beetles
Science and Teaching for Field Instructors

Student Activity Guide

Card Hike

Card Hikes are common activities in outdoor science programs designed to give students a safe "solo" experience in nature and are often powerful and memorable experiences for students. Guided quiet or alone time in the outdoors is one way for students to build their own relationships with nature. Reflection is a key aspect of learning, but often it is cut short or left out of learning experiences. A thoughtful Card Hike offers students a chance to reflect on and extend their learning and to spend time connecting with nature (and themselves).

In the *Card Hike* activity, students walk or move slowly down a trail (chosen ahead of time) one at a time, reading cards placed along the trail. The cards feature prompts and quotes that engage students in sensory explorations and reflections. This write-up activity focuses on how to build the prompts, quotes, and sensory experiences in a Card Hike around the science learning theme of a field experience or series of activities and includes two themed sets of cards (*Adaptations* Theme Cards and *Ecosystems, Matter, and Energy* Theme Cards).

Students will:

- **Spend time walking or moving alone in silence, experiencing nature.**
- **Think and wonder about the learning theme of a field experience.**
- **Read quotes and engage in brief sensory experiences related to the theme.**

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

Related Activities:
Mind Pie; Ecosystems Theme Field Experience; What Lives Here?; Food, Build, Do, Waste; Matter and Energy Diagram; Decomposition Mission; Adaptation Intro-Live!; Structures and Behaviors; Blending In and Standing Out; Related and Different; Mating and Cloning

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

Timing:
Timing depends on the size of your group, the number of cards you choose to use, and how far apart you space the cards. Expect an average Card Hike to last a minimum of 50 minutes.

Materials:
For details, see the Materials and Preparation section on pages 3–4.

Setting:
A safe trail that students can navigate easily (not physically challenging and the fewer forks the better) and that has enough space for your group to gather at the beginning and end.

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Card Hike is not a three-dimensional learning experience on its own, but it does give students the chance to think and wonder about science concepts related to either the themes of matter and energy and interdependent relationships in ecosystems or adaptations and structure and function.

For additional information about NGSS, go to page 17 of this guide.

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Card Hike

ACTIVITY OVERVIEW

Card Hike	Learning Cycle Stage	Estimated Time
Introducing the Activity	Invitation	5 minutes
Setting Up the Card Hike	Invitation	10 minutes
Students Follow the Card Hike	Exploration, Concept Invention, Application	30–60 minutes
Reflecting and Wrapping Up	Reflection	5 minutes
TOTAL:		~50+ minutes

TEACHING TIPS

Read the Instructor Support section. Beginning on page 7, you'll find more information about pedagogy, student misconceptions, science background, and standards.

Why add a learning theme to Card Hikes? Card Hikes are common in some outdoor science programs, and students often report them as a highlight of their field experiences. Adding a content theme to a Card Hike doesn't detract from the positive emotional impact that arises from spending time alone in nature. A Card Hike that focuses the sensory activities, quotes, and questions on the cards around the learning theme of the field experience can play a key role in students' learning experience. Combining tidbits of interesting information, questions, prompts for engaging with the environment, quiet, and solitude can offer students opportunities to tie together ideas and reflect, making this a great activity to use toward the end of a sequence of activities. This write-up includes cards for two different themed hikes: one for *Adaptations*, and one for *Ecosystems, Matter, and Energy.*

A supplement to, not a replacement of, other activities. Card Hikes focused on *Adaptations* or *Ecosystems, Matter, and Energy* are meant to be only one activity within a sequence of learning experiences in these content areas. A Card Hike shouldn't be the only thing you do with students related to building their understanding of concepts related to *Adaptations* or *Ecosystems, Matter, and Energy.* Students might remember a phrase they read from a card, but this alone isn't enough for them to understand these complex ideas. The themed cards will be more effective if they come after students have already had learning experiences focused on these concepts.

Set the tone to go slowly and curiously. Setting the tone for this activity is very important to invite students into a mindset of exploration, wonder, and inquiry. Without setting a strong tone, students may rush through the cards, missing the opportunities to think and reflect.

Field card. At the end of this activity write-up, you'll find a condensed, pocket-sized version to use in the field.

