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introduction

"In a world filled with the products of scientific inquiry, scientific literacy has become a necessity for everyone. Everyone needs to use scientific information to make choices that arise every day. Everyone needs to be able to engage intelligently in public discourse and debate about important issues that involve science and technology. And everyone deserves to share in the excitement and personal fulfillment that can come from understanding and learning about the natural world" (National Research Council 1996, 1).

"If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, the excitement, and the mystery of the world" (Carson 1965).

How do we keep alive this inborn sense of wonder in early childhood classrooms? How can teachers provide children with appropriate experiences and guidance? Using the Young Scientist series is one way. But before we describe the series and how to use this guide, we would like to share a few responses to two important questions: (1) Why is science knowledge important? and (2) Why should we start in the preschool years?

Why Is Science Knowledge Important?

One goal of science is to understand the natural world. Knowing some science can help us explain why things happen, such as why water evaporates and why plants grow in particular locations, what causes disease, and how electricity works. Scientific knowledge also can help us predict what might happen—when a hurricane may hit the coast or how severe the flu will be this winter.

But science is more than knowledge; it is also a process of exploration that we call *scientific inquiry*. When scientists try to learn something about events,

objects, or materials, they observe wonder, and ask questions. And they go further and focus on one question, predicting what they think they might find out and setting up an investigation. They observe closely, using their senses and tools to collect and record data and evidence. Through analysis of their data and reflection on all they've done, they develop new ideas and theories and communicate those to others.

Most of us are not scientists, but in many small ways, we do science. When you ask the question, "How much light does my geranium need to flower well?" then test the different possibilities by putting one in the sun and one in the shade to find your answer, you are doing science. When you compare two pens, predict which one you think will work best for the drawing you are making, and then try them out, you are doing science. When you use a book to find out what kind of birdseed will attract cardinals, you are doing science.

Whether we work in a lab or a school, chart the courses of hurricanes, or want to learn about sound, we all have questions—scientists and nonscientists, adults and children alike—and we all use some of the basic tools of scientific inquiry. Given the opportunity to explore and discover, we can feel the sense of wonder, joy, and excitement that Rachel Carson describes above.

Why Should We Start Science in the Preschool Years?

Children's curiosity about the natural world, their "in-born sense of wonder," is a powerful catalyst for their work and play. With this curiosity and the need to make sense of the world, children are motivated to ask questions, explore how things work, and look closely at the natural world around them.

But in today's world, children's experiences and their opportunities to do science are often limited—confined too frequently to the passive and secondhand experience of the television or video game. Modern technology also has hidden from view some of the basic ways in which things work. Our food comes from stores and few children have seen or engaged in growing and processing it. Toys that were once pushed or pulled or rolled now have hidden motors and batteries to drive them and a switch to turn them on and off.

Science curriculum is important in the early childhood classroom so that "doing science" becomes a natural and critical part of children's early learning. With carefully selected materials and thoughtful guidance, children's explorations will encourage them to observe more closely, develop new ideas about the world, and build a foundation of experiences and ideas on which to construct later understanding. Science in early childhood classrooms also provides a rich context in which children can develop other important skills, including large- and small-muscle control, language and early mathematical understanding, and cooperation.

What Is the Young Scientist Series?

The Young Scientist series is a science curriculum for children who are three to five years old. Each of the teacher guides provides background information and detailed guidance on how to incorporate science into your daily program using many of the materials you already have in the classroom in new ways. *Discovering Nature with Young Children* is about the living things right outside the classroom door. *Exploring Water with Young Children* takes a new look at the water table and *Building Structures with Young Children* challenges children to use building materials found in the classroom to explore questions of how to make things strong,

tall, or elegant. Each study can take several months or extend over longer periods of time.

The Young Scientist series is not about learning and repeating facts, information, and vocabulary with little direct experience. It is not following a set of directed activities or learning the scientific method. It is not a week focused on bears and it is not observing random objects on a science table. The Young Scientist series makes science the work and play of exploring materials and phenomena, while providing opportunities for children to learn from that experience. Young children may do this as they engage in fantasy and dramatic play—creating magic potions at the water table or building a home for the make-believe turtle in the block area. They may do science as they challenge themselves or invent a game: "Who can build the highest tower or empty the water bucket the fastest?" They also may engage in exploration as young scientists, wondering and questioning and seeking to make sense of the world: "What would happen if I rolled the ball from the very top of the ramp? What does my worm need to live? I wonder if I can find an anthill near the one we found yesterday?"

As they explore and interact with one another, young children try to make sense of what they see and do. They develop early theories about why things are the way they are, act the way they do, and how they relate to one another. As their experience broadens and their thinking deepens, their ideas and theories become more plausible and closer to current understandings in science.

Exciting science experiences for young children do not just happen. The Young Scientist series establishes your important role to ensure that children's play and ideas about science are focused, deepened, and challenged. The following examples illustrate the differences between activity-based nature study, a thematic approach, and an in-depth exploration of the science of living things in the environment.

Teacher A takes the children out to play. A small group finds a worm and carries it over to her with great excitement. They ask if they can bring it in and the teacher agrees, sending her aide to get a small cardboard box. Scooping a bit of soil into the box, the teacher asks children to put the worm into the box. Once back in the classroom, she puts the worm in its new home on the science table and invites the "worm finders" to observe it. At circle time, she asks the group to share their story about finding

the worm, then tells the class the worm will be the class pet for a few days. The next day the teacher reads *The Very Hungry Caterpillar* and asks children to compare the worm with the caterpillar in the book. She then creates a few rules for how to handle the worm and opens the table for groups of four during activity time. Over the next couple of days, different children observe and play with the worm. As their interest begins to wane, the teacher announces that together they'll put the worm outside the next day. However, she discovers she doesn't have time to return the worm with the children, and she deposits the worm in the playground herself.

In this example, the children actively enjoy playing with the worm at the science table, but opportunities for both independent and cooperative learning are limited. The worm stimulates their interest, but there is no guidance or encouragement for them to investigate ideas such as the relationship between the worm and the environment; its physical characteristics and behaviors. Children's interest and curiosity is clear, but the potential for reflection, dialogue, and developing ideas about some interesting and critical life science concepts is minimal. Moreover, there is little attention to developing children's respect for living things.

Teacher B notices the children's interest in worms and decides to do a project on worms. She gathers many materials: plastic worms for the sand table and block area; books about worms, snakes, and caterpillars along with a couple of Richard Scarry books (children love Lowly Worm); worm pictures she has found; clay for rolling worms; brown paper in the paint area for worm paintings; and a new insect puzzle with letters. She plans to use the opportunity to teach the letter *W* to the children. Teacher B introduces the project with a class discussion asking children to share their experiences with worms. She identifies the areas in the classroom where there are worm activities and encourages children to spend some time at each. During the week she moves through the classroom supporting children's play and, during group time, encourages them to talk about their worm experiences. Toward the end of the project, the children make a special trip outdoors and bring a worm back to the classroom to visit for a day.

In this example, children are surrounded with worm activities. The block area, the sand table, the art corner, and many of the choice tables have worm-related activities—all of which address basic literacy, math,

and social skills. The children are very engaged and the visiting worm is the highlight of the week. But this project with its science theme has little to do with scientific inquiry and exploration of science concepts.

Teacher C also responds to her children's interest in worms. But she decides that their interest in worms could be the beginning of an exploration of living things in the local environment. When children find a worm outside, she looks at it with the children and asks them to show her where it came from. The next day, she takes the worm finders (and a few other children who show interest) to the spot where the worm was found. There, she engages them in a dialogue about how they found the worm and where the worm lived. When children request to bring the worm in, she says it would be wonderful to have the worm in the class for a short time, but first they needed to plan for the visit. The teacher and the class talk and wonder together: What kind of home do they think the worm would need? How could they make it like his home outdoors? What might be important to remember when the worm was visiting? A couple of days later, after much discussion about the worm and its needs as well as some "research" about keeping small animals in the classroom, the children are ready to create the worm environment and they go outdoors and find a few to bring in. Over the next couple of weeks, the children carefully observe the worms as they measure them, draw pictures of them, and discuss their ideas at circle time. They explore and debate how worms move and what they eat. And then, because they are not sure that all the worms' needs are being met, the whole class goes out and carefully returns the worms to the spot from which they came.

