beetles
Science and Teaching for Field Instructors

Student Activity Guide

Spider Exploration

Many students are squeamish about spiders. But when you spray spider webs with a water mister, they are easy to see and gorgeous, and just about anyone can get caught up in exploring them! After this activity, students will probably notice and appreciate spider webs everywhere, including when they return home. They will also probably be more careful to avoid knocking webs down while walking around. In this activity, students notice spider webs as they walk. When students arrive at an exploration site, pairs search for different kinds of webs in the area, mist them with water, then regroup to discuss their observations and think about how different types of webs help spiders catch different kinds of prey. Students learn about different web types, then return to the field to use a key to identify different kinds of webs. They also make explanations about how the structures of the webs they find function to catch prey.

Students will...

- Ask questions about spiders and how they catch their prey.
- Use a key to identify types of spiders.
- Understand that there are many different kinds of spiders and spider webs.
- Understand that the structure of different kinds of spider webs helps spiders catch different kinds of prey.

Grade Level:
Grades 3–8. Adaptable for younger or older students.

Timing:
About 55 minutes.

Related Activities:
Spider Investigation; Interview an Organism; and *Structures & Behaviors*

Materials:
For instructor: Misting spray water bottle; large photographs of different web types (see page 23)
For each pair of students: 1 spider key (see the note on page 2 to decide which version of the key to use)

Tips:
To ensure a successful experience, review the teaching tips found on page 2 and throughout this guide.

Setting:
Choose an area where students can find different kinds of spider webs. For the optional webless spider exploration, choose a sunny playing field with running spiders. Season: It can be difficult to do this activity during winter when many spiders are in diapause, a form of hibernation, when webs are less common.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Constructing Explanations	Structure and Function	Structure and Function

For additional information about NGSS, go to page 10 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Spider Exploration

ACTIVITY OVERVIEW

Spider Exploration	Learning Cycle Stages	Estimated Time
Introducing the Activity	Invitation	10 minutes
Searching for Webs	Exploration	15 minutes
Sharing Discoveries	Concept Invention	10 minutes
Identifying Web Types	Application	15 minutes
Wrapping Up	Reflection	5 minutes
TOTAL		**55 minutes**

TEACHING TIPS

Field Card. On page 27 of this guide is a pocket-sized version of this lesson that you can use in the field.

Read the Instructor Support Section. Beginning on page 9, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Safety concerns. Be aware of the venomous spiders in your area and give a safety talk before exploration. Students should not touch any spiders or webs, for their own safety and also for the spiders' safety, but they should also know that out of thousands of species of spiders, very few are harmful to humans.

Options for preparing the key. Make a decision about how to prepare the Spider Key based on the needs of your students. There are 3 options: 1) For strong English readers and older students, use the Longer Version on page 14. 2) For less strong English readers, use the Shorter Version on page 19. Both versions share the same first page (page 13). 3) For an even simpler version (ideal for younger students) that just shows images, print the first page of the key (page 13).

Optional Extensions. Two optional extensions could fit into the Application phase of this lesson: Finding Spiders without Webs, and Quick and Dirty Web Study. Finding Spiders without Webs gives students a chance to keep thinking about structure and function of spiders, and also to learn about spiders that do not spin webs. In Quick and Dirty Web Study, students quickly compare the numbers of 2 types of webs in an area. It's a great lead-in to *Spider Investigation*, or other investigations.

All materials created by BEETLES™ at The Lawrence Hall of Science.
Find the latest activities and information at http://beetlesproject.org.

Introducing the Activity

1. **Explain that while spiders are often represented as "creepy" or "weird" in movies and books, they are almost never harmful to humans.**
2. **Then ask students to *Walk & Talk* or *Think, Pair, Share* about the following questions (model enthusiasm and curiosity while discouraging "eew!"** comments):
   - *Share something positive, cool, or interesting you have heard about or experienced with spiders. This is not a time to share negative things about spiders.*
   - *What do you think it might be like to be a spider? What is the world like from a spider's point of view? What adaptations (or, if you haven't introduced this term, say "useful body structures") might they have?*
   - *In what ways do you think spiders might be important in an ecosystem?*
3. **Tell students to look for different kinds of spiders as you walk to your exploration site, describing them out loud to a partner.**
4. **When you arrive at the exploration site, ask students to share some of the interesting things they discussed.**
5. **Explain the importance of spiders in ecosystems.**
   - *Spiders play important roles in their ecosystems—they are food for birds, reptiles, and insects, and they feed on and control insect populations.*

Searching for Spider Webs

1. **Ask students to *Turn & Talk* about how spider webs work:**
   - *Most people know spiders use webs to catch their insect prey. But how do webs actually work?*
   - *What are different kinds of insect prey that spiders might catch in their webs?*
2. **Hear a few student responses, asking follow-up questions and drawing out student thinking.**
3. **Explain that spider webs are like extensions of spiders' bodies, helping them sense the world.** Tell students that spiders depend on their webs so much that their webs can be thought of as an extension of their bodies. As we humans use our hands, mouths, noses, ears, and eyes to sense the world around us, many spiders use webs to help sense their world.
4. **Tell students to explore the area looking for different types of spider webs, comparing them and observing differences and similarities in the shape, structure, and location.** Challenge students to look everywhere for webs, even in small spaces like acorn caps, or under leaves.
5. **Set boundaries, tell students to observe spiders and webs closely without touching them, and assign a "spider kid."** Assign partners, set up boundaries for exploration, and make sure students know they should observe spiders and webs closely without touching them. Assign a "spider kid" (see sidebar) to make the webs more visible.

TEACHING NOTES

Involving a student who is adamantly protesting studying spiders. While one instructor was introducing this activity, one student repeatedly yelled, "I hate spiders!" The instructor eventually got her to stop, and gave her the job of misting spider webs with a sprayer for others. From then on, she participated well in the activity.

Changing students' feelings about spiders. Many students (and adults) have a fear of spiders that has roots in pop culture and media. Using this activity as an opportunity to give students positive experiences with spiders can lead them to start to notice and respect spiders everywhere.

Assigning a "spider kid." Often spider webs are not easy to see, but they are much easier to see after heavy fog or dew, or when misted with water from a spray bottle. Engage an energetic student (or one who is particularly afraid of spiders) by assigning them the role of "spider kid." Give them a spray bottle and ask them to lightly mist webs while other students are exploring. Make it clear that they are not to spray other students, or they will lose their job. It's best not to spray a web if you are interested in looking at the spider itself, because spiders often hide when their web is sprayed. The role of spider kid can also extend throughout the hike, and be traded off, as students continue to notice spider webs.

TEACHING NOTES

"This activity was great! Self-proclaimed arachnophobes and kids who said they didn't like spiders were joyously looking for them by the end!"

–Chris Soriano, WOLF (Web of Life Field School)

"I asked my students about times they may have felt misunderstood. Then I connected that to how spiders are often misunderstood but do a great service eating insects and not doing harm to humans."

–Jeremy Lin, WOLF School

Spiders benefit plants. Science research studies show that plants can have a better chance of survival when spiders are present and are eating herbivorous insects.

