beetles

Science and Teaching for Field Instructors

Student Activity Guide

Related & Different

Are you related to a lizard? This Adaptations Activity gives students insights into how very different organisms are actually related (distantly). Students search for two somewhat closely related organisms (like two kinds of insects, or a spider and an insect) to compare, using Venn diagrams. Then they debate which two organisms studied by a team are most closely related, supporting their ideas with evidence and reasoning. Finally, they interpret a "Tree of Life" diagram to see how living things on Earth share common ancestors. This activity helps students develop a foundation for understanding key ideas about evolution.

Students will…

- Compare and contrast organisms.
- Understand that all organisms are related.
- Use patterns in body structures to infer relatedness.
- Make explanations about how closely related different organisms might be.

Grade Level:
Grades 5–8. Adaptable for younger or older students.

Timing:
About 40 minutes

Related Activities:
Adaptations Intro-Live!; Structures & Behaviors; and *Blending In & Standing Out*

Materials:
For instructor: 1 portable whiteboard, whiteboard marker
For each student: pencil and paper or journal
For each pair of students: A copy of the Tree of Life diagram
Optional: Equipment for catching and containing organisms, e.g., bug boxes.

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

Setting:
A good site for catching and observing animals, such as a place with logs to look under, next to a pond or stream, shake-able foliage, or even a Nature Lab.

NEXT GENERATION SCIENCE STANDARDS

FEATURED PRACTICE	FEATURED CROSSCUTTING CONCEPT	DISCIPLINARY CORE IDEAS
Constructing Explanations	Patterns	Inheritance of Traits, Evidence of Common Ancestry and Diversity, Natural Selection, Adaptation

For additional information about NGSS, go to page 8 of this guide.

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

Related & Different

ACTIVITY OVERVIEW

Related & Different	Learning Cycle Stages	Estimated Time
Introducing the Activity	Invitation	5 minutes
Comparing Two Organisms of Different Types	Exploration, Concept Invention	15 minutes
Discussing Relatedness	Concept Invention, Application	10 minutes
Wrapping Up	Reflection	10 minutes
TOTAL		~40 minutes

TEACHING TIPS

Field Card. On page 12 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 7, you'll find more information about pedagogy, student misconceptions, science background, and standards.

One piece of the puzzle. This activity gives students an introduction to the diversity and unity of life on Earth, as well as some tools for thinking about the relatedness between different types of organisms. To help students develop a deeper understanding of how the current diversity of life arose, engage students in other adaptation- and evolution-related activities.

Introducing the Activity

1. **Ask students to describe out loud the similarities and differences of 2 trees.** Point to two trees of different types, (e.g. a pine and an oak tree) that students can easily see. Ask students to spend about 30 seconds quietly saying out loud the similarities and differences between the trees. It will sound like a cacophony of "They both have X! The pine has X but the oak doesn't!" etc.

2. **Explain to students that pairs will each search for two organisms, will compare differences and similarities, and will record their observations.**

Comparing Two Organisms of Different Types

1. **Lead the group through organizing characteristics of 2 organisms in a Venn diagram: Lizard and Bird.** Tell students a useful tool for comparison is a Venn diagram, then draw one with the word "Lizard" above one circle, and "Bird" above the other. Ask students to brainstorm characteristics of a lizard and a bird, writing things that are unique to lizards and birds in their own circles, and things they have in common in the intersection of both circles.

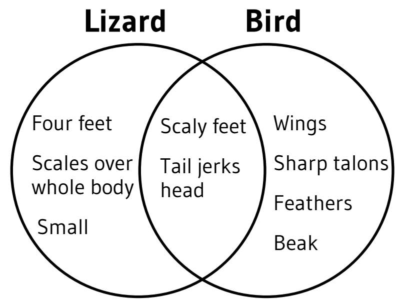
2. **Explain: In pairs, students will find and choose 2 somewhat closely related organisms and make a Venn diagram of their similarities and differences.** Explain that students will find and choose two organisms to compare in a Venn diagram, like the bird/lizard example, but they will choose actual organisms in the area that they can observe closely. The organisms they choose should be somewhat closely related, such as an insect and a spider, or two kinds of salamanders. This will make it easier to find similarities that may show relatedness. Comparing organisms that are very different, like a plant and an animal, would not be very productive for this activity, because there would be too few similarities. For a plant-focused lesson, students could choose two plants of similar size.