As in the other examples, children in this classroom enjoyed playing with the worms, but in this case they are also engaged in an active, hands-on science inquiry project that illustrates the approach of the Young Scientist series. The teacher builds on the children's interests and has defined a clear set of science concepts to guide their work with living things. She encourages them to conduct their own observations and explorations. While many other skills are practiced and learned, science is in the foreground. Using the outdoor environment and indoor visitors she promotes creative, deep exploration and children's use of inquiry.

She focuses the children's attention on important concepts about living things:

- Basic needs
- Physical characteristics
- Habitats
- Behaviors

She encourages deeper thinking to enrich their experiences without interfering in their own process of questioning and exploration. As she does this the children develop their skills in the following:

- Observing closely
- Describing what they see
- Raising questions
- Investigating
- Representing things and ideas
- Discussing

And as she engages the children in planning the worm's visit to the classroom, she guides the children in the following:

- Appreciating the connection between an organism and its environment
- Appreciating the need to care for the environment
- Realizing their responsibility for the animals they bring into the classroom

As you continue to read and begin to implement, you will learn more about science for young children and what they can do. You will also learn about how to make it possible for children to engage in the rich science exploration exemplified by Teacher C. As you teach, keep in mind these basic principles in the Young Scientist series.

- All three- to five-year-olds can successfully experience rich, in-depth scientific inquiry.
- The content of the science learning draws from children's experiences, is interesting and engaging, and can be explored directly and deeply over time. Expectations are developmentally appropriate; that is, they are realistic and tailored to the strengths, interests, and needs of individual children.
- Discussion, expression, representation, and reflection are critical ways in which children make

meaning and develop theories from their active work. Children learn from one another.

- Teachers can take on specific roles and use particular strategies to actively support and guide children's science learning.

Rationale and Goals

We live in a world filled with an enormous variety of living things that inhabit all kinds of environments. Even on city streets, small plants push their way up through cracks in the sidewalk, and ants appear seemingly from nowhere. Children are fascinated by living things. The teaching methods described in this book will help children expand on that fascination to become young naturalists, encouraged to see the outdoors as an authentic place to explore living things as they exist in nature and the indoors as a place to recreate small parts of the outdoors and look more closely at temporary plant and animal visitors. The emphasis of this exploration is not on naming specific living things. While knowing the names of living things makes for more efficient communication, it does little to deepen children's understanding. Instead, the specific goals of the exploration are to provide opportunities for children to

- Observe life around them more closely.
- Build an understanding about what is living and nonliving such as the characteristics and needs of living things—their life cycles, habitats, diversity and variation, and interdependence.
- Develop science inquiry skills including wondering, questioning, exploring and investigating, discussing, reflecting, and formulating ideas and theories.
- Develop scientific dispositions including curiosity, eagerness to find out, an open mind, respect for life, and delight in being a young naturalist.

The Classroom Environment

A *naturalist* is a person who studies living things, especially by direct observation of animals and plants. One of the most important roles you play in this exploration is creating an environment and culture in your classroom that supports and encourages children to be

young naturalists—the classroom must convey the excitement and wonder of observing and learning about living things. Some of the characteristics of such an environment and culture follow.

A RESPECT FOR LIVING THINGS

A naturalist environment conveys an attitude of serious respect for living things and their habitats. It is a place where children are asked to think about the needs of living things and how they are met. It emphasizes learning about plants and animals in their natural environments. Outdoors this means disturbing the environment as little as possible; indoors this means moving from practices such as keeping animals as pets and growing houseplants to creating mini-environments in which living things are in as natural an environment as possible, often only for short periods of time.

AN EMPHASIS ON INQUIRY

Naturalists ask questions, observe closely over time, and think about what their observations tell them. What are the special characteristics of a particular living thing? Where is a particular living thing found? Why is it found there? What are the differences between two kinds of snails? What changes are taking place? A naturalist environment encourages children to ask such questions and to try to find answers. It emphasizes the importance of gathering data through observation by having appropriate tools on hand and time to explore. The naturalist environment is full of children's ongoing dialogue and work, photographs, charts, and panels communicating the value of documentation and recording to good naturalist study.

SHARING OBSERVATIONS AND IDEAS

In a naturalist culture, children are encouraged to share their observations and ideas through small and large group discussions, and they learn to listen to what others have to say. They share their records of what they have seen; their ideas about science concepts, such as what makes something living or nonliving; and their thoughts about what different plants and animals need to survive. They learn that ideas are valued and important whether right or wrong; that people may have different ideas; and that one can learn by asking question of others. They also learn that they need to share how and why they know what they know as well as what they know.

DOCUMENTATION AND RECORDING

Naturalists spend a great deal of time documenting what they see—using careful sketches, descriptive words, and names to most accurately remember their experiences. They use their notes to reflect with others and find patterns in their observations. Young naturalists can begin to develop these skills no matter their level of development. In a naturalist environment, materials for representation are easily available and children's work is used to discuss their ideas and to stimulate more focused investigations.

A FOCUS ON ACTUAL LIVING THINGS

The naturalist culture emphasizes the wonder of living things as they are, not as they appear in fantasy. Therefore, the books and other resources you use are accurate in their portrayal of living things. As young naturalists, children are encouraged to try to represent what they see, not what they imagine, and to begin thinking about the needs and behaviors of living things. Fantasy certainly has its place, but is clearly distinguished from the real thing.

Children as Young Naturalists

This exploration is designed to provide experiences over time in which children can engage in multiple ways depending on who they are and what they bring. You may find that some children are immediately drawn into the exploration, constantly searching for clues about where different small animals live or how and what they eat. Other children may be more reluctant, shying away from bugs or anything that moves. Some children will quickly grasp the concepts of living and nonliving, while others struggle with these ideas. How children approach this exploration, and what they learn, is influenced by a range of factors including the different experiences, needs, skills, and ideas that young children bring. As you prepare for this exploration, you will need to consider these factors.

PRIOR EXPERIENCES

Young children bring to a study of living things their own ideas, interests, and beliefs based in experience and culture, and tempered by their developmental level. Some children may have had contact with many living things both in natural habitats and as part of a

household of pets and plants; others may have had little contact. Some may see many organisms as dangerous or scary; others may come from cultures in which certain organisms are to be feared or revered. It is, therefore, useful to talk to children's families to learn more about children's previous experiences, interests, and fears.

DIVERSE STRENGTHS AND CHALLENGES

Any class presents you with a diverse group of children. The Young Scientist series presents an ideal curriculum for diverse classrooms. All children can explore materials and objects; all children try to make sense of their environment. Each child in your classroom can engage with science and contribute to the classroom learning whether she is three or five years old, speaks English or Spanish or Creole at home, is typically developing or has a special need.

Naturalist exploration relies heavily on observation and direct access to living things and their habitats. Be sure that all children, including those with disabilities, have opportunities to observe and explore living things. As you plan, consider environmental adaptations you may need to make (such as how to arrange the space, how to place the materials so that all children know where to find them and can access them easily, or how to provide access to outdoor settings). Also think about curriculum adaptations (such as using visual cues or body language to convey information to children whose first language is not English) and materials adaptations (such as attaching thick upright handles to tools for children with small-muscle problems) that can support children's participation. Remember, some children may not have the internal control needed to handle living things safely. For this reason, it is critical that an adult is present whenever children handle animals.