6. **Warn students about any venomous spiders in the area while emphasizing that most spiders they will find are harmless, then send them out to explore.** Let students know that most of the spiders they encounter (and most spiders in the world) are harmless to humans.

7. **As students explore, circulate among them, ask them questions, and engage any struggling students.** Be a co-explorer with students, especially with those who may be scared of spiders. Share your enthusiasm and curiosity about spiders and webs. Ask students questions about what they find, help out pairs who may be struggling with working together, and make sure students are exploring safely.

Sharing Discoveries

1. **After about 10 minutes, call the group together and tell pairs of students to meet with another pair to talk about the similarities and differences they noticed between webs.**

2. **Call for the group's attention and ask students to share about webs they observed, using follow-up questions and encouraging students to build on each others' ideas.** For example:
   - *Describe different kinds of webs you saw.*
   - *What did you notice about them? What can you say about their structures?*
   - *How were they different from one another? How were they similar?*
   - *"Oh, this is interesting: Miguel said one of the differences he noticed were that some webs were a neat round shape, while others were kind of messy with 'strings' going everywhere. Does anyone want to add to that description?"*

3. **Hold your flat hand in a vertical position, ask students if they saw webs like this, then lead a brief discussion about the types of prey this kind of web could catch.** Ask students to make possible explanations for what kinds of organisms they think a vertical web might be best for catching. Encourage them to share their reasoning behind their ideas.
   - *What kind of prey do you think a vertical web might be best for catching? Flying insects? Crawling insects? Falling insects?*
   - *Why do you think so? How do you think the shape or structure of the web might help it catch that kind of prey?*

4. **Hold your flat hand horizontally, ask students if they saw webs in this position, then lead a brief discussion about the types of prey this kind of web could catch.** Ask students to make possible explanations for what kinds of organisms they think a horizontal web might be best for catching. Encourage them to share their reasoning behind their ideas.
   - *What kind of prey do you think a vertical web might be best for catching? Flying insects? Crawling insects? Falling insects?*
   - *Why do you think so? How do you think the shape or structure of the web might help it catch that kind of prey?*

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5. **Ask students to describe the structures of other kinds of webs they observed, and to make possible explanations for what kinds of prey those webs might be best for catching.**

Identifying Web Types

1. **Explain that spiders are often categorized by the shape of web they make.**

2. **Show students the Spider Web identification Key, and explain that it's a guide for identifying types of webs.**

3. **Give each pair of students a key, and use large photos to lead students in identifying 4 major spider web types: orb, sheet, funnel, and cobweb.** Hold up a photograph and ask pairs to use their key to find the type of web shown, and guide them to identify it correctly, asking questions that lead to accurate observations and identification if necessary. Do this for photographs of an orb web, a sheet web, a funnel web, and a cobweb. Point out the following to help students in identifying web types:
   - Orb webs are round, and are what people often picture when they think of spider webs.
   - Sheet webs are shaped like flat sheets, domes, or bowls.
   - We commonly refer to webs we find in the corners of houses as "cobwebs," especially when they're old and covered in dust, but a true cobweb is a small platform, with threads going up and down above and below the platform.
   - Funnel webs are like flat sheet webs, but they have a funnel-shaped tube where the spider often hides.

4. **Challenge students to go back out and use the key to identify kinds of webs, and to observe the shape and structure of each web, discussing how its shape might function to help the spider survive.** Ask students to observe the shape and structure of each web and to discuss with each other how the particular type of web might be useful for catching different kinds of prey, or for helping the spider survive in some other way. Challenge students to find evidence of prey in webs.

5. **Circulate, troubleshoot, and engage students in discussion about identification and structures of spider webs.** Help students identify spider webs. If a student is excited about a certain kind of web, engage them in discussion about how that web might function. Share relevant knowledge and encourage students to read more about that kind of web if they are interested, and if it leads them to further observation and curiosity. More information about spiders and webs can be found in the *Instructor Support Section* and in the *Spider Web Identification Key*.

TEACHING NOTES

Common web types. Spiders are often classified by web type. Orb, sheet, funnel, and cobweb web types are found almost anywhere. Your students may find other kinds of webs not in the key, and you can discuss these other web types if they ask about them. See the Instructor Support Section and the Spider Key for more information.

TEACHING NOTES

6. **Ask students to *Turn & Talk* about any new observations they have or information they learned about how the different webs they identified help spiders sense and catch their prey.** Note how each kind of web has a unique structure that functions differently to help the spider catch prey and survive.

7. **Remind students that spiders use webs to both detect and catch prey, then ask them to share some of their explanations about how webs work.** Ask follow-up questions, encourage agreement and disagreement, and occasionally add content about how different types of webs work, such as:
   - Some webs (e.g., orb webs) are sticky, which helps catch flying insects. Other webs (e.g., funnel webs) are not sticky, so prey slip and bounce on them while spiders move around nimbly to catch the prey.
   - Some webs (e.g., sheet webs) have trip threads that catch insects and and knock them down into a part of the web where the spider can grab their prey.
   - Some spiders make webs (e.g., cobwebs) with lines of silk that reach the ground. They put sticky drops on the ends of silk lines so insects crawling on the ground get caught in the drops. Then the silk line snaps to fling the prey into their web where they can eat it.

8. **Point out that it can be cool and interesting to observe organisms' structures and think about how they work, then explain that this is a way scientists think, too.**
   - *You were just using what you noticed about the the shape of spider webs to make explanations about how the webs work to catch prey.*
   - *When you find any kind of organism or living thing, it can be fun and interesting to look at its structures, then think about how those structures function to help it survive.*
   - *This is similar to how scientists sometimes figure things out in nature, too.*

Optional: Quick and Dirty Web Survey

A deeper study. For a more scientifically rigorous web survey, see the BEETLES activity *Spider Investigation*.

1. **Walk to a different plant community than the one the group has been exploring, then ask students to think about whether they think there will be more vertical or horizontal webs there.**

2. **Do a very informal survey of web types in the area: tell each pair of students to have one partner count vertical webs, and the other count horizontal webs until you say "Stop."** Tell students it's not a competition to see who can count the most webs and that it's important to be accurate and honest in their reports.

3. **Ask pairs to share results: each pair that counted more vertical webs raises their hands, then each pair that counted more horizontal webs raises their hands.**

4. **Lead a brief whole group discussion, asking students to come up with possible explanations for the results, and asking them what factors might affect which spiders are more successful in a particular area.**
   - *Why do you think there are more of this type of web here? What are some possible explanations?*
   - *What kinds of things do you think might affect which type of spiders is more successful in an area?*

5. **Explain that this is a quick study, and the group could get more accurate information with a more careful count, then ask students what they could change about their counting process to be more accurate or more careful.**

Optional: Finding Spiders without Webs

1. **Tell students that there are some kinds of spiders that don't use webs to catch prey, then ask them to *Walk & Talk* about the following questions as you move to an area where you know there are running spiders.**
   - *How might spiders that don't build webs catch their prey?*
   - *What kinds of body structures might a running spider have to help it chase down and catch prey?*
   - *How might these structures be different from those of spiders that build and live in webs?*

2. **Tell students they will search for and observe the structures and behaviors of running spiders.** Explain that the group is in an area with lots of webless spiders, and students will work in pairs to find them, observing their body structures and behaviors, and thinking about how these help the spider catch prey and survive.

