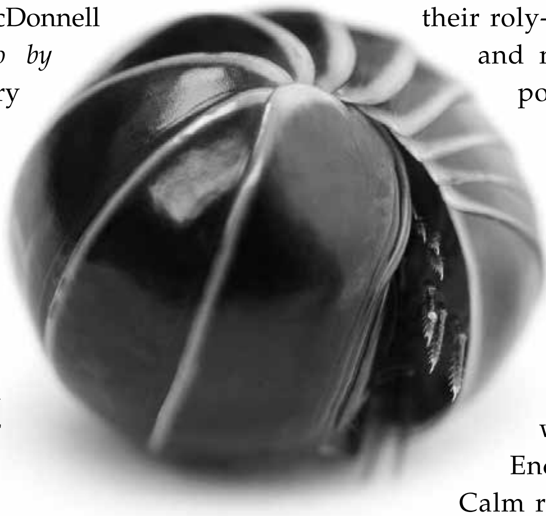
Similar experiments can be conducted to investigate additional roly-poly preferences (light vs. dark, different types of food, etc.); let your children decide which variable to test. After each experiment, have children verbalize or write the answer to their research question (e.g., "Roly-polies prefer wet environments"). You can find variations of this experiment described in *Observing Earthworms*, page 30.

## Integration to Other Content Areas

### Reading Connections

The activities in this lesson include opportunities to draw children's attention to print and to use print in meaningful ways that support children's development of emergent literacy skills. These include verbally describing and drawing roly-polies, making comparisons with different animals, and labeling drawings. Many books, including *Next Time You See a Pill Bug* by Emily Morgan (2013), *A Pill Bug's Life* by John

Himmelman (2000), and *I'm a Pill Bug* by Yukihisa Tokuda (2006), provide informational text paired with images of roly-polies. Students can explore sets of related animals with books such as *The Beetle Book* by Steve Jenkins (2012), *Sorting Snakes* by Mary Rose McDonnell (2013), and *Animals Two by Two* by Lawrence F. Lowery (2015). And the fun book, *Roly-Polies,* by Monica Carretero (2011), informs children about roly-polies while helping children to learn to judge people (or roly-polies) based on their abilities and creativity and not by their appearance.



### Writing Connections

With conspicuous *R*, *P*, and *L* sounds, along with long *O* (/ō/) and long *E* (/ē/) sounds, *roly-poly* is a great word for children learning to write letters associated with different letter sounds. Ask your children which letter sounds they hear and help them to write *roly-poly* in a way that makes sense for them. (Expect and applaud, "R O L E" and "P O L E.") With two long *O* (ō) sounds and a body, when curled-up, that resembles the letter *O*, let roly-polies inspire you and your children to search for other things in the class that have the long *O* (ō) sound. For each object found, write a label for the object and have children identify the *O* in the word you have written. Read the word together before going on to the next object.

### Math Connections

"Roly-Poly Races" can provide children with several opportunities to use their emergent math skills. Draw a small circle in the center of a large piece of paper and let children place their roly-polies in the circle. Use a timer and encourage children to count with you. (Depending on how active your roly-polies are, about 20 to 30 seconds should be enough time for the race.) At the end of the race, let children mark their roly-poly's position on the paper and measure how far their roly-poly traveled using standard or nonstandard units (paper clips, dominos, and so on). [Note: Although frightened crickets and frogs will jump farther in similar races, the strategies of touching the animal or tapping the ground next to it won't work with roly-polies. Encourage children to be still. Calm roly-polies will crawl farther; startled ones just curl up into a ball.]

## Other Connections

### Child's Life Connection

Students will be amazed to find how prevalent roly-polies are. Conduct a roly-poly search with your children. Let children know that roly-polies like moist, dark places and invite the children to search in the grass, at the base of bushes, and under rocks. Be sure you've scouted the area ahead of time and have made sure it's free of hazards. If you and your children can't seem to find any roly-polies, try to lure them to you. Place half of a raw potato, cut side down, in a moist grass or dirt area and wait. In the next day or two, you should have roly-polies—check first thing in the morning, but use caution, as roly-polies may not be the only animals beneath the potato. [Note: This technique works well for capturing roly-polies to use in the lesson as well.]

## Center Connections

Very few animals are round. Celebrate the roly-polies' ability to curl up into a ball in your centers. In the **art center,** try marble painting. Tape paper (to be painted on) to the bottom of a shallow box. Set out small cups of paint (or use an empty egg carton). Have children place a marble in a paint cup and swirl the marble around to make sure it gets covered in paint. Students can use a spoon to transfer one or more marbles from the paint to the box. Students can then paint by tilting the box and having the marbles roll over the paper, leaving paint trails behind. Ask how the marbles are moving and help children to use the word *rolling*. Fill the **sensory table** (or a tray) with polished stones and add a few marbles. Students can feel among the smooth stones and try to identify the marbles without looking. Encourage children to describe what "round" feels like. For **dramatic play**, have children become "rolling experts." Provide a small ramp and a variety of different objects, along with paper and pencils for children to record their data. Students can test objects to identify those that roll and those that do not. Supply measuring tapes so children can try to determine which objects roll the farthest; encourage children to explain their findings.