3. **Share equipment, and give instructions on how to search for organisms.** If there are small critters in the area, give students instructions on how to catch them and equipment to do it. This could include a sheet-shake for insects, an under-log hunt for critters, or a pond or stream search for macroinvertebrates. See the BEETLES resource *Ecosystem Literacies & Exploration Guides* for useful techniques and tips for finding organisms in different ecosystems.

4. **Hand out pencils, journals, paper, and clipboards as needed.**

5. **Circulate and troubleshoot as each student pair finds 2 actual organisms.** Depending on what kinds of organisms they're looking for, how they're looking, and the amount of time you have, you can encourage a lot of exploration during this phase or can set a time limit so students choose their organisms fairly quickly.

TEACHING NOTES



Indoor activity option. If bad weather strikes or if you have structured time in a nature center at your site, this activity could be done successfully indoors with taxidermied animals (but live animals are more engaging).

Introducing the term "species." If students are ready for it, this would be a good time to define the term "species." A species is a group of individuals that are able to reproduce and successfully produce offspring. Note: Breeding of two different species in some cases may produce offspring, but those hybrids won't be able to reproduce, e.g. male donkeys and female horses producing sterile mules.

6. **Support pairs of students as they each make a Venn diagram of 2 found organisms.** If your students are observing invertebrates, provide cups, bug boxes, or other containers to keep their organisms where they can see them. As you circulate, prompt observations with questions like “What do you notice?” “What structures does each organism have?” “What are the organisms doing?” Check that students are writing similarities and differences in the appropriate sections of their Venn diagrams.

7. **After students have had time to make their Venn diagrams, but before they lose interest, gather the group, ask pairs to stand together, and tell them to come up with one similarity and one difference to share with the group.**

8. **Do a Whip Around, pointing at each pair to set their diagram in the circle, share the organisms they compared, and tell a similarity and a difference to the whole group.** Make sure students are standing so you can easily recognize pairs. Keep this sharing brief. Point at a pair and say, “let’s see your diagram” and “what were the two organisms you compared?” Ask,“similarity?” Then, “difference?”

Discussing Relatedness

1. **Lead a brief group discussion in which students debate which pair of organisms might be most closely related.** Ask students to Turn & Talk about the question below, then to share their thoughts with the group. Ask students follow-up questions to probe their thinking.
   - ▶ *Of the pairs of organisms the group found, which pair do you think is most closely related to one another? What’s your evidence?*

2. **Explain: Some similarities (e.g.** numbers/shapes of legs, body parts) may be evidence of relatedness, while others (e.g. color) are not. Explain that not all things in common are signs of relatedness. For example, a frog and a tree may both be green, but that’s not evidence of relatedness. Other traits, though, like numbers or shapes of legs, other external body parts, or internal body parts, often are evidence of relatedness.

3. **Explain: Noticing patterns in different organisms’ characteristics can be helpful to understand relatedness of different organisms, and scientists used to depend on it.** Explain that when students compared organisms and looked for similarities and differences between them, they were looking for patterns to help them figure out how closely related the organisms are. Explain that in the past, scientists looked for patterns in the characteristics of a wide variety of organisms to figure out how related they are.

TEACHING NOTES

Highlighting the NGSS Crosscutting Concept: Patterns. Students may only have experience with the idea of patterns in mathematics, when it’s used to describe repetitive number sequences or tessellating shapes. They may not be familiar with how noticing patterns can be applied in many other branches of science (and life!). Pointing out how students’ and scientists’ identification of patterns is useful for figuring out the relatedness of organisms helps students understand how useful patterns can be as a thinking tool. For students to appreciate patterns as a big idea of science, they’ll need to have multiple experiences with using this lens to explore nature. See the Instructor Support section for more information about making connections between this activity and the NGSS.