3. **Share any spider-catching devices you have, and set boundaries and safety protocols.** Show and demonstrate for students any devices you have for catching spiders, such as bug boxes, clear plastic cups with lids, or "poofer" devices (see sidebar).

4. **If students will be using "poofers" to catch running spiders, remind them to be gentle with them and tell them not to "poof" spiders that build webs, then set them to explore.** "Poofing" a spider with a web can damage the webs.

5. **Look for other evidence of spiders: draglines, sleeping sacs, shed exoskeletons, etc.** You might also tell them to look for draglines, the single line of silk spiders leave behind wherever they go, to prevent falling. Under rocks or logs you can also often find spider sleeping sacks, egg cases, or exoskeletons that have been shed.

6. **Send students out to explore.**

7. **Call students back, and ask them to briefly discuss structures and behaviors they observed.**
   - *What were some of the structures and behaviors you observed?*
   - *How do you think these help them survive in their habitat?*

TEACHING NOTES

Finding running spiders. Running spiders live in many places, but it's easiest to find, observe, and catch them in areas with little vegetation, such as dry hills and playing fields with short grass, making the spiders more visible. Running spiders may also be found under rocks. Scout ahead to make sure there are enough spiders for students to observe around the time of day you will be there.

Crab spiders & spiders in the ground. You can look for crab spiders inside flowers, where they look like they are part of the flower as they wait for their unsuspecting prey. There are also spiders that make tunnels in the ground, lined with silk. Some of these close, and some are always open.

Catching spiders that don't build webs. It's easy to accidentally squish webless spiders by trying to catch them with your hands. It's also easy, simple, and cheap to make a spider "poofer" (a device used by scientists to collect spiders) that students can use to safely catch spiders (and other small insects). Find resources on how to make these "poofers" in the BEETLES Ecosystem Literacy and Exploration Guides, under the section Buggy Bushes and Grasslands.

TEACHING NOTES

Invite students to count spider webs informally. As you're walking down the trail after the activity, ask students how many spider webs are nearby; and count all those that are visible in a small area. Students are often stunned when they count over 100 spider webs within sight while standing still on a trail. You can use this as an invitation to or bridge towards the *Spider Investigation* activity.

Wrapping Up

1. **Ask students to *Turn & Talk* or *Walk & Talk* to discuss interesting observations and questions, and to reflect on the learning experience.** When you're finished with your organized spider explorations, ask students a few questions from this list to help them reflect on what they learned about spiders, or on any questions they still have:
   - *How do you feel about spiders now? Is this different from how you felt before studying their webs?*
   - *What helped you to learn today?*
   - *Why might there be similarities in types of spider webs found in different places in the world?*
   - *Where are places you'd expect to find spiders and webs near where you live?*
   - *How could you get someone who doesn't like spiders to become interested in them?*
   - *What questions do you have about spiders? How can you learn more?*
2. **Encourage students to keep noticing spiders throughout the rest of their field experience.** You may want to keep a sprayer (operated by a "spider kid") and a spider key available at all times for ongoing spider web exploration. Or have students count spider webs in different ecosystems.

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Instructor Support

Teaching Knowledge

Pacing for this lesson. Introducing the Activity, Searching for Webs, and Sharing Discoveries can all happen in one place. If students are having trouble focusing after Sharing Discoveries, consider switching locations or incorporating a high-energy activity before doing Identifying Web Types.

Conceptual Knowledge

Spiders are generally abundant, very diverse, and fascinating for students to study. Students often have many misconceptions and preconceived ideas about spiders. Here are some more accurate ideas to help inspire curiosity in your students.

Spider webs. Different types of spiders spin different kinds of webs, and spiders are often classified by the type of web they weave. The spider key helps to identify which type of spider made a particular web. Spiders can produce different types of silk, in different sizes and with different textures and strengths. Some web-building spiders have both sticky and nonsticky threads in their webs. One explanation for why spiders don't get caught in their own webs is that they only walk on the nonsticky strands. Another explanation is that spider legs are covered in small, nonsticky hairs.

Spiders catch many types of prey in their webs, not just flies. Orb webs catch flying insects, and their sticky silk is strong enough to trap strong fliers like bees, butterflies, and flies. Sheet webs have strong, non-sticky lines that extend above the sheet that disturb the flight of clumsier fliers such as beetles. These insects then fall to the sheet below and are trapped immediately by the spiders.

Running and jumping spiders. Some spiders don't build webs at all. Instead, they chase down prey or lie in wait for prey to come near. Running spiders, jumping spiders, and crab spiders are all spiders that do not use webs to hunt. Trapdoor spiders don't build webs, but they use silk lines on the ground to feel prey.

Other evidence of spiders. Besides webs, spiders leave lots of evidence of their presence. Most spiders leave draglines behind them wherever they go. They can use these draglines to travel in wind, to catch themselves from falling, to swing to a new spot, or to lower themselves down. Like climbers leaving behind "protection" on a rock wall, periodically spiders use a special kind of silk to make attachment points on whatever surface they are on. This is why you may have seen that usually when a spider "falls," its fall is softened by the dragline they release as they drop, which is attached to the surface they fell from. Many spiders also leave behind sleeping sacs, egg sacks, wrapped insect bodies, or exoskeletons that have been shed.

TEACHING NOTES

Sitting in the center. Spiders on orb webs sit in the center of the web so they can pluck the surrounding strings to see if there is anything caught there; if one of the strings feels different than the others, the spider knows there is prey there. Often they can even tell how large the prey is just by plucking the string.

TEACHING NOTES

About the Next Generation Science Standards (NGSS). The development of the Next Generation Science Standards followed closely on the movement to adopt nationwide English language arts and mathematics Common Core standards. In the case of the science standards, the National Research Council (NRC) first wrote a Framework for K-12 Science Education that beautifully describes an updated and comprehensive vision for proficiency in science across our nation. The Framework–validated by science researchers, educators and cognitive scientists–was then the basis for the development of the NGSS. As our understanding of how children learn has grown dramatically since the last science standards were published, the NGSS has pushed the science education community further towards engaging students in the practices used by scientists and engineers, and using the "big ideas" of science to actively learn about the natural world. Research shows that teaching science as a process of inquiry and explanation helps students to form a deeper understanding of science concepts and better recognize how science applies to everyday life. In order to emphasize these important aspects of science, the NGSS are organized into three dimensions of learning: Science and Engineering Practices, Crosscutting Concepts and Disciplinary Core Ideas (DCI's). The DCI's are divided into four disciplines: Life Science (LS), Physical Science (PS), Earth and Space Science (ESS) and Engineering, Technology and Applied Science (ETS).

Read more About the Next Generation Science Standards at:

- www.nextgenscience.org/
- ngss.nsta.org/

Common Relevant Misconceptions

Misconception. Spiders are evil and try to hurt humans (bwa-ha-ha!).

More accurate ideas. Spiders are generally harmless to humans and only bite them to defend themselves, much like other animals would. Very few spider bites actually cause reactions in humans, and even fewer species are venomous.