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MATERIALS AND PREPARATION

MATERIALS

For the group:

- pre-written cards on a theme related to your field experience (see pages 19–40)
- cards with arrows
- blank cards
- marker
- optional: long nails (to attach arrow cards to dirt to prevent them from being turned)

PREPARATION

1. **Choose a location, prioritizing safety.** Think carefully about where to do this activity and the needs of individuals in your group. It's important that students feel safe and *are* safe during the Card Hike. Choose an obvious trail with few (if any) forks so students don't lose the trail. Choose a trail that is accessible to every member of your group and isn't physically challenging. Don't use trails near serious hazards, such as a cliff. The beginning and end of the trail should have enough space for the group to circle up. Take into consideration any program and site rules and considerations. Use this information to make a thoughtful decision about where to do the Card Hike. Consider your students' needs, lived experiences, and comfort with the outdoors as you plan the activity and prepare to communicate clearly about expectations and students' safety as you introduce the activity. See the Instructor Support section (beginning on page 7) for more considerations in deciding when and how to do this activity safely.
2. **Choose, print in color, cut apart, and prepare cards from the Card Hike library.** There are two themed sets of cards included in the library: *Adaptations* Theme Cards and *Ecosystems., Matter, and Energy* Theme Cards. Each card set features a combination of sensory activities, quotes, content-related questions, and explorations on the theme. In order to provide you with choices, each card set has been carefully planned to offer more cards than you'll need to set up a themed Card Hike. Choose the cards that make the most sense for your students and location. Some cards are more complex conceptually, and some require more reading than others. Other cards are feature-specific (i.e., *Listen to a creek.*). For some cards in the library, you'll need to bring additional materials such as hand lenses and a mirror. Consider translating sets of cards into languages frequently used by students you work with.
3. **Make arrow cards, additional sensory cards, or other supplemental cards.** Make several arrow cards to use to show

TEACHING NOTES

Card Hike. *Card Hike* offers students an opportunity for unsupervised "alone" time while moving along a trail in the outdoors. Facilitating the activity requires specific and careful attention to support participation and access for all students in a group.

At least two adults. To run this activity, you need at least one chaperone (adult or high-school aged) in addition to the instructor. One person (you) sets out the cards, while the other stays back to facilitate and send students on the hike, one at a time.

Considering access. It's essential to know the physical, emotional, and academic needs of students in your group well in advance of leading the Card Hike. Connect with classroom teachers or families to make sure you are aware of any students in your group who may have mobility impairments, are deaf or hard of hearing, are blind, who may require emotional support, or who may need reading or translation support. With this knowledge in mind, choose a trail or setting that will be accessible to *all* your students and make a plan ahead of time to offer accommodations for students who may need it. Some examples of accommodations include: pairing a sighted student or chaperone with a blind student for the hike; including cards that feature prompts to engage a range of senses including smell, touch, sight, and hearing (not just cards focused on sight or hearing); adjusting the route to avoid obstacles that would exclude members of the group from participating; or pairing students with a chaperone or peer who can support language translation or read prompts out loud.

Cards with photographs. Many cards include quotes with images or photographs of the person who said the quote. If there is a quote card without a photograph to go with it, we encourage you to find an image of the speaker on the Internet and add it to the card before you print it out.

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the direction students should go on the trail. There are plenty of sensory and reflection cards included in each set, but if you want any additional cards, such as social emotional learning reflection cards (e.g., *What is something you are proud of?*), make them. If there are plants that students should avoid, such as poison oak or poison ivy, make cards that tell students how to avoid those plants. Be sure to go over any hazards like this BEFORE students go on the Card Hike.

4. **Laminate and/or prepare to weigh down the cards.** Lamination protects the cards from wind, rain, and dirt. Gluing pennies or setting a rock on top of a card works well to weigh down the card. It's particularly important that arrow cards not be turned, accidentally or intentionally. Two long nails attached to opposite ends of an arrow card and tapped into the dirt work well to keep an arrow card from turning.

5. **(As you set up the hike) Add custom-made cards.** Your Card Hike should direct students' attention to what is present in their location. The cards in our library are designed to be flexible so they can be used in many scenarios (e.g., *Look at this tree. What do you think made these holes? Check out these leaves. Lift this log.*). Bring along some blank cards and a marker in case you want to improvise a few cards along the way. You never know what you might find that's not on the cards! If you regularly lead your Card Hike on the same trail, you might want to make some more permanent cards that focus on specific things along the trail that are consistently there and interesting for students to engage with.