4. **Explain: Now scientists mostly use DNA to more accurately figure out which organisms are most closely related.** Since DNA testing became possible, scientists compare DNA to tell relatedness between organisms. This is much more accurate.
5. **Explain: DNA comparisons have shown that most relatedness based on characteristics was accurate, but in some cases it wasn't.** Now that we can examine DNA, scientists have sometimes radically changed relatedness charts, because they've found out that some organisms that seemed more related aren't, and some that seemed less related are actually more related.
6. **Show the Tree of Life diagram from page 14, and ask pairs to discuss what they notice, then share out.** Ask pairs of students to briefly discuss what they notice about how the organisms are grouped, then ask them to share out.
7. **Explain that the diagram shows how all organisms are related, but also that some are more closely related than others.** Current evidence, including DNA testing, supports the idea that all organisms are related, but some are more closely related than others.
8. **Explain that:**
    - If organisms are more closely related, you don't have to trace their branches back very far to find a connection.
    - If organisms are more distantly related, you have to trace the branches back father until they connect.
    - Each point where branches connect represents a common ancestor.
9. **Explain: In general, the more that two organisms have in common, the more related they are, because species inherit body structures from a common ancestor population.**
10. **Point out an example of a body structure (e.g. 8 legs, backbone, 4 limbs) that was inherited by a group of related organisms on the diagram.** Use one of the following examples, or use something that students noticed about the grouping of organisms.
    - 8 legs: All the arachnids (ticks, spiders, harvestmen, scorpions) had a common ancestor with 8 legs.
    - Backbone: All the organisms on the branch labeled "backbone," starting with the jawless fish, had a common ancestor with a backbone.
    - 4 limbs: all of the organisms at the top of the "backbone" branch, starting with amphibians and reptiles, had a common ancestor with 4 limbs.

TEACHING NOTES

What is DNA? DNA has become commonly used in everyday language, and many students have enough of an idea of what it is to understand the ideas presented here. If you think your students could benefit from a definition, DNA is the chemical basis of heredity that make up genes. Genes are a code, or "instructions" for how to make an organisms' body. Genes are found in almost every cell in an organisms' body. By studying DNA, scientists can get much more precise and accurate information about relatedness between organisms.

Consider giving pairs their own copies of the Tree of Life diagram. Providing each pair of students with their own diagram will help them to make closer observations and may keep them more engaged.

Misleading appearance of some 4-limbed descendants. Some descendants of the 4-limbed common ancestor are missing limbs! What happened? As they adapted to their particular environments, some organisms no longer needed four working limbs, e.g. hind limbs for walking were not crucial to survival in the ocean. That's why, over generations, some organisms evolved to lose these body parts because they became useless. But some of these organisms, such as whales and certain snakes, actually have hidden, now useless limbs, called vestigial limbs. These are evidence that these organisms evolved from an ancestor with four limbs.

TEACHING NOTES

"Hey, Cuz!" All organisms are related, some more closely than others. For a playful application, you might encourage students to find an organism and say, "Hey, Cuz!" to it. They could also embellish by saying, "Hey, super-distant Cuz!" or "Hey, close Cuz!" with more and less closely related organisms.

"What you people call your natural resources our people call our relatives." –Oren Lyons of the Turtle Clan of the Seneca Nations of the Iroquois Confederacy

11. **Ask the group to point out and name groups of organisms on the Tree of Life they've seen on their field experience so far, and to keep looking for others, while discussing evidence of their relatedness.** If you're checking out lots of organisms, it's not hard to be able to see a bunch of the groups represented on the diagram during a field experience (especially if students get to go to both a terrestrial ecosystem and an intertidal area). Consider challenging students to keep looking for representatives of other groups, and discussing evidence of their relatedness, then bring the Tree of Life back out towards the end of the field experience to do this again.

12. **If students collected small critters, tell them to carefully release them.** Tell students to carefully return their organisms to their habitat as close as possible to where they found them.

Wrapping Up

1. **Optional: Journal activity.** Give students a chance to reflect and write on the following prompt. Reading their responses will help you recognize what they took away from the lesson.
   - *What do you have in common with all organisms? What makes you unique from all other organisms?*

2. **Ask one or more of these *Walk & Talk* reflection questions:**
   - *What helped you to learn today?*
   - *What surprised you today?*
   - *Did any of your ideas change during this activity? What made them change?*
   - *How might you explain or show some of what you learned in this activity to a family member?*
   - *What questions do you still have about organisms and their relatedness?*

3. **Optional: Lunch question.** To keep discussing this theme throughout a several-hour field experience, use the question: "How many things can you think of that all, most, or many organisms have in common?" Have students call out possible answers to the group and then explain their reasoning. You might want to challenge students to try to come up with traits that are shared by the most organisms.