COMMUNICATION SKILLS

Central to the role of the naturalist is the close observation of living things. As with all science, describing and recording what is observed is essential. Children will have varying levels of observation, language, and representational skills depending on experience and developmental level. Some children may not have the use of many words to describe what they see but may use their bodies and actions instead. Others may draw with great detail. The drawings of others may only include one major characteristic of a living thing: for example, a line may represent a worm, or a swirl may

represent a snail. In each case, an important characteristic of the living thing guides the representation. Some children will document what they see using three-dimensional materials. It is important to encourage thinking and representation without expecting or pushing children to go beyond their capabilities.

CHILDREN'S IDEAS

Because all young children have had some experiences with living things, they all have ideas and theories about them, which may be more or less accurate. *Discovering Nature with Young Children* will give children many experiences with which to modify their ideas and theories and build new ones. But do not expect children to "correct" their initial ideas based on this exposure alone, and do not try to correct them directly. Through conversation, questions, and gentle probing, some children will come to new understandings, more reasonable, but not necessarily more accurate, than their old ones. Other children will need repeated exposure to ideas and experiences over extended periods of time to let go of old ideas and begin to refine and deepen their understanding.

The questions children have also may be very different from the ones you have. You cannot know what every child in your group is thinking, but you may get an idea of different children's points of view by listening to, questioning, and observing children as they explore. It also is helpful to think about some of the typical ideas, questions, and naïve conceptions young children have about some of the basic science concepts that are related to this exploration. You will find information about some of the more common ideas children hold in step 1 of the "Getting Ready" section (p. 13).

Science Exploration through Play

Play is fundamental to children's development, and they approach much of what they do through play. Children engage in many kinds of play, including dramatic or symbolic play, exploratory play, and constructive play (Eisenberg 2000). As young naturalists, children will be engaging in exploratory play as they look for living things, find out what they are like and what they do, examine where they live, and learn

about what they need. This will help children gather information and experiences necessary to ask and pursue new questions.

You also will want to encourage symbolic play in this exploration by asking children to assume the role of the young naturalist with their own naturalist tools and other props such as hats and aprons with many pockets. They might also become creatures themselves, moving and behaving as though they were a particular animal. Symbolic play may go on in the block corner or sand table as well, with children creating homes or environments for play animals or imaginary ones. There may well be opportunities for you to join this play and engage children in discussion and activity around some of the concepts they are learning.

Many children will see the study of small animals as an opportunity to become caregivers, the animals becoming pets or substitute babies. It is important to respect children's caring but to carefully reinforce the idea that it is essential to meet the needs of living things. Looking for animals outdoors may lead some children to take on the role of hunters rather than the role of the naturalist. It is best to redirect this kind of play at this time as it may lead to rough treatment of the animals and may conflict with developing an attitude of respect for the living environment.

Children may also want to engage in constructive play with animals. Their interests can be focused on building terraria or designing a garden. They may also want to create raceways for worms or build block houses for snails. In these instances, you will need to stop the play and refocus children's attention, discussing, if appropriate, why the children cannot do these things with living creatures.

Connections between Science Outcomes and Other Domains

As you provide opportunities for children to explore living things, and guide them in their development of science inquiry skills, you will also see growth in language, literacy, mathematics, and social skills, as well as in children's approaches to learning. The chart that appears in the appendix (pp. 147–153) shows the connections between science inquiry outcomes as we define them in the Young Scientist series and the

outcomes of other subject areas taken from the Head Start Child Outcomes Framework.

Mathematics is one of the languages scientists use to record and reflect on their observations and to communicate their ideas to others. Children who are exploring living things will also become meaningfully involved with mathematics ideas as they count, measure, sort, categorize, and compare the many plants and animals in their surroundings. They will also use other mathematics skills as they look at the shapes of leaves and trees, at small animals, and for patterns.

Scientists also communicate with words. As children communicate their findings, participate in discussions, and represent their experiences they are certainly increasing their language and literacy skills. In fact, research suggests that engaging children in rich science experiences provides a context and a purpose for meaningful language and literacy learning. By engaging with science, children build their vocabulary while developing an ability to communicate their ideas. Such a capacity for oral language provides the foundation for all literacy learning. Children also learn about the importance of books as they use them to find out what their snails need to live or to get ideas about building techniques, materials, and designs. They learn to record their observations, explanations, and ideas about how worms or snails behave by using multiple forms of representation, including drawings, simple graphs, and writing. Such representations provide a visible record that encourages children to reflect on and talk about their theories and what they have discovered.

Science is a social activity. Whether in person or through other means of communication, scientists exchange ideas, build on one another's work, and often collaborate on science investigations. As children pursue their questions about living things, they need to work together to find interesting plants and animals, build a classroom terrarium, and exchange ideas about how a snail moves or when a pill bug curls up. Together their individual ideas can suggest a bigger picture and new ideas—all things that eat are alive. Such collaborative work (that involves sharing materials and ideas) provides children with significant opportunities for developing their social skills.

Making the Most of the Curriculum

Teachers who implement the Young Scientist series will use a specific approach to teaching: a set of strategies that balance the children's rich explorations with some more structured activities. This curriculum and the many accompanying tools and resources are designed to support you as you learn to use this approach. As you prepare to implement *Discovering Nature with Young Children*, we encourage you to focus on four basic aspects of teaching that may be new to you: the science, the physical environment of the classroom, time and scheduling, and the facilitation and guidance of children's learning.

SCIENCE

You do not need to be a scientist to implement this curriculum. But in order to be responsive to children's explorations, you need to recognize and experience the science phenomena children are experiencing. There is no better way to build this understanding than to engage with the science. When you are outside helping a child find a small animal, you will be much better at guiding her if you have been looking yourself. When children raise questions about how a snail eats, your observations and reading will help you suggest what children might focus on and what you might show them in a book or tell them. You will appreciate the challenge of drawing a ladybug if you have tried it yourself. Before introducing *Discovering Nature with Young Children* to children, take time to be a naturalist yourself. You will find activities to guide you in step 1 of the "Getting Ready" section on p. 13; this section will also help you understand common ideas children have about the living things around them.

PHYSICAL ENVIRONMENT

Science for young children is about investigating real things, developing new ideas and theories, and sharing them with others. The richer and more varied the environment is, the richer and more varied the experiences the children will have. In addition, children's exploration will be more independent and sustained if the tools they need are readily available where and when they need them. You will find guidelines for setting up this environment in steps 3 and 4 of the "Getting Ready" section and in the preparation section

of each step. Additional ideas are provided in the resources section.

TIME AND SCHEDULING

Scientific inquiry takes time. Going out to observe living things in the environment requires careful looking and several trips. Finding out how a worm moves means observation over a period of time and comparing movement to another animal. Planting seeds and then watching plants grow requires observations and discussions throughout the plant's life cycle. A typical schedule often does not include regular time periods of forty-five minutes to an hour and yet this is what is needed for groups of children to study something closely. Often the program calls for a new theme or topic weekly or every two weeks, but *Discovering Nature with Young Children* should go on for two to three months with some observations and activities spread out across the year. Suggestions for scheduling different activities are provided in the "Getting Ready" section and throughout the guide. You will also find suggestions for making extended study possible.

FACILITATING AND GUIDING LEARNING

With your own naturalist exploration under your belt, a physical environment that invites and supports children's inquiry, and a schedule that allows the time, the stage is set for the most important part of teaching—your interactions with the children. There may be some new strategies to learn, new expectations required, and old approaches to let go of. This guide is designed to help you become a teacher of science—engaging children in science and focusing and deepening their experiences and thinking. The step-by-step guide is designed to help you as you learn new roles and approaches.

Involve Families

Families are important to *Discovering Nature with Young Children*. In cases where parents are not the sole caregivers, you can involve a grandparent, foster parent, aunt, uncle, older sibling, or cousin. As you involve families, consider how culture might influence a child's experiences with living things. For example, some families may have a particular reverence for nature or certain animals; some families may discourage children

from handling insects or other creatures; and others may come from cultures where children are expected to listen, not to question. Talk with family members to learn about their cultures and children's experiences. This knowledge will help you engage families appropriately and respectfully.