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Introducing the Activity

1. **Share the goal of the activity: safe alone time with others nearby.** Share that students have an opportunity to be quiet and alone in nature in a very safe way and with others nearby.

2. **Set the tone for an unhurried exploration and explain the procedure.** Share:

   ▶ *We've been spending a lot of time exploring, thinking, and discussing. Now, this is your chance to do something really cool! You'll get to go slow, get distracted if you want, look at things, and get some quiet time. You will have a chance to move along the trail by yourself, following cards that I lay on the ground.*

3. **Introduce rules and offer guidelines.** As you introduce the rules, act out and model what it could look like for students to follow each rule.

   - **Spend some time with each card.**

   ▶ *Think about each card or try to answer what's written on each card. If a card says to do something, do it! Don't worry. No one will be watching you.*

   - **Keep your distance**

   ▶ *It's not a race. In fact, it's the opposite. Moving through quickly makes it difficult to get the full benefit of the experience. Don't move on to the next card if you can see the person in front of you. If you do get close enough to see the person in front of you, don't wait impatiently. Follow their lead by slowing down. Give them space and pause and check out what is around you while you wait for them to move on.*

   - **This is a silent activity.**

   ▶ *There are times when we've been exploring and sharing ideas with one another, and we can do more of that later. But for this activity, we're going to be quiet. Experiencing nature without human voices or interaction can be magical and really fun! Please respect others' experiences by staying quiet.*

   - **Look around and allow yourself to get distracted.**

   ▶ *If you keep your senses open, there's no telling what you'll notice. Take in what's around you, or get down low to check out small things.*

   - **Safety protocols.** Tell students to follow the cards, stay on the trail, and leave cards as they found them. Explain your site's protocol for what students should do if they need help, end up on the wrong trail, or off the trail altogether.

Setting Up the Card Hike

1. **Set clear expectations for adults staying behind: Set up a simple, quiet activity; after 10 minutes, send each student 2 minutes apart; then go last on the trail, picking up the cards and gear.** Give the teacher, chaperone, or other adult clear instructions on when and where to start students on the Card Hike. They should wait about 10 minutes before

TEACHING NOTES

Students often crave some quiet. Although they may not realize it, students often crave down time when involved in an exciting and socially rich outdoor science experience.

Accommodations and support. Students may need accommodations and support to engage in this activity. If you have a third adult, one way to offer support is to assign them to walk or move behind a student who might need support staying on the trail or who might need help following the directions. If appropriate, the adult might keep the student barely within sight, available for support if needed but allowing the student to have their own experience. If needed, the adult can also walk or move along with the student, offering support in any ways the student needs. Send extra energetic students first so they don't end up pressuring other students to go faster. If an extra energetic student zooms through the Card Hike and finds you while you're still laying out cards, either direct them to slow down or find a way for them to engage in the process of setting up the Card Hike, helping you choose locations for cards or laying out arrangements of leaves, rocks, or sticks in patterns around the cards.

Emergent readers. Students who are emergent readers can do the Card Hike by whispering quietly with a student partner who is more comfortable with reading or with an extra adult.

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sending any students. Then, they can send one student approximately every 2 minutes. Prepare the adult with an activity to do with the students while they wait to begin the Card Hike.

2. **[Optional] If students will be using journals for an activity before or after the Card Hike, share a suggested way for carrying them.** Before and/or after a Card Hike can be a great time for journaling and reflection. It can work well to set up students with a drawing or sketching activity to do while they are waiting and then inviting them to write a poem or reflection after the Card Hike is done. If students will be using journals before and/or after the hike, ask the chaperone staying with them to make sure each student brings their journal and a pencil with them on the Card Hike.

3. **Start hiking and set out cards.** Place cards far enough apart so students have the chance to reflect on each card before seeing the next one, but close enough so they don't worry that they might have lost the trail. Place the last card in an area near where there's enough room for the whole group to sit or explore. Scout the trail ahead of time so you can quickly place cards in the moment.

Students Follow the Card Hike

1. **Students follow cards.** Ten minutes after you leave, the chaperone should invite the first student to grab any gear they have and head down the trail. Then, the chaperone can continue sending students one by one, every 2 minutes.