Instructor Support

Conceptual Knowledge

Relatedness of Species

TEACHING NOTES

The ability to accurately figure out relatedness between species has improved over time, and biologists have used different evidence to do it. Biologists look at organisms' traits that can be inherited (like number of limbs) to understand how related different species are. This involves looking at organisms' physical characteristics (which may include looking at body parts of living species as well as fossils of now-extinct species), behavioral traits, and genetic code. They look for evidence of shared characteristics, which are evidence of shared common ancestors. Using this evidence, biologists make "trees of life," known as phylogenetic trees, to graphically represent how they think organisms are related to one another. In the past, biologists' ability to estimate relatedness using DNA was limited because they were only able to compare small portions of organisms' DNA. As technology improves, it is becoming easier for biologists to compare all of an organism's DNA—its genome—to the genome of another organism. This allows biologists to make increasingly accurate trees of life.

Some shared characteristics of organisms. All animals can move around at some point of their lives. Almost all plants can photosynthesize. All living things have cells, and all have biological processes. All living things can grow. They can all respond to stimuli and they can all reproduce. All animals and plants are multicellular. Animals breathe in oxygen and breathe out CO . Plants do the opposite. Animals and plants have eukaryotic cells (meaning they have a nucleus and other organelles enclosed in a membrane). Bacteria and archaea are single-celled, and have prokaryotic cells (meaning they have no no membrane-bound nucleus, mitochondria or other membrane-bound organelles).

All living things have a code in each of their cells, called DNA. This code is a set of instructions that make up the organism. When an organism goes through asexual reproduction, it makes a genetically identical clone of itself. During sexual reproduction, male and female DNA is combined and forms the unique DNA combination of their offspring..

Diversity is one of the benefits of sexual reproduction. Every time an organism reproduces sexually, DNA from two organisms is combined to form a unique combination. If you look around a room you see that every human is unique. That diversity helps the species survive. If a serious disease came through, those without immunity would die. But because there is diversity, some would likely survive to pass their genes on to their kids. The diversity we see in humans, and in many other species, comes from sexual reproduction; we aren't clones of one another.

Another source of diversity within a species comes from mistakes in copying DNA, known as mutations. On average a human has ~60 mutations that their parents don't have. Mutations can be helpful, harmful, or neutral for an organism's survival. Most mutations are neutral—they don't harm or help the organism. Some mutations do harm the organism, while some mutations

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/

help. Those that are beneficial can help an organism survive in its habitat, giving it a greater chance of having babies, and passing that mutation on through the population, increasing the species' success. Harmful mutations are less likely to be passed on because those that have them have less chance of surviving and reproducing.

Speciation is when one species splits into two or more separate species. Speciation can happen when populations of a species get geographically separated from each other, e.g. because a river changes course and separates one population from another, or because part of the population migrates, or because individuals in different areas within a population's range stop mating with each other. When populations of a species (or groups of individuals within a population) stop mating with each other, and start only mating within their separate populations (or groups), it's possible for the populations (or groups) to become so different that they can no longer reproduce. That's when they're considered different species. This can happen when different populations adapt to different environments.

Misconception. If two organisms look the same, they must be closely related; if two organisms look different, they are distantly related.

More accurate information. Historically, biologists estimated the relatedness of organisms based on their outward appearance. But biologists are now making more accurate estimates of relatedness by comparing organisms' DNA. Genetic studies have shown that similar-looking organisms aren't always closely related. For example, although crocodiles and lizards have been historically put together in the reptile group, biologists have learned that crocodiles are actually more closely related to birds than they are to lizards. And organisms that look very different from each other may be more closely related than they look. If you just look at them, it's hard to believe that Chihuahuas and Great Danes are both the same species, but DNA, and our knowledge of canine history, provide evidence that they are.

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 *Related & Different*, students engage in the practice of Constructing Explanations and have the opportunity to relate what they learn to the crosscutting concept of Patterns. Students will build a foundation for understanding disciplinary core ideas related to *Inheritance of Traits, Evidence of Common Ancestry and Diversity, Natural Selection*, and *Adaptation*.

Featured Science and Engineering Practices

Engaging students in constructing explanations. According to the National Research Council'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 it. Therefore, students should develop their understanding of science concepts through making their own explanations about natural phenomena.