Misconception. Experiments are a necessary part of the scientific process. Without an experiment, a study is not rigorous or scientific.

More accurate ideas. Many people think science can only be done through experiments. But there are many ways to "do" science. Controlled experiments are useful for testing some scientific ideas. But making detailed observations is equally valid, and in some cases is a better method to learn about the natural world. For certain investigations, both strategies are needed. Students can learn a lot by doing a "Quick and Dirty" web study, and field scientists might do a similar short observational study while coming up with a question or refining their experimental design. The BEETLES activity *Spider Investigation* is a more structured, thorough approach to counting spider webs, and has more information on how to engage students in asking questions and reflecting on the process of investigation. The BEETLES activity *Exploratory Investigation* is a format for students to work on coming up with testable questions and designing a quick investigation, which could be about spiders.

Source: undsci.berkeley.edu/teaching/misconceptions.php#b5

Additional Resources

- *Spiders in Your Neighborhood* by Pat Stadille, available through Heyday Books
- "Arachnid Day," a song about spiders and their webs, by the Bungee Jumpin' Cows. It can be sung a cappella with students clapping the beat and joining in yelling the "no way!"
  - www.moo-boing.com/mp3/Foundations/Arachnidae.mp3
  - *lyrics:* www.moo-boing.com/lyrics/

Connections to the Next Generation Science Standards (NGSS)

BEETLES student activities are designed to incorporate the "three-dimensional" learning that is called for in the Next Generation Science Standards (NGSS). Three dimensional learning weaves together Science Practices (what scientists do), Crosscutting Concepts (thinking tools scientists use), and Disciplinary Core Ideas (what scientists know). Students should be exploring and investigating rich phenomena, and figuring out how the natural world works. The abilities involved in using Science Practices and Crosscutting Concepts —looking at nature and figuring things out, using certain lenses to guide thinking, and understanding ecosystems more deeply—are mindsets and tools students can take with them and apply anywhere to deepen their understanding of nature. And, they're interesting and fun to do!

In *Spider Exploration*, students engage in the practice *Constructing Explanations* and apply the Crosscutting Concept *Structure and Function.* Students have the opportunity to build understanding of Disciplinary Core Ideas related to Structure and Function. (Note: "Structure and Function" is a both a crosscutting concept and also a category of Disciplinary Core Ideas within Life Sciences.)

Featured Science and Engineering Practices

Engaging students in Constructing Explanations. According to NRC's A Framework for K-12 Science Education, a major goal of science is to deepen human understanding of the world through making explanations about how things work. Students should develop their understanding of science concepts through making their own explanations about natural phenomena.

- In *Spider Exploration*, when students talk about how a certain kind of spider web would help a spider catch a specific kind of prey, they are constructing explanations for how the spider web's structure functions to help it survive.
- Engagement in this practice is deepened as students go back to observing webs and thinking about how a web's structure might help the spider catch organisms and survive in its habitat.
- When showing photos of different spider web types and asking students to think about how they might function, use the opportunity to coach them to include evidence and reasoning when they make explanations, and to consider different possible explanations.

Featured Crosscutting Concepts

Learning science through the lens of Structure and Function.

- In *Spider Exploration*, students observe and compare different kinds of spider webs, then discuss how the structure of those webs helps the spider survive in its habitat.
- The words "structure and function" are introduced AFTER students explore, observe, and compare different kinds of spider webs.
- It's important to give students the chance to observe and compare web types before asking them to make explanations about how those webs might function differently, so that they will have some concrete observations of web structures to refer to when they make explanations.
- It's also important to call attention to how students were thinking about structure and function, so that they have the opportunity to recognize the idea as a useful way of looking at any part of the world.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. Students need multiple learning experiences to build their understanding of NGSS disciplinary core ideas. *Spider Exploration* gives students an opportunity to develop understanding of some disciplinary core ideas related to LS1.A Structure and Function.

TEACHING NOTES

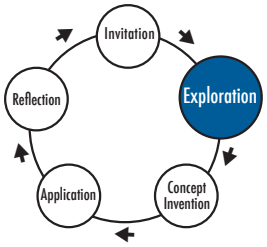
Importance of teaching science practices. "Engaging in the practices of science helps students understand how scientific knowledge develops...It can also pique students' curiosity, capture their interest, and motivate their continued study..." –National Research Council, A Framework for K-12 Science Education. Focus on these science practices will help to ensure a more scientifically literate public who will be better able to make thoughtful decisions.

About Crosscutting Concepts in the NGSS. Crosscutting concepts are considered powerful thinking tools for how scientists make sense of the natural world. The seven "big ideas" listed as crosscutting concepts are: Patterns; Cause & Effect; Scale, Proportion & Quantity; Systems and System Models; Energy & Matter: Flows, Cycles and Conservation; Structure & Function; and Stability & Change. These concepts may sound familiar, as they are quite similar to the themes referred to in science literacy documents as being important ideas that unify all disciplines of science and engineering.

TEACHING NOTES

Translating the codes used in the NGSS. Each standard in the NGSS is organized as a collection of performance expectations (PE) for a particular science topic. Each PE has a specific code, provided here so that they can be easily referenced in the NGSS documents. The first number or initial refers to the grade level: K - kindergarten, 1 - first, 2 - second,etc...MS - middle school, and HS - high school. The next letters in the code refer to the science discipline for the standard: LS, PS, ESS, ETS. The number following the discipline denotes the specific core idea within the discipline that is addressed by the PE, and the last digit identifies the number of the PE itself.

So 3-LS4-4 means it's part of a third grade standard (3) for life science (LS), addressing the fourth core idea (4), Biological Evolution: Unity and Diversity, within the life science standards, that deals with Biodiversity and Humans. It's also the fourth performance expectation (4) that makes up the complete LS4 standard at this grade level.



This activity completes a full learning cycle. Within a series of experiences focused on studying organisms' structures and functions, this activity falls in the *Exploration* phase.

- When students describe different web types and make explanations about what types of prey different web types would best catch, and how those webs help spiders survive, they are building understanding that organisms have characteristic structures that serve functions in growth, survival, behavior, and reproduction (LS1.A).
- Students further their understanding of this content when they use the key to identify webs and continue to look for evidence of how different web types may function to help spiders survive in their habitats. *Note: In this case, a spider web is considered to be one of a spider's external structures, because spiders use their webs to sense the world.*

You can informally assess students' understanding of these concepts during different stages of the activity in individual interactions with students, and by listening carefully during the group discussions. This information can help you decide which ideas to focus on in future lessons, so follow-up activities or discussions can be used to further student understanding.

Performance Expectations to Work Toward

No single activity can adequately prepare students for an NGSS performance expectation. Performance expectations are designed as examples of things students should be able to do to demonstrate their understanding of content and big ideas in science after engaging in multiple learning experiences and instruction over a long period. They are not the "curriculum" to be taught to students. Below is one performance expectation that this activity can help students work towards.