## Family Activities

*In school, your child has been learning about roly-polies. We conducted several different investigations that your child can tell you about and repeat at home. Conduct a roly-poly search with your child. Look in moist, dark places outside. If you can't find any roly-polies, try to lure them to you. Place half of a raw potato, cut side down, in a moist grass or dirt area and wait. Check for roly-polies with your child each morning. Count them together. Let your child tell you about roly-polies and their legs and body segments. Collect a few roly-polies and have your child show you how to test whether roly-polies prefer wet or dry environments. With your child, place roly-polies in the center of a tub and place dry napkins on one side of the tub and wet napkins on the other. Let your child lead. After a minute or two, uncover the roly-polies to see which side of the tub they prefer. Be amazed as your child shows you the results of the experiment and ask your child to explain it to you.*

## Actividades Familiares

*En la escuela, a su hijo se le ha enseñado sobre las cochinillas. Llevamos a cabo numerosas investigaciones sobre las cuales su hijo le puede hablar y repetir en casa. Realice una búsqueda de cochinillas con su hijo. Busque en la humedad, lugares oscuros al exterior. Si no puede encontrar ninguna cochinilla, intente atraerlas. Ponga la mitad de una papa cruda sobre el césped húmedo o en una zona con lodo, con el lado cortado hacia abajo, y espere. Revise si hay cochinillas con suhijo cada mañana. Cuéntenlas juntos. Deje que su hijo que le hable sobre las cochinillas y sobre sus patas y segmentos corporales. Recoja unas cuantas cochinillas y haga que su hijo le muestre como probar si las cochinillas prefieren los ambientes secos o húmedos. Con su hijo, ubique cochinillas en el centro de una bañera y ponga servilletas secas en un lado de la tina y servilletas húmedas en el otro. Deje que su hijo guíe. Luegode uno o dos minutos, descubra las cochinillas para ver qué lado de la tina prefieren. Sorpréndase cuando su hijo le muestre los resultados del experimento y pídale que se lo explique.*

## Assessment—What to Look For

- ***Can children describe features of roly-polies based on their observations?***
  *(using senses to gather information, identifying properties, using new or complex vocabulary)*
- ***Can children provide verbal comparisons of different crustaceans?***
  *(comparing properties, explaining based on evidence, using new or complex vocabulary)*
- ***Can children identify objects as similar and different?***
  *(comparing properties, explaining based on evidence, using complex patterns of speech)*
- ***Can children record (draw or write) observations and contribute to class discussion?***
  *(using new or complex vocabulary, documenting and reporting findings, discussing scientific concepts, listening to and understanding speech)*

## Standards

| Head Start Early Learning Outcomes Framework |
|---|
| **P-SCI 4. Child asks a question, gathers information, and makes predictions.** "Asks more complex questions. Uses other sources besides adults to gather information, such as books or other experts. Uses background knowledge and experiences to make predictions." |
| ***Next Generation Science Standards*** |
| **Science and Engineering Practice: Constructing explanations and designing solutions.** "Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena." |
| ***Common Core State Standards for Mathematics*** |
| **K.MD.A.2. Describe and compare measurable attributes.** "Directly compare two objects with a measurable attribute in common, to see which object has 'more of'/'less of' the attribute, and describe the difference." |
| ***Common Core State Standards for English Language Arts*** |
| **SL.1.4/5. Presentation of knowledge and ideas.** "Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly. Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings." |

# Index

## C



## D



## E

**W**

# A HEAD START ON LIFE SCIENCE

## *Encouraging a Sense of Wonder*

***"I can't wait to get this book into the hands of our teachers. The author uses animals and plants that children see every day in their backyards or on the school playground to make science accessible to our youngest students. Finding solid resources for early childhood is such a challenge. All our early childhood teachers will have a copy of* A Head Start on Life Science *to enrich their science instruction."***

**— Dr. Karen S. Norris**
Director of curriculum and instruction, Momentous Institute

This book nurtures a lifelong love of science in children—and helps them find joy while doing it. Rather than teaching science facts to 3- to 7-year-olds, you can use the 24 inquiry-based activities in this book to prompt children to make discoveries on their own.

*A Head Start on Life Science* follows up on NSTA Press's popular *A Head Start on Science*. The new book lets you

- **Generate greater interest in life science.** The lessons are inquiry-based and designed to engage. Through sections on animals, plants, and nature walks, children will explore critter camouflage, probe pumpkin insides and outsides, make nature bracelets, and more.
- **Offer related learning opportunities.** Each lesson connects to multiple subjects, including reading, writing, and math, as well as dramatic play, art, and sensory centers.
- **Extend beyond the classroom** in ways that lead to more meaningful and longer-lasting science learning with at-home activities written in English and Spanish. The lessons relate to children's everyday lives and offer ways for them to continue exploring with their families.
- **Use the material easily and in a variety of settings.** All lessons include lists of learning objectives and required materials, plus relevant background to help you prepare. You can use them in preschools, elementary schools, informal science settings, and home schools.

Author William Straits sees teachers as partners in helping the youngest scientists investigate the natural world. As he writes, "Your sense of wonder will be heightened as you engage in science explorations with children, actively following as their curiosity leads them to discoveries about all that they see, hear, smell, and touch."

**Grades PreK–2**

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