And families have much to share about their children. Individual children may have had interesting and/or problematic experiences with living things that are important to know. Some children may have pets or have had farm experiences. Others may have helped with a garden or have plants at home. Still others may have had a bad experience being bitten by a dog or stung by a bee. Families can provide you with important clues about such experiences as well as what living things intrigue their children, what questions they have, and what strategies you might use to support children's learning.

Take steps at the beginning to inform families about *Discovering Nature with Young Children*—what you will be doing, what children will learn, and why this is important for children's development. Feel free to use or adapt the sample letter on p. 131 that introduces families to the exploration. If a caregiver does not speak English, find someone to help you translate the letter or make an audiotape in their home language. Also invite families into the classroom or host a family night where families can experience firsthand the importance of your science explorations and experiment with ways to promote children's explorations of living things at home and in the community.

Be sure to let families know that their participation is welcome and needed and that you are interested in having them share their expertise as well as their concerns. Family members can be rich resources if they have cultural stories to share, experiences with raising plants and/or animals, or knowledge about places to visit. Also, encourage family members to work as classroom volunteers. Some families may be able to help in the classroom on a regular basis; others may come in just for special occasions such as field trips or special events. They can serve as invaluable assets when you take the class outdoors, providing children with the adult guidance they need to help them focus and observe more deeply. Indoors, family volunteers can assist with small group explorations and ensure that an environment of respect for living things is maintained while children's curiosity is promoted.

Let parents know what they can do at home with their children. They might look for living things in

their neighborhood or plant seeds with their children. Family outings are another great way for children and families to see the science in their communities. Suggest places to go. For example, a trip to a local greenhouse or nursery can spark children's curiosity. Such activities can reinforce and extend the science children are learning in the classroom, while helping children and families see science phenomena in their daily lives. It is also helpful to provide sample questions that families can use to spark children's thinking and questions. "Discovering Nature with Families," included in the resources, offers ideas for activities and thoughtful questions that families can ask children. You might also provide families with a list of children's books that relate to the science concepts they are learning. See the "Books and Videos" section (p. 130) for some suggestions.

How to Use This Guide

Discovering Nature with Young Children includes three stages that will guide you in promoting children's exploration of living things and their use of inquiry.

GETTING READY. To facilitate this exploration, you will need to prepare. This section will help you to explore the science concepts embedded in this exploration. This section will also help you prepare the physical environment and think about routines and schedules that support children's inquiry into living things.

OPEN EXPLORATION. During this stage, children explore plants and animals, both outdoors at a local playground or park and indoors in a terrarium you create. These initial explorations are intended to encourage children to use their senses to observe living things as young naturalists by noticing and describing the physical characteristics, behaviors, and needs of living things in their natural environments. During this stage, children will also learn to use basic tools, such as hand lenses and penlights, which will extend their senses and help them be better observers of the plants and animals around them. At this time, do not share your own ideas of what children should be noticing. Instead, encourage children to look more closely at different living things and pay attention to what they observe, what intrigues them, and what they understand about living things.

FOCUSED EXPLORATION. After children have had multiple opportunities to openly explore the characteristics,

behaviors, and needs of living things in their natural environment, they are ready for focused exploration. During this stage, you encourage children to look more closely at living things, moving from descriptions of general external features to more complex observations of body parts and their functions. At the same time, you help children connect their observations of plants and animals with the environment in which they live. Your role is to deepen children's understandings by asking probing questions, encouraging children to represent their work, and creating opportunities for discussion and reflection. Extension activities—such as a field trip to a nearby bird sanctuary, sharing an interesting book or reference material, or a visit from a naturalist—take place about once a week throughout “Focused Exploration.” These experiences motivate children to continue their indoor and outdoor explorations in new ways, provide new information, and/or connect their work to their lives outside of school.

“Focused Exploration” includes two different studies. The plant study focuses on plants' growth and development, the interrelatedness of their different parts, their needs, and their life cycle. This study relies on regular indoor and outdoor explorations as well as monthly observations of a tree or bush. The animal study focuses on animals' physical characteristics, behaviors and needs, and their life cycles. The animal study relies on regular explorations of animals in the indoor terrarium and outdoors in their natural habitats.

Each step of “Open Exploration” and “Focused Exploration” includes the following sections:

CORE EXPERIENCES provide a rationale for the step—the science ideas you'll be focusing on, why this is important for children, and how this step relates to the overall exploration.

The **PREPARATION** section will help you get ready for each step as you consider your classroom schedule, the materials you will need, what you'll need to check in the outdoor environment, and ways to connect with families.

The **TEACHING PLAN** offers detailed guidance for implementing the step, including what you might say and do to engage children and facilitate their explorations and help them reflect on their experiences and ideas. The left-hand column of this section guides you through the exploration. Issues teachers have raised and our responses are found in the right-hand column, which also includes photographs, drawings, and sample dialogue. This column gives a picture of what the

plan looks like “in action,” while suggesting ways to extend science explorations.

At the end of the section on open exploration, you will find three different types of extensions for enriching children's naturalist explorations. They include planning a field trip to explore different environments, inviting experts into the classroom, and using books and videos to extend the exploration.

The resource section provides more information about the teaching approach of *Discovering Nature with Young Children*, essential information for working with living things indoors and out; and book and video resources. We encourage you to familiarize yourself with this section before you start. You will find references to the resources throughout the guide. Some of what is there may be useful to you right away; other material may be more helpful after you have had some initial experiences teaching *Discovering Nature with Young Children*.

Worm City: Excerpts from a Teacher's Journal

These journal entries illustrate what one preschool teacher learned when she helped her children become young naturalists.

SEPTEMBER 8

Last week during circle time we talked about being naturalists. The kids were so excited at first—they loved the idea of going outdoors to observe plants and animals. We talked about what they might see and they had lots of ideas—caterpillars, worms, ants. But when they got outside, they didn't find much except for a few dead leaves. They were pretty disappointed.

Then yesterday Brent found a bunch of wormy creatures under rocks near the door. So we have a new spot for exploring, and I now have a class full of diggers!

SEPTEMBER 18

Kids were really into digging at first, but the playground was a big temptation. When the choice was to dig or to swing, digging didn't always win out. I kept thinking, “Hey, aren't my kids supposed to be naturalists? What's the matter with these kids? What's the matter with me?” I finally talked to my supervisor and she got me thinking about what I could change to get kids more involved. We came up with the idea of working in small groups and it's been great.

I got some parent volunteers to come in, and they supervised the other kids during our outdoor time. So they watched the runners and the swingers, while I spent my time with the diggers. I recorded what kids noticed. I took photos and drew pictures of the plants and animals they found. And we talked—about where spiders live, why leaves get brown, how worms move. The other day Brent held a squiggly worm in his palm and announced, “my worm is alive.” I asked how he knew. He said, “Because it’s struggling.”

SEPTEMBER 23

During circle time, I asked the kids who’ve been focusing on outdoor explorations to share what they’ve found and where they found them. These conversations invite other kids in, so my group of young naturalists is growing. I’m also teaching the kids how to use tools. It took a lot of practice for them to get the hang of it, but they’re finally figuring out how to hold the hand lens and look through it at the same time (no easy task), how to use a penlight and a trowel. They’re seeing more, noticing more.

SEPTEMBER 30

The kids have all of these ideas about living things—some accurate, some inaccurate—and it’s hard, because I’m not always sure how to respond. I’ve been talking to my supervisor about it, and I’m learning to see what my task is. It’s not to correct kids but, rather, to use words, pictures, and drawings to bring their ideas back to them. And by bringing in resources and offering new experiences, kids can explore their ideas and check them out.