4-LS1-1.Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Activity Connections

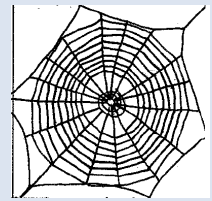
Ideally, use a routine like *I Notice, I Wonder, It Reminds Me Of* or *NSI: Nature Scene Investigators* to develop students' observation skills before doing *Spider Exploration*. *Spider Investigation* is designed as an optional follow-up to this activity for instructors interested in leading a more careful scientific investigation. Or, you might use *Exploratory Investigation*, while choosing to focus on the topic of spiders, in which students work to come up with testable questions, then design quick investigations to begin to answer them.

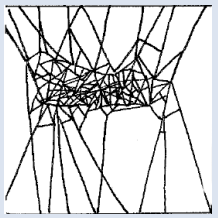
To continue building student understanding of disciplinary core ideas related to Structure and Function, use the BEETLES activity *Structures & Behaviors* or *Blending in and Standing Out*.

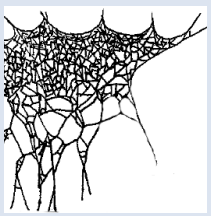
SPIDER KEY

Web-Building Spiders

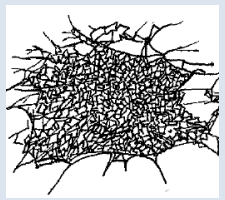
Sheet Web Spiders


Orb web spider

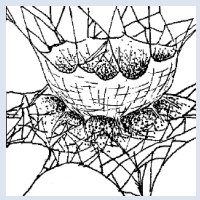

Cobweb spider


Cellar spider

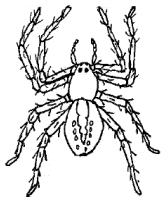

Funnel web spider

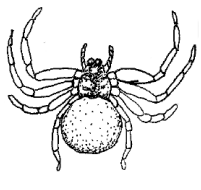

Platform spider

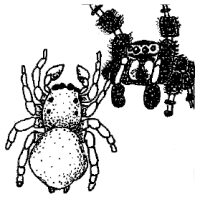

Filmy dome spider

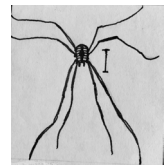

Bowl & doily spider

Spiders without Webs


Wolf & nursery spider


Crab spider


Jumping spider


Harvestmen

Burrowing Spiders


Trapdoor spider


Turret & folding door spider

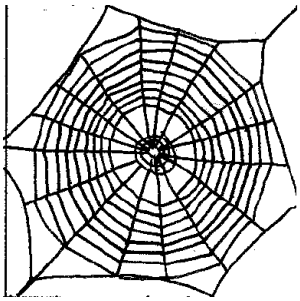

Tarantula spider

See Photo Credits on page 22 for sources.

Longer Version

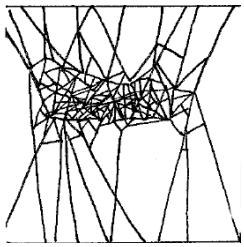
SPIDER KEY

Web-Building Spiders



Orb web spiders. These often (but not always) live alone, and will eat other spiders they meet. The motto of many female orb spiders might be that "a husband's place is inside the stomach of his wife," because many female orb spiders would eat their former mate just as they would any insect.

Most orb spiders eat and rebuild at least part of their web every day or night. Their webs are almost like another part of their bodies. They use them to catch meals and to sense the world around them. Orb spiders have very poor eyesight, but they don't need to see well because they use their webs to feel the world around them. They have special lines in their webs to sense prey. When something touches these lines, the lines vibrate, and the vibrations are a message to the spider, telling it there is something in the web. The spider can tell by the way the web vibrates if the movements are from a male spider looking for a mate, a delicious struggling insect victim, or something else. If these lines were cut, the spider's main sense would be cut off and it would not be able to sense movement in its web. The orb spider prepares its trap by putting sticky drops on a thread in the web, and then "plucking" the thread (like a string of a guitar) with a leg. This spreads the sticky drops along the silk lines of the web. When it catches an insect, an orb spider uses its front legs to quickly spin the insect as it uses its back legs to pull out silk, wrapping the victim like a mummy.



Cobweb spiders. The webs made by spiders in this family are irregular, usually with a platform with threads going up and down above and below it. The threads are sticky and tough, and the webs can be found in cracks, and underneath leaves, rocks, or loose bark. This large family has many kinds of spiders in it, including the poisonous black widow. Be careful not to touch black widows, and do not reach under rocks or logs without looking.

Some cobweb spiders set traps to catch insects that crawl on the ground. They put sticky drops at the ends of silk lines where they connect to the ground, called "sticky gumfoot lines." When an insect walks by, it may get caught in one of these sticky drops and try to get away. When it does, the silk line breaks off the ground like a rubber band, snapping the victim into the center of the web, and to its doom. As it struggles, it gets tangled in other threads. These spiders are also called comb-footed because they have tiny combs of hairs on their back pair of legs. They use these to comb silk out of their spinnerets to wrap their prey.

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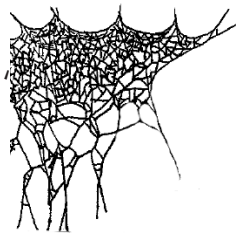
Find the latest activities and information at http://beetlesproject.org.

Longer Version

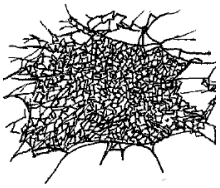
Web-Building Spiders



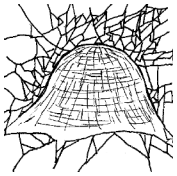
Cellar spiders. You'll find these spiders hanging upside down in loose, irregular, "messy" webs in corners of houses or cellars. These spiders have long thin legs. If you scare them, some shake their webs to try and make themselves and their web blur and seem to disappear. The female carries her round egg sac in her jaws like a dog carries a ball. People often call their webs "cobwebs," but they are not actual cobweb spiders. They are sometimes called daddy-long-legs, and are often confused with Harvestmen (see below).

Funnel web spiders. Most funnel web spiders spin platform webs leading to a silk tube. Funnel spider silk is not sticky, and when insects land on a funnel spider's web they find it hard to move around on the funnel shape and may bounce, as if on a trampoline. Funnel web spiders can run quickly on top of their webs, grab their struggling victims, and return with them to their funnel to eat them. The back end of their funnel is open, so it can be used to escape when threatened.

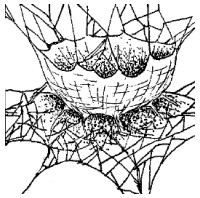
The males often move in and share the female's web after mating. In fall, the females hide their eggs under bark or leaves, not in their web.



Platform spider



Filmy dome spider



Bowl & doily spider

Sheet web spiders. There are different kinds of spiders that build sheet webs, including platform spiders, filmy dome spiders, and bowl and doily spiders. These spiders usually hide, hanging upside down underneath their platform, dome, or bowl, waiting for prey.

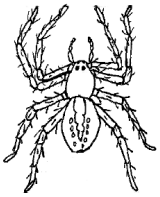
Their webs have trip thread traps that extend vertically above the platform, and that break when flying insects crash into them. The threads snap like rubber bands, knocking the insects into the silk web to their doom.