- In *Related & Different*, when students compare pairs of organisms using Venn diagrams and then discuss which pair of organisms is most closely related, they're constructing explanations about the relatedness of different species.
- If you engage students in looking for organisms from the Tree if Life diagram while in the field, and you ask them to find closely related organisms in the surrounding area and explain why they think they've found such organisms, you'll be giving them another chance to construct their own explanations.
- The large group discussion in which students share their ideas about which pair of organisms is most closely related is a critical step in this activity, because it's an opportunity to encourage students to include their evidence and reasoning when they give an explanation, and to consider different possible explanations.

Featured Crosscutting Concepts

Learning science through the lens of Patterns. The idea that patterns can be found everywhere and that noticing them can lead to interesting questions about why they happen is an important lens for scientific investigations. Recognizing patterns can be a step towards using classification systems to make sense of the natural world.

- In *Related & Different*, students make comparisons between different organisms using Venn diagrams. Although the word "pattern" isn't used, students are in fact looking for similarities and differences that show how closely related different organisms might be.
- The instructor supports students in using patterns to better understand the natural world by calling out how using patterns as a thinking tool helps scientists classify species, and by encouraging students to find patterns in the characteristics of different groups of organisms.

TEACHING NOTES

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

- Be sure to point out to students that looking for patterns is something scientists do to lead them to make interesting observations or ask useful questions about organisms, or any other topic in science. This will help emphasize the idea that pattern recognition is a useful skill in any field.

Featured Disciplinary Core Ideas

Building a foundation for understanding Disciplinary Core Ideas. Students need multiple learning experiences to build their

- When students observe similarities and differences in organisms and think about what that tells them about the organisms' relatedness, they work towards understanding how the unity and diversity of organisms in the present is due to evolution from common ancestors (LS4.A).
- As they interpret the Tree of Life, they continue to build this understanding of LS4.A, and also build a foundation for understanding how traits are inherited and passed down through generations (LS3.A), as well as how adaptation (LS4.C) by natural selection (LS4.B) is the process through which the diversity of species arose.

This should not be the only activity students experience to develop their understanding of these concepts and their skill with this practice. Do multiple activities over the course of a day or a program to give students more opportunities to deepen their understanding (see Activity Connections below).

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 of big ideas in science after engaging in multiple learning experiences and instruction over a long period of time. They are not the "curriculum" to be taught to students. Below is one performance expectation that this activity can help students work towards.

3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

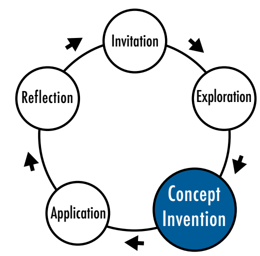
MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and

differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

Activity Connections

This activity involves complex thinking and works best after some practice in observation and discussion. Help students build these skills with *I Notice, I Wonder, It Reminds Me Of, NSI: Nature Scene Investigations,* and *Discovery Swap*. Introduce the theme of adaptations with *Whacky Adapty* or *Adaptations Intro-Live!* Deepen students' understanding with *Structures & Behaviors* and *Mating & Cloning*. See the BEETLES *Adaptations, Structure, and Function Theme Hike* for more on how to connect the activities to one another. Of course, this activity can stand on its own, though students will develop a deeper understanding of core ideas with more experiences.

TEACHING NOTES



This activity takes students through a full learning cycle. Within a series of activities Adaptations and Relatedness of organisms, this activity serves as a Concept Invention.

FIELD CARD

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

Related & Different

Introducing the Activity

1. Students describe out loud similarities & differences of 2 trees.
2. Explain: Pairs will each search for 2 organisms, will compare differences & similarities, & will record observations.

Comparing Two Organisms of Different Types

1. Lead group through organizing characteristics of 2 organisms in a Venn diagram: Lizard & Bird.
2. Explain: Pairs will find & choose 2 somewhat closely related organisms & make a Venn diagram of their similarities & differences.
3. Share equipment & give instructions on how to search for organisms.
4. Hand out pencils, journals, paper, & clipboards as needed.
5. Circulate & troubleshoot as each student pair finds 2 actual organisms.
6. Support pairs of students as they each make a Venn diagram of 2 found organisms.
7. But before they lose interest, gather group, ask pairs to stand together, & tell them to come up with one similarity & one difference to share with group.
8. Do a Whip Around, pointing at each pair to set their diagram in the circle, share the organisms they compared, & tell a similarity & a difference to whole group.