2. **As students finish the Card Hike, invite them to do an end-of-hike activity.** Students will arrive one at a time, so choose an activity that is simple to communicate to each of them. If you're interested in extending the solo experience, set up students with sit spots or a journal activity in which they reflect on the Card Hike. If you'd like to give students a break from silent time, you might invite them to explore freely within boundaries or chat quietly with their peers. This option only works well if the end point of the hike is separated from the trail so the noise won't disturb students who are still doing the Card Hike.

Reflecting and Wrapping Up

1. **Invite students to *Thought Swap* (formerly known as *Walk & Talk*) or *Think-Pair-Share* about the questions below.** Listen to students' responses and ask for clarification or for other students to agree or disagree.
   - *What was your experience like?*
   - *What surprised you on this hike?*
   - *What was a favorite card or memorable moment?*

2. **[Optional] Dominoes Discussion Routine.** Invite each student to share one word to describe their Card Hike experience.

TEACHING NOTES

Activities for students waiting to begin the Card Hike. Good options include a quiet game, a journaling activity, or sit spots. Individual exploration activities also work well, such as cards that direct students to find specific things in the area (e.g., *Find 3 different kinds of seeds. Find 5 different shades of brown.*), a scavenger hunt, finding natural colors that match paint chips, finding things in nature that start with each letter of the alphabet, etc. If waiting students don't have a clear activity to keep them occupied, they are more likely to become unfocused and impatient, and adults are more likely to send them on the Card Hike at closer intervals. Make sure the adult leaves enough time (2 minutes) between each student so students get the most out of each stop at a card.

Changing the name *Thought Swap*. Wondering why we changed the name from *Walk & Talk*? We received feedback from community partners on how we can use more inclusive language, and we decided to change the name so we were not normalizing walking as the only way of moving and talking as the only way of communicating.

Logistics of Discussion Routines. See the BEETLES *Thought Swap* activity and the Discussion Routines resource for the logistics of the *Think-Pair-Share*, *Thought Swap*, and *Dominoes* (formerly known as *Whip Around*) routines.

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Instructor Support

Teaching Knowledge

Why use cards based around a learning theme? Any Card Hike can be a powerful experience for students, no matter how it's structured. Card Hikes can also be used to introduce thoughtful content and to center the experience around a learning topic. Students can read interesting tidbits of information and engage with their surroundings through the cards, which can be more engaging than being directly told information and what to do by an instructor. This approach can sometimes be very effective as a way for students to engage in content and ideas on their own terms. Including questions and statements on the cards that connect to activities from your day can add a lot to your students' conceptual experience. The cards can guide students to keep thinking and building on concepts from earlier in the field experience. This can also lead to some profound *Wow!* moments of connection to nature for students as they think about big concepts, such as how just by breathing, they are part of the ecosystem! The two themed Card Hike collections in our library are designed to integrate content into cards that invite students to reflect on and engage with their surroundings, including sensory experiences and inspiring quotes.

Additional considerations for Card Hikes. Card Hikes are incredible opportunities for students and often make their list of favorite activities from an outdoor science experience. Feeling alone in nature in a safe environment is often a new, exciting, and powerful experience for students. Keep the following in mind to help set up students for success:

- **How far apart you place your cards depends on the terrain.** In more open areas, such as a grassland or on fire roads, space the cards farther apart so students are less likely to clump together. In a densely forested area, you can place cards closer together. If the cards are behind trees or around corners, students will feel a sense of mystery and excitement. More rugged (but not dangerous or physically challenging) terrain will help students move slowly and take their time. If you do use rugged terrain, make sure the path is very clearly marked. You might also lead students on the same trail before the Card Hike so it's familiar and so they feel confident they can do it. Whatever terrain you choose, make sure your students have enough time to observe and wonder about their surroundings in between the cards.
- **Know and address the specific safety concerns at your site.** Think about poisonous snakes, mountain lions, poison oak, stranger danger, etc. that might affect students' safety during the activity. Cards can help students avoid poison oak or poison ivy, but animal-based dangers might require an orientation ahead of time (e.g., what to do if you see a rattlesnake while alone on the trail). If the chance of danger is too high, then don't do the activity in that location.
- **Making the path very clear.** If there is a left or right turn or an intersection of any kind, tell students about it before you leave. Prepare them for arrow cards and remind them not to tamper with the cards in any way.