The spider quickly grabs the victim through the web and pulls it underneath to eat it. Because this rips their webs, sheet web weavers have to fix their webs after every catch.

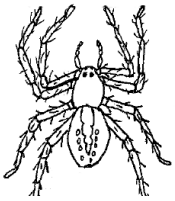
The males and females often live together in the same web.

Longer Version

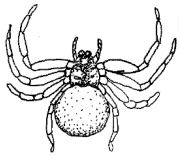
Spiders without Webs



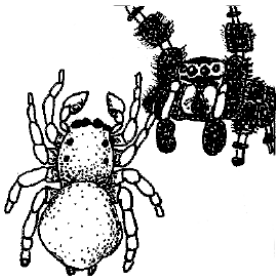
Wolf spiders. These spiders are one of the most commonly seen spiders. Instead of making webs, these spiders chase down their prey like lone wolves. They run around on the ground and some climb plants, leaving a silk "dragline" wherever they go. Some hunt during the day and some at night, and they rest under stones or wood in silk "sleeping bags." The male finds a female to mate with by following her dragline. To convince her that he's a date and not a meal, he waves in a pattern as he approaches her. After mating, her mood changes, and she may try to eat him. After the eggs are laid, the female carries the eggs attached to the end of her abdomen, then when her large young hatch, they hang on to their mom's abdomen for weeks or months. But after they leave, she may eat them.



Nursery web spiders. These look a lot like wolf spiders, but they carry their eggs next to their mouth, like a dog carries a ball, not at the end of their abdomen. They don't spin webs, but when their eggs are almost ready to hatch, the female spins a nursery tent, and puts the eggs inside. Many can run on the surface of water and even stay underwater for some time.



Crab spiders. These spiders hold their legs out at their sides like crabs, and can walk forward, backwards, or sideways. Crab spiders wait in ambush for passing insects. Some are brightly colored and wait inside flowers to ambush bees and other insects.



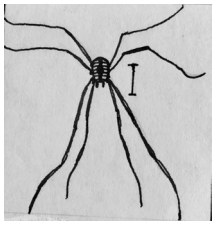
Jumping spiders. These spiders are often brightly colored, active during the day, and in sunshine. They walk with a lot of stops and starts, and jump on their prey. They are easy to tell apart from other spiders because they have four big eyes on the face and four smaller ones on top of the head.

Jumping spiders sometimes jump 40 times their own length! Try multiplying your height by 40 and see how far you would have to jump to do this. Before jumping, the spider attaches a silk thread so it can climb back in case it misses. Because they use their eyes to find prey, jumping spiders have the best eyes of any spiders, and among the best of all animals without backbones.

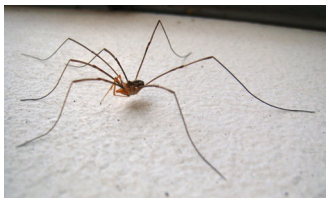
Most spiders do some dancing, but jumping spider dances can be fancy. After finding a female by spotting her, or by following her silk dragline, the male does a courtship dance. He waves his first legs in front of the female, wags his abdomen, and hops. If the female is of the same species, she may signal with her legs to "Come on over!"

Spiders without Webs

Longer Version



Harvestmen. A-ha!! Caught you! These are spider "cousins," not real spiders. Spiders have bodies clearly divided into two parts, abdomen and cephalothorax. Although Harvestmen also have these two parts, they appear not to—in other words, they don't have a "waistline." They are called harvestmen because when first scientifically described they were seen at harvest time.



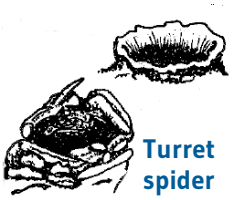
Harvestmen clean their long, thin legs by pulling them between their jaws. They can't make silk and they eat very small insects. For real spiders that eat each other, mating can be dangerous. That is not the case with harvestmen, who eat only tiny insects. They can easily mate with any number of partners of the opposite sex they meet. But sometimes males fight with each other. They often have armor or spines on their body for defense.

Burrowing Spiders

Trapdoor spiders. These dig tube-like burrows lined with silk. The top of the lid may be hard to find, because it is camouflaged with leaves, twigs, or whatever may be lying around. The trapdoor may be held shut by the spider, sometimes with an amazing amount of force.

The trapdoor spider makes many silk "telegraph lines" around its burrow, then waits inside for a vibration that tells it that an insect is walking by. Then it rushes out, grabs its prey, and pulls it into its burrow where it eats it.

Turret & folding door spiders. Some spiders make an open "turret" around the entrance to their burrow. They mix soil and plant materials with silk to build a small wall, up to about 1 inch high, at the burrows' opening. These spiders hide inside, sense vibrations from insects wandering by, and then run out to catch their prey. Some turret spiders attach plant materials to their turrets so they stick out from the burrow, like spokes on a bicycle wheel. This allows the spiders to sense vibrations over a larger area.



Folding door spiders live in burrows, but they don't close their burrows with trapdoors. Instead they build silk and plant materials into an opening that can be pulled closed. These spiders lie in wait at the entrance of their burrow and feel shaking to sense and catch prey.

Longer Version

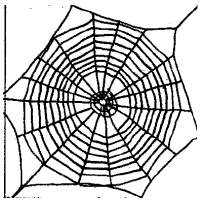
Burrowing Spiders

Tarantulas. These spiders are the largest of all spiders. Most tarantulas are covered in fuzzy hair, and live in silk-lined burrows in the ground or in trees. Many people keep tarantulas as pets because they live a very long time, and aren't harmful to humans. They do have big fangs and a painful bite, but they need them for catching their prey. Tarantulas are sit-and-wait predators that almost never leave their silk-lined burrows, waiting for prey to stumble in. They ambush and eat big insects, other spiders, centipedes, and millipedes. "Tarantula hawks" are wasps that paralyze a tarantula, then lay an egg inside their body. The most common time of the year to observe tarantulas is during mating season, when males leave their burrows to search for the burrows of females.

SPIDER KEY

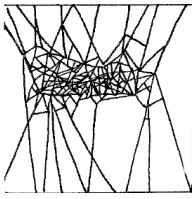
Shorter Version

Web-Building Spiders

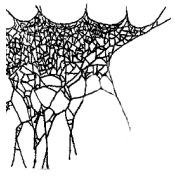


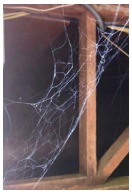
Orb web spiders. These spiders don't have great eyesight, but use their webs to feel the world around them. There are special lines in their webs that shake when something touches them. When the lines shake, orb spiders can sense it. The orb web spider can tell the difference between shaking from a prey that got caught in their web, a male spider that has come to mate, or something else.

Orb spiders make their webs sticky to catch prey. They do this by squirting sticky drops on the web and then plucking it with their legs so the sticky drops spread out along the silk lines.



Cobweb spiders. These spiders are irregular, usually with a platform with threads going up and down above and below it. The threads are sticky and tough. Some cobweb spiders set traps to catch insects that crawl on the ground. They put sticky drops at the ends of silk lines where they connect to the ground. When an insect walks by, it may get caught in one of these sticky drops and try to get away. When it does, the silk line breaks off the ground like a rubber band, snapping the prey to the center of the web where it struggles and gets tangled in other threads till the spider catches it.