OCTOBER 4

I’ve been looking at all the photos of my young naturalists, and as I look, I always ask, “why don’t I have pictures of Elaine or of Andrew?” because that’s very telling about kids and about myself as a teacher. By seeing which kids don’t appear in those photos, I can see who hasn’t been engaged. At the beginning of our study, the younger kids in the class were noticeably absent, but that’s beginning to change. At this point, it seems like all the kids are involved at some level. The younger kids are into who’s the mommy and daddy and baby worm. The children who are learning English are exploring just like the others, and they’re learning some new words as well! There are a bunch of kids who are engaged with worms in a more focused way—measuring them, drawing them, and thinking about how they move. I think it’s time to figure out how to narrow the study, to move on to a deeper investigation of living things.

OCTOBER 10

We’re really beginning to focus on the basic needs of worms—observing them outdoors in their natural habitats to figure out what they need to survive. And now we’re building a terrarium so we can bring the worms indoors, and that’s generated a lot of excitement. Tomorrow, I’ll take a small group to the big park to look for worms and to collect leaves for the terrarium.

OCTOBER 11

Eddie was in charge of pulling the wagon to the big park (that’s his regular job). Kids were really attentive. I noticed Terry stopping when she spotted a stone wall and when I asked her what she was doing, she said, “Lookin’ for snails,” since that’s where some kids had found snails before. As we got closer to the park, the kids noticed a sound. One of the kids said it sounded like bells. Then we stopped and they figured out it was coming from a wind chime. Then we waited and listened and thought about why sometimes it chimed—and sometimes it didn’t. Alyssa said, “’Cause of the wind,” and just then there was a gust of wind and her hair started to blow. Alyssa laughed and said, “And it’s blowing my hair, too.”

On our way to the park, the kids also noticed lots of dead worms. (It had poured the day before.) I asked how they knew they weren’t alive and they said, “They’re not moving.” “They’re not in the ground.” Then I asked why there were so many dead ones and Eddie said, “’Cause someone shot them.” Alyssa said her mother said it was because of the rain. (It struck me then that kids’ conversations about living things don’t just take place within the classroom, but also at home. It also struck me how we’ve created a whole culture of inquiry. It seems like wherever kids are—in the classroom, in the park, or just walking somewhere—they are so attuned to what’s around them, and there’s always a sense of wonder, a sense that there’s something to examine and investigate and discover.)

At the park, most of the small group dug for worms and collected leaves. (Some of the kids were sidetracked on this windy day by the blowing leaves; they just wanted to run and jump in them.) The diggers talked about the worms—what they looked like, their color, their length—and how many they had collected (twenty-seven total!). Eddie was into collecting rocks. (He managed to put a big boulder into the wagon. Later he told me that the rock was too big for the terrarium; it would squish the worms, so he wanted to cut it up into little pieces of clay and then put it in the terrarium. I might follow up on that at another time—the concept that rocks could be turned into clay.) At the park, kids drew pictures of the worms and leaves.

Then they told me about the pictures, and I wrote the words down: "The worm hides under the leaves." "Worms are long." "Here is the daddy worm."

OCTOBER 12

During circle time, we all counted the worms we found in the park and put them in the terrarium. Eddie said we should call our terrarium "Worm City." He then said we should put a lot of leaves on top because there were lots of leaves in the wormhole.

Kids then broke up for some free play. It was interesting that the kids who had done the collecting were "wormed out" for the moment, and went off to other areas of the classroom. Other kids now seized the opportunity to spend some time with the worms, and each kid spoke a different language. One spoke Spanish. Another spoke Arabic. Another spoke Russian. I sat around the terrarium with them. I pointed to a worm wiggling in the dirt and said, "Look how it moves." After we observed for a while, I asked, "Can you show me with your body how the worm moves?" Vanessa got on the floor. First, she stretched out, then pulled her legs in. "Like this," she said proudly.

Then Anthony saw the worm burrowing into the dirt, he said "It's going downstairs." (The Spanish word "abajo" means down and downstairs.) Anthony had kept calling worms "snails," but today he got it (!!). They were worms, and that was a big leap for him. He drew a picture of a worm and dictated a caption in Spanish that the parent volunteer recorded.

When lunch arrived, the kids were reluctant to leave the terrarium so I put the terrarium in the middle of their lunch table so they could watch the worms while they ate.

One child wondered aloud, "Think worms like ice cream?" Another said, "They eat leaves, silly." Another said, "It's berries they like." I wrote down their ideas . . . and so a new investigation begins.

OCTOBER 16

During circle time, I shared children's theories about what worms eat. Then I asked the group, "So how can we find out if they eat ice cream? How would we know if they like leaves?"

As a group, we decided to observe worms in their natural habitat, checking out what is available for them to eat. We are also going to put different foods in the terrarium (though we'll skip the ice cream!), to test out kids' ideas. I'll also bring in some nonfiction books about worms, so kids can compare their discoveries to what they find in books. I've learned to take children's lead, using their theories as a starting point, then helping them think about how they might test out those theories. And by helping them test their theories, they're able to refine their thinking, and develop new theories that lead to new questions and deeper investigations.

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getting ready

Step 1: Preparing Yourself—Science

Whether you are a gardener or have had little experience growing plants, or whether you are a pet lover or feel uncomfortable around bugs and other animals, you can become a naturalist with your children. This section will provide you with basic experiences and understandings that prepare you for helping children explore important science ideas about the world of living things. All you need is an outdoor area, a hand lens, a notebook and pencil, and a willingness to explore and wonder. In this step, you will also learn about some of the ways young children often think about these science ideas. Understanding their point of view can help you decide what experiences to provide or what to focus their attention on or the questions and responses that might further challenge their thinking.

TEACHING PLAN

Take a “naturalist” walk in a park, your neighborhood, or your backyard. On your walk, take a hand lens, a clipboard with some paper, and a field guide for your local area, if you have one. What do you see? What is living and what is not? It seems obvious to adults, but the understanding of what makes something alive is a basic concept of life science.

All things on earth are either *living* or *nonliving*. All living things share certain characteristics that become more evident as we acquire experience with the natural world. Interesting misunderstandings about this concept abound. A leaf that falls from a tree was alive and is now dead. Think about a category of things that were alive to distinguish them from things, such as a stone, that were never alive. As you explore your environment, make some lists and categories of what you see. What is alive? What was once alive? What was never alive?

Stop and look closely at the plants. Turn over a stone, log, or pile of leaves and see what you find. Pick out a small area where there are

TEACHER NOTE: **MONDAY**

I took a walk around my neighborhood to see what living things I could find. I found trees (maple, oak, beech, and three that I couldn't identify). I also saw many weeds (dandelions, crabgrass, and lots of others that I couldn't identify—most were grasslike).

Children ages three through five are beginning to construct their own criteria for what makes something living or nonliving. For instance, if they believe that movement is a characteristic of living things, many young children will insist that the wind or a mechanical toy is living. The greater the variety of living things they encounter and the more guidance they have in thinking about what makes things living, the more likely they are to add new criteria, such as growth, development, and reproduction, as well as the need for food and respiration.

living things. Try to become knowledgeable about the kinds of living things you come across by referring to your field guide to help you with identification and with the habits and needs of each of these living things. Remember, while the name of a living thing can help you find more information and talk with others about what you've seen, knowing what it looks like, what it needs, what is its habitat, and what it does are more important than its name.

Careful observation is not always easy or natural for adults. Sketching will force you to look more closely. Choose a living thing and sketch it. Have you learned anything new about the living thing by observing and drawing it? As you look closely, what do you notice about the *basic characteristics* of these living things (color, size, body structure)? Use your hand lens. What else can you see? Sketch again. Do you see any relationship between the living things' structures and where they are located or how they behave?