Discussing Relatedness

1. Lead brief group discussion in which students debate which pair of organisms might be most closely related.
2. Explain: Some similarities (e.g. numbers/shapes of legs, body parts) may be evidence of relatedness, while others (e.g. color) are not.
3. Explain: Noticing patterns in different organisms' characteristics can be helpful to understand relatedness of different organisms, & scientists used to depend on it.
4. Explain: Now scientists mostly use DNA to more accurately figure out which organisms are most closely related.
5. Explain: DNA comparisons have shown that most relatedness based on characteristics was accurate, but in some cases it wasn't. Now that we can examine DNA, scientists have sometimes radically changed relatedness charts, because they've found out that some organisms that seemed more related aren't, and some that seemed less related are actually more related.
6. Show the Tree of Life diagram from page 14, & ask pairs to discuss what they notice, then share out.
7. Exphe diagram shows how all organisms are related, but also that some are more closely related than others.
8. Explain that:
   - If organisms are more closely related, you don't have to trace their branches back very far to find a connection.
   - If organisms are more distantly related, you have to trace the branches back father until they connect.
   - Each point where branches connect represents a common ancestor.
9. Explain: In general, the more that two organisms have in common, the more related they are, because species inherit body structures from a common ancestor population.
10. Point out an example of a body structure (e.g. 8 legs, backbone, 4 limbs) that was inherited by a group of related organisms on the diagram:
    - 8 legs: All arachnids (ticks, spiders, harvestmen, scorpions) had common ancestor with 8 legs.
    - Backbone: All on the branch labeled "backbone," starting with jawless fish, had a common ancestor with backbone.
    - 4 limbs: all at top of "backbone" branch, starting with amphibians & reptiles, had common ancestor with 4 limbs.
11. Ask group to point out & name groups of organisms on Tree of Life they've seen on field experience so far, & to keep looking for others, while discussing evidence of their relatedness.
12. If students collected small critters, tell them to carefully release them. Tell students to carefully return their organisms to their habitat as close as possible to where they found them.

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Related & Different

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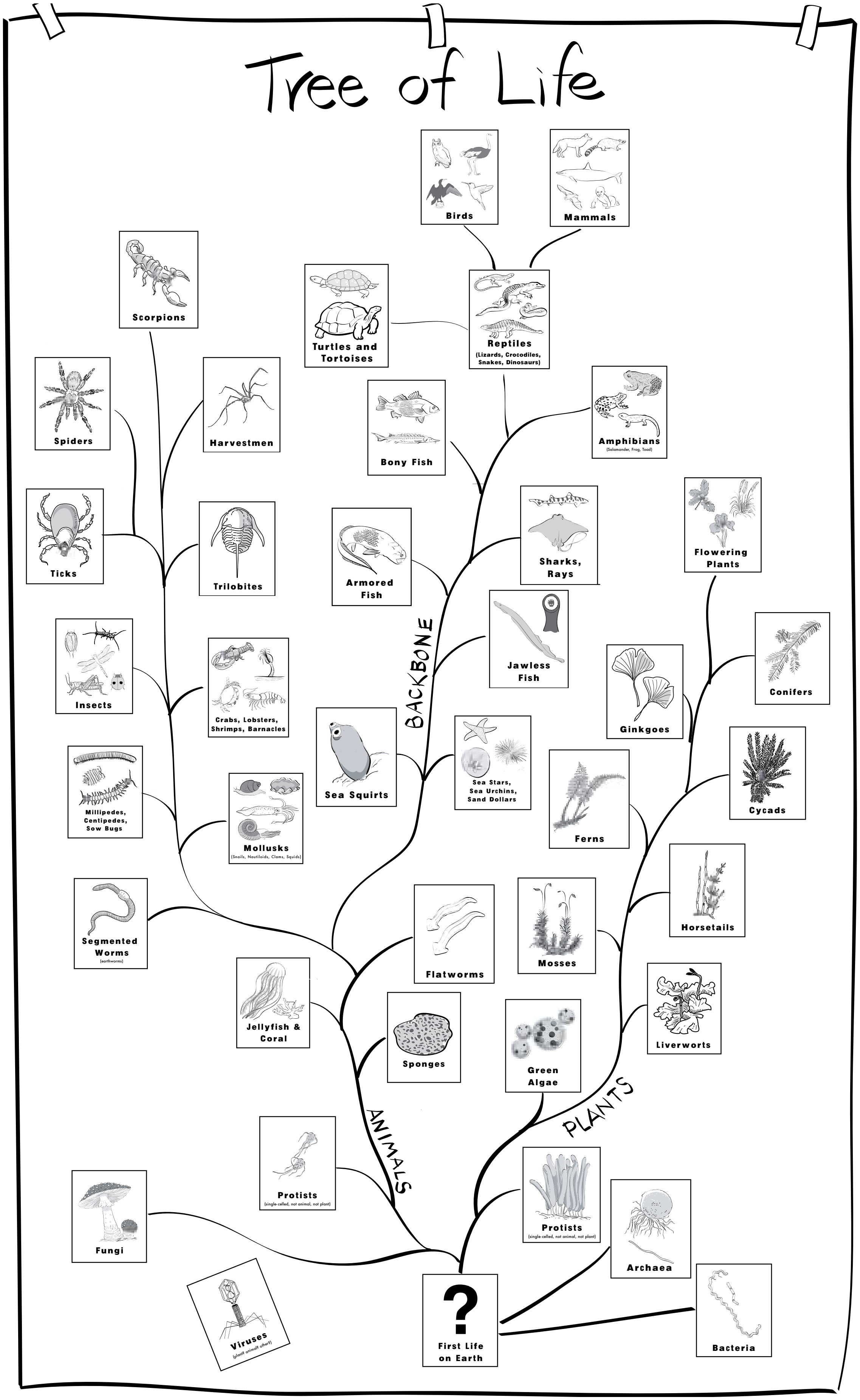
Wrapping Up