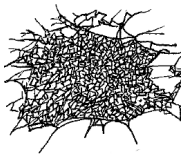


Cellar spiders. These spiders build irregular "messy" webs in the corners of structures—houses, dumpsters, etc. Daddy-long-legs sometimes shake their webs when threatened, to blur the web and make it seem to disappear.

Funnel web spiders. Most of these spiders spin platform webs with a silk tube. Funnel webs are not sticky, so when insects land on the web, they have trouble moving around and may bounce, like running on a trampoline. Funnel web spiders can run quickly on top of the web to grab the struggling prey. Funnel spiders return to their funnel to eat their prey. The back end of the funnel is open so the spiders can escape if threatened.

Shorter Version

Web-Building Spiders

a) 

b) 

c) 

a) 

b) 

c) 

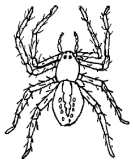
Sheet web spiders. These spiders usually hide, hanging upside down underneath their platform, dome, or bowl.

Their webs have trip threads that break when flying insects crash into them. The threads snap like rubber bands, knocking the insects into the silk web. Then the spider quickly grabs the prey through the web, pulls it underneath, and eats it.

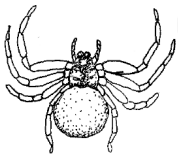
Sheet web weavers have to fix their webs after every catch.

Left: a) platform spider, b) filmy dome spider, c) bowl & doily spider

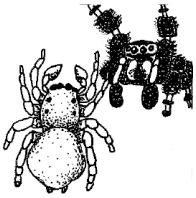
Spiders without Webs



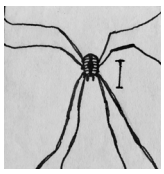
Wolf spiders. Instead of making webs, wolf spiders chase down their prey. They run on the ground, and some climb plants, leaving a silk "dragline" wherever they go. Some hunt during the day and some at night, and they rest under stones or wood in silk "sleeping bags."



Crab spiders. Crab spiders hold their legs out at their sides like crabs and can walk forward, backwards, or sideways. They wait in ambush for passing insects. Some are brightly colored and blend in with flowers where they hide to ambush bees and other insects.



Jumping spiders. Jumping spiders are often brightly colored, are active during the day, and in sunshine. They walk with a lot of stops and starts, and jump on their prey. Jumping spiders sometimes jump 40 times their own length! Before jumping, the spider attaches a silk thread so it can climb back in case it misses. Jumping spiders have four big eyes on the face and four smaller ones on top of the head. They have the best vision of any spiders, and use it to find prey.



Havestmen. A-ha!! Caught you! Harvestmen are spider "cousins," not real spiders. Though harvestmen have two body parts like spiders, they look like they don't—they don't have a "waistline." Harvestmen cannot make silk. They eat tiny insects.

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Burrowing Spiders

Shorter Version

Trapdoor spiders. These spiders dig tube-like burrows lined with silk. They hide the top of the lid with leaves, twigs, and other things that are lying around. The trapdoor spider can hold its door shut with a lot of force. It makes silk lines around its burrow, which shake when insects walk by them. The spider feels these movements, rushes out, grabs its prey, and pulls it into its tube to eat it.

Top: folding door spider

Bottom: turret spider

Turret & folding door spiders. Some spiders make a "turret" (small tower) around the opening of their burrow. They mix soil and plant materials with silk to build a small wall, up to about 1-inch high, at the burrows' opening. The spiders feel shaking from insects wandering by and run out to catch their prey. Folding door spiders can close the opening of their burrow.

Tarantulas. These spiders are the largest of all spiders. Many people keep tarantulas as pets because they live a very long time, and aren't harmful to humans. They ambush and eat big insects, other spiders, centipedes, and millipedes. They almost never leave their silk-lined homes, waiting for prey to come by.

Photo and Illustration Credits for the Spider Key and Handouts

Web-building spiders

Orb web: rattyfield
Cobweb: davidm69
Cellar: lygren
Funnel web: kqedquest

Sheet web spiders

Platform: elygren
Filmy dome: Frank Starmer
Bowl & doily: Nancy Magnusson

Spiders without webs

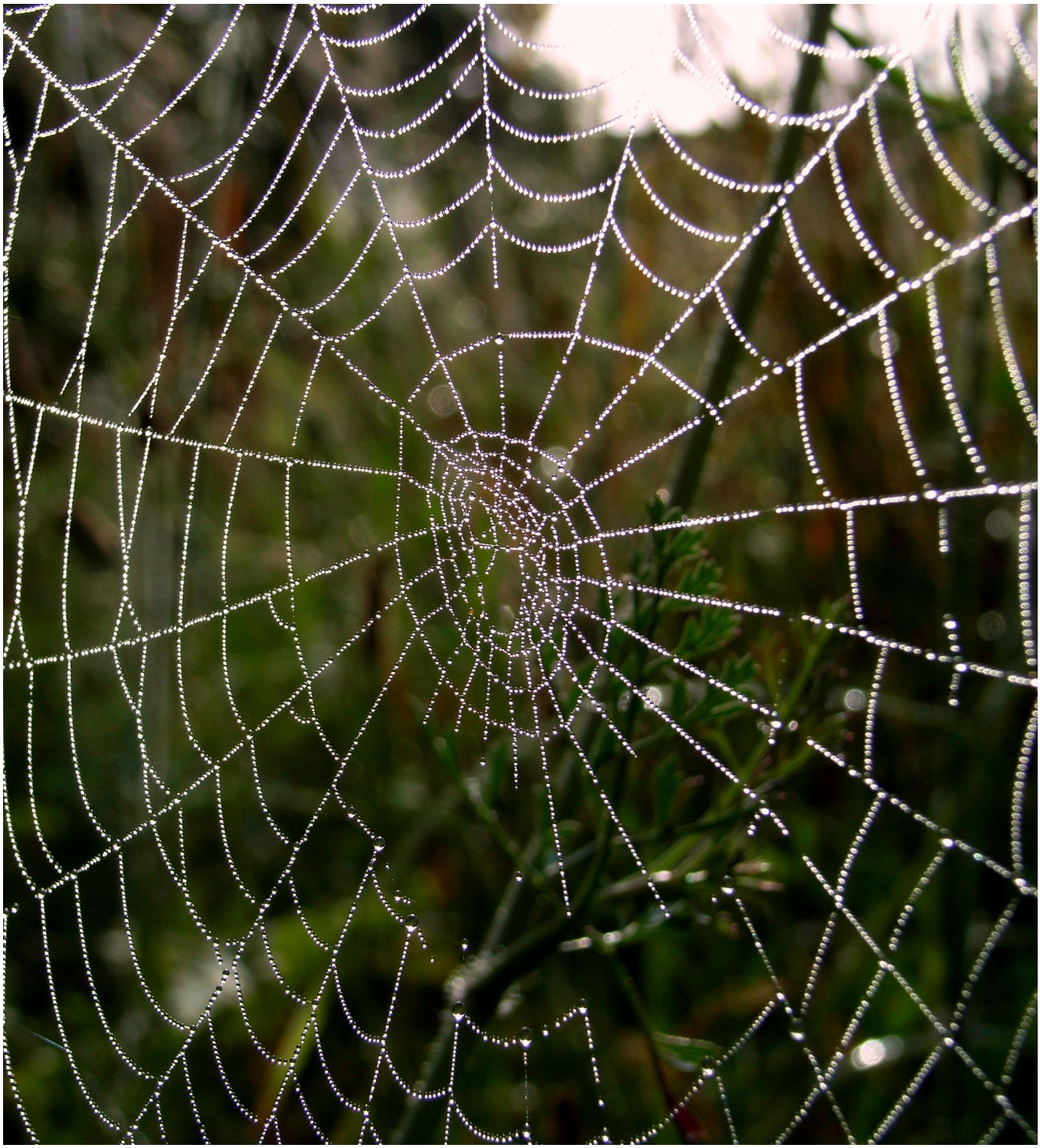
Wof & nursery: wikimedia commons
Crab: dogtooth
Jumping: Andreas Kay
Harvestmen: Ciar