Step back from your close observation of one living thing and look at its surroundings. In order to survive, grow, develop, and reproduce, living things must meet their basic needs. Animals need food, water, and oxygen. They need space in which to live, and many of the animals we come across need light. Plants, too, need food but can make it themselves using the energy from light, water, and carbon dioxide. They also need oxygen and space in which to grow.

As you study the surroundings, can you tell how your living thing or others meet their needs? Where do they find all they need to stay alive? All living things live in a particular environment and each has its own habitat. The *habitat* is the part of the total environment that a living thing uses to meet all its basic needs. The habitat of a squirrel may include a number of trees in a park, the ground beneath them, and the little pond nearby. The habitat of a worm in that same park may be a very small patch of earth. The pigeons in the trees may have a habitat that includes the nearby baseball stadium where they find food after ball games. People's habitats have become enormous since we no longer grow our own food but buy it in stores that import from around the world, and we get our water from reservoirs miles away. As a result, a living thing's habitat may be barely adequate.

Another question you can ask yourself as you look at living things is whether they depend on one another in any way. Did you see squirrels in trees? Did you see worms in the soil? Were bees carrying pollen from one flower to another? Critical to understanding the living world is the exploration of the *interdependence* of living things—most are dependent on others. Squirrels in the park gather nuts and seeds to eat, often hiding them in holes in the ground. The forgotten ones are planted and grow into trees. Worms make their way through the soil, making it lighter and richer so that plants can grow and other organisms can burrow easily. Human beings depend on a range of plants and animals for food and, in earlier times, were dependent on animals and plants for clothing and shelter. All living things need the oxygen emitted by plants and those same plants need the carbon dioxide exhaled from animals.

Can you find more than one example of a living thing? How many different kinds of living things can you find? There is tremendous

TEACHER NOTE: WEDNESDAY

I went out again to see if I could find any animals. I couldn't really find anything and was about to give up but then looked under a log. There were lots of things under there! I found worms, ants, and round bugs that I thought might be pill bugs. When I looked them up in my field guide I found that they WERE pill bugs—also known as wood lice—and they actually breathe by gills, which is why they can be found in moist places.

Young children are likely to think that an animal's needs and behaviors are similar to their own, believing that snails are looking for their parents or that worms love ice cream. Observing the natural world up close and caring for living things help children broaden and deepen their understanding of the differences and similarities in the needs of different living things and how they are met.

TEACHER NOTE: THURSDAY

I brought a hand lens out with me today so I could observe more closely. This is what I saw:



It looked like some sort of beetle. I could see that it had six legs—three on each side. According to my field guide, this means that it is an insect!

diversity of living things on Earth. Even within the confines of a vacant lot or backyard, many species of plants and animals live—each in its own habitat, using the resources very differently. If you look closely in a simple patch of weeds, you'll find many different kinds of plants. Turning the soil will likely result in the appearance of a number of different insects and other bugs. If you look closely at one kind of living thing, you will see the *variation* as well. All worms are not alike; neither are all squirrels. We take the idea of variation for granted when we think of human beings, dogs, and cats. But plants and other animals vary too.

Once you get started, you may spend a while simply observing living things around you, enjoying an increasing ability to notice what exists in your surroundings. Take notes and keep sketching. But nature study is more than observations: it is also thinking about what you see and trying to answer questions such as where are particular living things located (in dark or light, wet or dry)? What kinds of places seem to have the most living things? What patterns can we see?

You can learn different things about living things if you can observe them closely over time. Pick a small plant or animal to bring indoors as a temporary "visitor." What are its basic needs? How will it survive indoors for a few days? Can you create a temporary habitat? Bring the plant or animal in and take care of it for three to four days, then return it where you found it. What did you learn about this living thing by taking care of it indoors?

You can go still deeper. All living things have a *life cycle* that includes a beginning (birth for animals and germination for plants), growth, development, and death. All living things also reproduce, creating a cycle that maintains the species. Depending on when you look, you will see living things at different stages in their life cycles, but you may be able to see more than one of these stages if you pick out a particular outdoor space and return frequently. You may also find animals that can live indoors for a short time while you observe them growing, developing, and if you're lucky, reproducing. Or you may sprout and grow seeds indoors. With certain conditions, you may be able to observe the entire life cycle of a plant from seed to seed.

As children explore living things in their own surroundings, they will begin to develop an understanding of habitats and environments and how different living things meet their needs. While they may find stories about very different environments interesting—the arctic tundra, the rainforest, or the desert—they are more likely to understand the implications for living things in those environments after becoming familiar with the living things in their own environment.

TEACHER NOTE: MONDAY

I actually sat down and looked closely at a patch of grass about one foot on each side of me. It is fascinating to look up close at one area like that for a while. I counted seven different plants.

Young children are certainly aware of their own changes, such as growing taller, growing older, and maturing. Some may have had experiences with pets or plants and know they, too, grow bigger and older. They also may have experiences with birth and death. But given their sense of time and their focus on the immediate, young children are unlikely to have an understanding of the life cycle or that all living things go through similar stages or that death is final. Yet, children can talk about some of the stages and observe the appearance of baby snails; meal worms changing to beetles; and plants growing, flowering, and making seed pods. If living things die, take the opportunity to discuss death as a natural part of the life cycle.

Step 2: Preparing Yourself—The Guide

This teacher's guide offers detailed, step-by-step guidance on how to prepare and implement each step. Read it through before you begin.

TEACHING PLAN

Read the guide carefully. The left-hand column guides you through the exploration. The right-hand column shows what the plan looks like in action; it contains issues teachers have raised with corresponding suggestions, photographs, drawings, sample charts, brief dialogue transcripts, and ways you might extend children's science explorations.

In addition to the step-by-step direction, the guide includes a section of extensions, which has suggestions for planning field trips to

explore different environments, inviting experts into the classroom, and using books and videos. The resources section provides more information about science teaching, observation and assessment, essential information for working with living things indoors and out, strategies for involving families, and book and video resources.

Step 3: Preparing the Physical Environment—Materials and Resources

Finding the places where your children can explore living things is fundamental to this exploration. Tools and resources must be collected and available before you start. In this step you will do the following:

- Identify a nearby outdoor environment for children to explore.
- Prepare an indoor environment for exploring living things (terrarium); prepare an outdoor environment for attracting living things (compost heap).
- Collect and inventory young naturalist tools.
- Collect and inventory art and writing materials children can use to represent and describe their observations of living things.
- Collect and inventory books, videos, and posters related to plants and animals.

TEACHING PLAN

Use the classroom environment checklist on p. 139 to help you find outdoor space for the exploration, inventory classroom materials, set up your classroom, and plan your schedule.

1. Be certain that children will be able to explore an outdoor environment for living things. Explore a nearby outdoor environment (many schoolyards are fine), and note the kinds of living things children are likely to find there. Look for the following:
 - Small animals, such as snails, ants, pill bugs, and/or worms (check under piles of old leaves, under or in logs, on or near trees)
 - Larger animals, such as birds and squirrels
 - Plants, such as flowers, weeds, seedlings, bushes, and trees
2. If you have difficulty finding animals and plants after looking carefully around school grounds, locate a spot in a quiet, preferably shady area where you can begin a compost heap. Moisten the earth around the area well. Place either a piece of wood or a pile of leaves directly on the moistened ground, and then wet the leaves or wood. If you keep the area wet, in about a week (but even better if you can wait two or three weeks), you should notice some evidence of animals—most likely worms, pill bugs, or ants. (See “Creating an Open Compost Heap,” p. 122.)

Young children certainly categorize things in their world. There are bugs, flying things, trees, and birds. Their categories are built on their own criteria—what is important to them. Research (Bell 1981; Bell and Barker 1982; Osborne and Freyberg 1985) has indicated that children tend to have varying ideas about living things and how they are grouped. For example, in one survey, almost all five-year-olds said that cows are animals but that spiders and people are not. Similarly, young children often do not think that trees are plants, but rather distinctly different organisms. As children focus more closely on living things by describing and representing them and as they explore one kind of living thing, they will notice variation: not all worms are exactly alike; two flowers on the same plant do not look exactly the same.