1. Optional: Journal activity with prompt:
   ▶ *What do you have in common with all organisms? What makes you unique from all other organisms?*
2. Walk & Talk:
   ▶ *What helped you to learn today?*
   ▶ *What surprised you today?*
   ▶ *Did any of your ideas change during this activity? What made them change?*
   ▶ *How might you explain or show some of what you learned in this activity to a family member?*
   ▶ *What questions do you still have about organisms and their relatedness?*
3. Optional: Lunch question: "How many things can you think of that all, most, or many organisms have in common?"


Tree of Life
Birds
Mammals
Scorpions
Turtles and Tortoises
Reptiles
(Lizards, Crocodiles, Snakes, Dinosaurs)
Spiders
Harvestmen
Bony Fish
Amphibians
Ticks
Trilobites
Armored Fish
Sharks, Rays
Flowering Plants
BACKBONE
Jawless Fish
Insects
Crabs, Lobsters, Shrimps, Barnacles
Conifers
Ginkgoes
Sea Squirts
Sea Stars, Sea Urchins, Sand Dollars
Millipedes, Centipedes, Sow Bugs
Mollusks
Cycads
Ferns
Horsetails
Segmented Worms
Flatworms
Mosses
Jellyfish & Coral
Sponges
Green Algae
Liverworts
ANIMALS
PLANTS
Protists
(single-celled, not animal, not plant)
Fungi
Protists
(single-celled, not animal, not plant)
Archaea
Viruses
?
First Life on Earth
Bacteria

ABOUT BEETLES™

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Principal Investigator and Articulate Beetle: Craig Strang
Project Director, Lead Curriculum & Professional Learning Developer, and Idea Beetle: Kevin Beals
Project Manager, Professional Learning & Curriculum Developer, and Beetle Herder: Jedda Foreman
Curriculum & Professional Learning Developer and Head Fireball: Lynn Barakos
Curriculum & Professional Learning Developer and Champion-Of-All-The-Things: Emilie Lygren
Research and Evaluation Team: Bernadette Chi, Juna Snow, and Valeria Romero
Collaborator, Super Naturalist, Chief Scalawag and Brother-from-Another-Mother: John (Jack) Muir Laws
Project Consultants: Catherine Halversen, Mark Thomas, and Penny Sirota
Advisory Board: Nicole Ardoin, Kathy DiRanna, Bora Simmons, Kathryn Hayes, April Landale, John Muir Laws, Celeste Royer, Jack Shea (emeritus), Drew Talley, & Art Sussman.
Editor: Mark Woodsworth
Designer: Barbara Clinton

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To contact BEETLES™, email beetles@berkeley.edu