Burrowing spiders

Trapdoor: Jean and Fred
Turret & folding door: Ken-ichi Ueda
Tarantula: quintin

All spider illustrations by Kevin Beals, except funnel spider web by Lisa Baker.

Orb Web



Cobweb

Funnel Web

Sheet Webs

FIELD CARD

Cut out along outer lines and fold along the centerline. This makes a handy reference card that will fit in your pocket.

Spider Exploration

Introducing the Activity

1. Explain: Spiders are often seen as "creepy," but are almost never harmful to humans.
2. *Walk & Talk* or *Think, Pair, Share*:
   - *Share something positive, cool, or interesting (not negative) you have heard about or experienced with spiders.*
   - *What do you think it might be like to be a spider? What is the world like from a spider's point of view? What adaptations or useful body structures might they have?*
   - *In what ways do you think spiders might be important in an ecosystem?*
3. Students look for different kinds of spiders as you walk to exploration site, describing them out loud to partner.
4. At exploration site, ask students to share things they discussed.
5. Explain importance of spiders in ecosystems: Food for birds, reptiles, & insects, and they feed on & control insect populations.

Searching for Spider Webs

1. *Turn & Talk*:
   - *Most people know spiders use webs to catch insects. But how do webs actually work?*
   - *What are kinds of insects spiders might catch in their webs?*
2. Hear responses & ask follow-up questions.
3. Explain: Spider webs are like extensions of spiders' bodies, helping them sense the world.
4. Students look for different types of spider webs, comparing & observing differences & similarities in shape, structure, & location.
5. Set boundaries, explain to observe spiders & webs closely without touching them, & assign "spider kid."
6. Warn about any venomous spiders in the area, emphasizing that most spiders they find are harmless, then send them to explore.
7. As students explore, circulate, ask questions, and engage any struggling students.

Sharing Discoveries

1. After ~10 minutes, gather group, & tell pairs to meet with another pair to talk about similarities & differences between webs.
2. Get group's attention & ask students to share about webs they observed, using follow-up questions & encouraging building on each others' ideas.
3. Hold flat hand vertically, ask students if they saw webs like this, then lead brief discussion about types of prey this kind of web could catch. Flying insects? Crawling insects? Falling insects? How might the web shape or structure help it catch that kind of prey?
4. Ask students to describe structures of other kinds of webs they observed, & to make possible explanations for what kinds of prey those webs might be best for catching.

Identifying Web Types

1. Explain: Spiders are often categorized by the shape of web they make.
2. Show Spider Web Identification Key, & explain it is a guide for identifying types of webs.
3. Give each pair of students a key, and use large photos to lead students in identifying 4 major spider web types: orb, sheet, funnel, & cobweb.
4. Students use key to identify webs, & to observe shape & structure of each web, discussing how its shape might function to help the spider survive.
5. Circulate, troubleshoot, & engage students in discussion about identification & structures of spider webs.
6. *Turn & Talk* about new observations or information they learned about how the webs they identified help spiders sense & catch their prey.
7. Remind that spiders use webs to detect & catch prey, then ask them to share some of their explanations about how webs work.

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Spider Exploration

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8. Explain: It can be interesting to observe organisms' structures & think about how they work. This is a way scientists think, too.

Optional: Quick and Dirty Web Survey

1. Walk to a different plant community than the one the group has been exploring, then ask students to think about whether they think there will be more vertical or horizontal webs there.
2. Do informal survey of web types in area: tell pairs: 1 partner count vertical webs, & other count horizontal webs until you say "Stop."
3. Each pair that counted more vertical webs raises hands, then each pair that counted more horizontal webs raises hands.
4. Whole group discussion: students come up with possible explanations for the results, & asking what factors might affect which spiders are more successful in a particular area.
   - ▶ *Why do you think there are more of this type of web here? What are some possible explanations?*
   - ▶ *What kinds of things do you think might affect which type of spiders is more successful in an area?*
5. Explain: This is a quick study, & the group could get more accurate information with a more careful count. Ask what they could change about counting process to be more accurate.

Optional: Finding Spiders Without Webs

1. Explain: There are some kinds of spiders that don't use webs to catch prey, then Walk & Talk as you move to an area where you know there are running spiders:
   - ▶ *How might spiders that don't build webs catch their prey?*
   - ▶ *What kinds of body structures might a running spider have to help it chase down and catch prey?*
   - ▶ *How might these structures be different from those of spiders that build and live in webs?*
2. Explain: They will search for & observe structures & behaviors of running spiders.
3. Share spider-catching devices you have, set boundaries & safety protocols.
4. If students will be using "poofers" to catch running spiders, remind them to be gentle & not to "poof" spiders that build webs, then set them to explore.
5. Look for other evidence of spiders: draglines, sleeping sacs, shed exoskeletons, etc.
6. Students explore.
7. Gather group, & ask them to briefly discuss structures & behaviors they observed.
   - ▶ *What were some of the structures and behaviors you observed?*
   - ▶ *How do you think these help them survive in their habitat?*

Wrapping Up

1. *Turn & Talk* or *Walk & Talk*:
   - ▶ *How do you feel about spiders now? Is this different from how you felt before studying their webs?*
   - ▶ *What helped you to learn today?*
   - ▶ *Why might there be similarities in types of spider webs found in different places in the world?*
   - ▶ *Where are places you'd expect to find spiders and webs near where you live?*
   - ▶ *How could you get someone who doesn't like spiders to become interested in them?*
   - ▶ *What questions do you have about spiders? How can you learn more?*
2. Encourage students to keep noticing spiders throughout the rest of field experience.

ABOUT BEETLES™

BEETLES™ (Better Environmental Education Teaching, Learning, and Expertise Sharing) is a program of The Lawrence Hall of Science at the University of California, Berkeley, that provides professional learning sessions, student activities, and supporting resources for outdoor science program leaders and their staff. The goal is to infuse outdoor science programs everywhere with research-based approaches and tools to science teaching and learning that help them continually improve their programs.

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