TEACHER NOTE: TUESDAY

I saw a lot of ants on the playground today. I can't tell whether they are all the same or different kinds. They seem to vary in size, yet they're the same color and shape.

TEACHER NOTE: THURSDAY

I've decided to plant some seeds so I can observe the life cycle of a plant. I have a small garden, but I've always bought little plants. This time I'm going to do it myself and see if I can grow one from a seed!

Another way to introduce living things into a barren area is to plant some easy-to-grow things in boxes or tubs, or transplant others from a nearby yard or park.

3. Make a terrarium for your classroom so that children can explore living things indoors during choice time. Be sure that the animals you put in the terrarium can survive in that habitat. (See pp. 123–125 for instructions.)

Before starting “Focused Exploration: Plants,” collect materials for growing plants, pp. 127–129.

Likewise, before starting “Focused Exploration: Animals,” collect materials for making a terrarium for visiting animals, pp. 123–127.

4. Collect naturalist tools.

Each child needs the following:

- Hand lens
- A few tongue depressors
- Clipboard (Option: cardboard with a bulldog clip attached)
- Pencil, ideally attached to clipboard by Velcro fastener or string (Some classes might prefer shorter, stubbier writing implements.)

Each group of four children needs the following:

- Hand trowel
- Penlight or other small flashlight
- Container for safely collecting living things
- Piece of Plexiglas, approximately 8 by 11 inches

The class needs the following to share:

- Two or more empty large terrariums (one for the teacher-made terrarium and one for the children’s animal terrarium)
- Plant sprayer
- Measuring tapes or a ball of string
- Field guides of local plants and animals
- Still camera and/or video camera, if possible

5. Collect as many of the following art materials as possible so that children will have opportunities to record and represent what they discover:

- Crayons and markers (both fine and thick point)
- Paints
- Clay or plasticine
- Collage materials
- Bendable wire

TEACHER NOTE: FRIDAY

It’s hard to really know how some things get what they need. It’s easier with plants, but I was surprised where I found some of them:

- Little weeds in tiny cracks in the pavement
- A little plant actually growing out of a wall
- Some weeds way back in an alley next to a trash area

While a terrarium provides children with an environment to observe, on its own the experience is not nearly as powerful as exploring outdoors. Even if the outdoor area is small and thin on living things, use it.

TEACHER NOTE: I planned to have the class look around the school grounds for living things, but I took a look myself and noticed there was very little to see. I talked to the custodian who helped me set up a compost heap in a quiet corner. I can’t wait to see what kinds of bugs we attract!

High-quality, easy-to-use tools will help children explore the plants and animals around them. It is better to have four good hand lenses that young children can easily see through and carry, than six bad ones that are scratched or too small. Good tools also help children become independent learners. For example, children can use sprayers to independently water plants, and sturdy, lightweight clipboards to regularly document their observations.

6. Collect other resources related to living things, particularly those that relate to the plants and animals children are likely to find:

- Books, including field guides for local plants and animals
- Posters
- Web sites about living things

See “Books and Videos” (p. 130) for specific suggestions.

Documenting what they’ve seen and representing their ideas will help children to reflect on their experiences and deepen their understanding. A rich array of art materials will provide opportunities for two- and three-dimensional representation.

ISSUE: *I don’t think the field guides I have are appropriate for young children. After all, they’re geared for adults.*

RESPONSE: It’s certainly true that children will not be able to read or understand the information in adult field guides. But when you look at field guides with children, you are modeling how to use books to find things out. Children will also enjoy looking and talking about the pictures with you, and you can read or paraphrase certain parts of the text to help them learn more. You might even point out particular words such as *tree* or *leaf*.

ISSUE: *How will I find space?*

RESPONSE: Finding extra space in classrooms is difficult. Teachers notice that children really get involved in explorations when they find living things in many areas of the classroom, so it’s worth clearing whatever surfaces and shelves you can. You might want to make more room for living things by putting away some classroom materials during focused exploration.

ISSUE: *I have no wall space.*

RESPONSE: Finding places to post and display children’s work, documentation panels, or photographs can be a real challenge. Some teachers have found display space on the backs of cupboards and doors or on large pieces of cardboard. They found that these displays allowed children important opportunities to share their explorations and revisit their work.

Step 4: Preparing the Physical Environment—Classroom Set-Up

Once you have collected materials and found an outdoor area for your young naturalists to explore, you need to think about how to create an indoor environment that motivates and supports young naturalists as they do the following:

- Observe, explore, and care for different types of plants and animals
- Grow a variety of plants
- Use resource materials and naturalist tools
- Represent and reflect on their explorations of living things
- Share and analyze their observations and theories

TEACHING PLAN

1. Organize your classroom to provide children with the following:

- *Opportunities to care for and observe plants and animals*
You will need small containers, living plants, and shelf or table space on which to set up two terraria—one for open exploration and one for focused exploration. The space cannot be too hot or cold. A shelf at child height can be useful but limits the number of children that can observe at one time. You can place the terrarium on a table or on the floor when a group wants to observe it more closely. This allows them to see it from all sides, sit and talk about or draw what they see, or use reference books to identify and learn more about what is in their terrarium. (See pp. 123–125 for further information about setting up terraria.)
- *Access to tools*
Hand lenses or tabletop magnifiers for more careful viewing, tongue depressors for probing, plates or Plexiglas on which to place the plants or animals
- *Access to materials for drawing, writing, modeling, and collage*
Pencils, markers, paper, clay

2. Organize your classroom display spaces to provide children with the following:

- Wall space at children's eye level on which to hang their drawings and paintings, as well as pictures or posters of living things
 - A selection of books related to living things (See "Books and Videos," pp. 130–136)
3. Place a selection of books in the book area and others about the animals and plants living in it near the terrarium.

Step 5: Long-Term Planning

Discovering Nature with Young Children has many parts. You may choose to do some or all of them. You may focus intensively on this study at some points during the year and not so much at others. Here are some suggestions for some things to think about as you plan this study.

- *Observing a tree or bush each month throughout the year*
By beginning these monthly observations from the start of the school year, children have opportunities to notice as much change as possible.
- *Exploring the outdoors*
The study calls for outdoor exploration two or three times a week when children are fully focused on this study. By continuing to explore outdoors at least once every week or two you give children opportunities to see what happens to local plants and animals over a long period of time and during seasonal changes. Buds and flowers appear in the spring; seeds appear in the fall. These can be compared to the growth of flowers and seed studied indoors.
- *Exploring the indoor terrarium*
By keeping your terrarium going all year long, children who are interested can continue to observe what is happening. Children can continue to compare what they are seeing indoors with the outdoor environment.
- *Observing plants indoors*
It takes time for plants to grow and change. By beginning plants early in the school year and maintaining them, you give children opportunities to closely observe growth and development, and possibly the full life cycle.
- *Observing animals indoors*
It takes time for animals to grow and change. If you raise painted ladies, for example, it will take close to a month for the caterpillar to become a butterfly. You may want to do this at a time when the children can observe similar organisms outdoors.

EXAMPLE: These sample year-long schedules illustrate the different ways three teachers incorporated *Discovering Nature with Young Children* into their school calendars.

Sample Calendar 1 (All parts)

SEPTEMBER

- Begin open exploration
- Begin tree study

OCTOBER

- Begin "Focused Exploration: Plants": Start plants and observe early growth and development
- Begin "Focused Exploration: Animals": Bring worms indoors and observe body parts and movement
- Continue tree study
- Continue explorations of outdoor area and indoor terrarium

NOVEMBER–MARCH

- Continue tree study
- Continue explorations of outdoor area (until it freezes) and indoor terrarium

APRIL–MAY

- Continue tree study
- Continue explorations of outdoor area and indoor terrarium
- "Focused Observation: Plants": Parts and life cycle
- "Focused Observation: Animals": Body parts, behaviors, and life cycles of long-term visiting animals
- Invite families in to see mural and class book

continues...

TEACHING PLAN

Review the parts of discovering nature.

OPEN EXPLORATION

These explorations of the outdoor environment and the indoor terrarium occur two or three times a week and last for a few weeks, or until children develop an interest in a focused exploration.

THE TREE/BUSH STUDY

These monthly observations ideally begin in September. Children create a class book to document the study.

ONGOING EXPLORATIONS OF THE OUTDOOR AREA AND THE INDOOR TERRARIUM

These explorations occur two or three times a week at the terrarium and outdoors, depending on the weather and the season. They provide opportunities for children to relate their focused explorations of plants and animals to the plants and animals they are getting to know over time outdoors and in the terrarium.

FOCUSED OBSERVATION: PLANTS

This focus begins with children starting a variety of indoor plants and is best done at the beginning of the school year. That way, children may have the opportunity to observe plants throughout the school year and, hopefully, to see some go from seed to seed. The remainder of the focused exploration of plants can last anywhere from four weeks to all year and involve studying plants' needs, their parts, as well as how and why they grow and develop in the outdoor environment and in the classroom.

FOCUSED OBSERVATION: ANIMALS

This focus begins with an outdoor search for small animals. In most parts of the country this focus needs to begin in the early fall or in the spring. If it begins in the fall, it can last all year, or it can stop for awhile and then resume again in the spring. The focus on animals encourages children to observe and think about ways animals' bodies and behaviors help them meet their needs. Ideally, you'll want children to experience animals' life cycles, too, which means you'll need to introduce some animals as long-term visitors in plenty of time for the children to observe a life cycle.

Sit with your school-year calendar and block the time you will need to facilitate discovering nature. See the introduction on p. 4 for a rationale for using this curriculum to meet literacy and math goals.

Sample Calendar 2 (All parts except for "Focused Exploration: Animals")

SEPTEMBER

- Begin open exploration

OCTOBER

- Begin "Focused Observation: Plants": Start plants and observe early growth and development
- Begin tree study
- Continue explorations of outdoor area and indoor terrarium

NOVEMBER–DECEMBER

- Continue tree study
- Continue explorations of outdoor area and indoor terrarium
- Begin "Focused Observations: Plants": Plant parts
- Begin "Focused Observations: Animals": Terrarium animals

JANUARY–JUNE

- Continue tree study
- Continue explorations of outdoor area and indoor terrarium

Sample Calendar 3 (All parts of "Discovering Nature," but in different order)

SEPTEMBER

- Begin open exploration
- Begin bush study

OCTOBER–MARCH

- Continue bush study
- Continue explorations of outdoor area and indoor terrarium
- Begin "Focused Observations: Animals": Body parts, behaviors, needs, and life cycle; outdoors and indoors

APRIL

- Continue bush study

continues...

Step 6: Classroom Schedule and Routines

Children need time to be able to explore. You may need to adjust your schedule for this exploration to give them that time. Establish simple rules and routines for yourself and the children so that the time is well used.

TEACHING PLAN

1. Review your schedule. Make time for the following:
 - 20–30 minutes outdoor exploration, twice per week
 - 5–10 minutes before each choice time to prepare children for exploration
 - 30–45 minutes of choice time, at least three times per week (Be sure to include opportunities for children to explore the terrarium during this time.)
 - 10–15 minutes for a meeting with whole group, at least once per week
2. Review your safety procedures for exploring living things.
 - Be sure that the areas where children explore are free of glass, poison ivy, and other potential safety hazards, such as swings. (See “Safety” on p. 121.)
 - Consider how to keep the plants and animals safe as children explore. Think about ways to help children understand that plants and animals are living things and need to be treated with respect. Also think about ways to help children understand the differences between playing outside and being a naturalist.
 - Some children may have allergies. Be sure to check with their families.
3. Be prepared to observe children’s indoor and outdoor explorations and record what you notice.
 - Schedule times that you can observe children’s explorations for about ten minutes, two or three times per week. When you have other adults available to help, plan activities where other children can work or play independently.
 - Read the observation and assessment section (p. 119). Prepare a clipboard so you can easily record your observations of children’s indoor and outdoor explorations.

- Continue explorations of outdoor area and indoor terrarium
- Begin “Focused Observation: Plants”: Start plants and observe early growth and development

MAY–JUNE

- Continue bush study
- Continue explorations of outdoor area and indoor terrarium
- Continue “Focused Observation: Plants”: Parts, growth, and development

ISSUE: *I am worried we will not be able to go outside much because of bad weather.*

RESPONSE: If the weather does not cooperate, involve children in observing the terrarium during choice time. (Whether children explore indoors or outdoors, choice time can always provide opportunities to observe living things.)

We use the term *choice time* to mean the time during the day when children are working in small groups or individually on a variety of activities. Some people call this time *activity time*, *center time*, *play time*, or *work time*.

ISSUE: *I can't focus so much of the children's time on science because they have other things to learn.*

RESPONSE: *Discovering Nature with Young Children* provides opportunities for children’s physical, social, and cognitive development, as well as for language and math development. When teachers sit down to study their program goals and outcomes, they will see many connections between inquiry skills and outcomes in other domains. (See the introduction on p. 4)

Step 7: Families

By the time they start your class, children have already had many experiences and formed numerous ideas about living things. Connecting with families as you get started will allow you to build on children's life experiences and use family resources. It will also help you build a partnership with families with the goal of engaging their children in science inquiry.

TEACHING PLAN

Send a letter to families that describes the important science understandings children will develop as they become naturalists. There is a sample letter to families on p. 131 in the resource section; you can adapt it to fit your circumstances and your families.

Also, provide families with tips for exploring outdoors and indoors with their children by sending home the "Families Discovering Nature" handout on p. 132. Preview the suggestions described in the "Connect with Families" sections at the beginning of each step of open and focused exploration in the teacher's guide for specific ways you can partner with families around their children's science learning.

- Check the children's health records for allergies.
- Find out who might volunteer or who has skills and experience to share with the class.
- Consider asking families to volunteer to care for short- and long-term visiting animals and plants over weekends or during vacations.
- Make a list of ways families can help in the classroom. You might want to post this list in the classroom so families are reminded that their help is welcome.
- Set up a bulletin board where family members can see their children's work.

REFERENCES

Bell, Beverley. 1981. Animal, plant, living: Notes for teachers learning in science project. Working Paper No. 30.

Bell, Beverley, and Miles Barker. 1982. Towards a scientific concept of "Animal." *Journal of Biological Education* 16 (3): 197–200.

Osborne, Roger, and Peter Freyberg. 1985. *Learning in science: The implications of children's science*. Portsmouth, N.H.: Heinemann Educational Books.

ISSUE: *I worry that when we go outside, my children will just want to run around and play.*

RESPONSE: Naturally, children want to play, and some will have more difficulty focusing than others. Before each outdoor exploration, try reviewing the difference between going outside to play and acting as young naturalists. Model the young naturalists' behaviors you expect children to practice, such as looking closely and carefully at plants. Also, bring other adults to work alongside of you and engage with the naturalists. Similarly, if you can, bring out one small group of children at a time so you can focus on them.

ISSUE: *I don't have time to devote to observing children.*

RESPONSE: Many teachers struggle to find time to observe children. Some teachers keep pads of sticky notes and pens around the classroom so they can quickly scribble down a few words to remind them of important happenings. Other teachers divide up the group and observe specific children on specific days. A periodic review of your notes will provide the information you need to guide the children's inquiry.

Families and teachers can work together to support children's science learning in a variety of ways. One of the most powerful ways to partner is for family members to come into the classroom for the following:

- Share experiences or expertise
- Assist with small group explorations
- Provide guidance when children explore outdoors, helping them focus and observe more closely