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Make it clear that tampering with the arrow cards is not funny and can be harmful. Attaching each arrow card to the ground with two long nails helps prevent deliberate tampering, as well as students accidentally kicking the cards as they pass by.

- **Give any adults present a role to support the activity.** One adult can stay at the beginning of the hike, while another can monitor the middle of the trail. You may want to station an adult at any particularly challenging spot, or at a fork in the trail, to watch and help if needed. A spare adult could also hold a cool critter somewhere along the trail for students to see. A student who struggles significantly with self-control, or otherwise needs support, may benefit from an adult partner to walk the trail with or to follow closely behind them.
- **Consider the order of students.** Students who are likely to run or walk quickly should go first so they don't interrupt other students. Nervous students might benefit from going first or last so they are near an adult. You might ask your chaperone to avoid sending close friends right after one another on the trail so they aren't tempted to catch up to one another and walk together.
- **Card placement.** Some cards can be placed anywhere, but others need a certain setting or props to go along with a card. The more you can integrate your cards into their specific settings, the better. For example, place a card inviting students to touch water next to a creek, or a card suggesting students explore a tree next to a particularly interesting tree, or a card drawing students' attention to animal tracks next to a muddy area with tracks.

Cards with photographs. Many cards include quotes with images or photographs of the person who said the quote. In a few cases, we weren't able to find a publishable photograph of the person, so we left a blank space for their image. For these cards, we suggest downloading images on your own to attach to the quotes.

Quote cards and representation. In each theme hike library, we have included a variety of quotes on cards, along with images of the person being quoted. We intentionally chose inspirational and thought-provoking quotes from thinkers and scientists from a range of cultural backgrounds and identities. Black, Indigenous, and People of Color have historically been underrepresented in the sciences (particularly in environmental science) and in the field of outdoor recreation and outdoor education. Students from populations that are currently underrepresented in the sciences can benefit from seeing inspiring leaders from their community represented. Additionally, students from dominant groups or groups that have been historically well-represented also benefit from engaging in learning experiences that represent leaders and thinkers from a range of cultures, identities, and backgrounds.

Representation is just one piece of creating an equitable, inclusive, and culturally relevant learning experience for students. Want to learn more about this topic? Check out our blog: Partnering to Develop Equitable, Inclusive, and Culturally Relevant Student Activities (http://beetlesproject.org/partnering-to-develop-equitable-activities/).

Additional considerations for choosing and preparing your card hike. Don't use all the cards! There are more than you will need. We did that on purpose to give you options. Choose the cards that work best with what is along your trail, with your students, and with the length of your trail.

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Many of the cards depend on being next to a particular thing for students to explore, such as a flower, scat, hole, creek, or fungus. As you set up the cards, pay attention to what is present along your trail and use the cards that draw students' attention to these features. Don't use cards that prompt students to observe something that isn't there.

Some of the cards depend on minimal props, such as a water bottle, mirror, or journals for students to write in. The cards that require props or other specific situations are listed below. Skip any of these for which you don't have the props or that don't align with the expectations of your program.

Adaptations Theme Cards: Considerations and Special Instructions

- ***If you want, take off your shoes and socks and walk to the next card barefoot.*** and ***Look at your bare feet.*** Only use these cards if walking barefoot is in line with your program's rules and if the terrain is not too rough.
- ***Look at all the ___s.*** This card is meant to point out one type of living thing in nature, can be used anywhere you have a lot of one type of plant, especially if it's a fairly small and simple plant. It can also work if you have a lot of one kind of animal, such as a ladybug. Use a Vis-à-Vis (or wet erase) marker to fill in the blank line on the card with the name of the organism.
- ***Look at the organism in the container.*** Only use this card if you have found a small organism that you can safely keep in a container with a lid and will be able have someone return and release it where you caught it.
- ***Look in the mirror.*** To use this card, you will need to place a small mirror next to it.
- ***This type of plant has been around for millions of years.*** This card can be used if you have horsetails or ferns.
- ***In your journal, draw a nearby tree.*** This is meant to be the final station for students as they sit quietly near you while waiting for the other students to finish the Card Hike. Students will need to have their journals and something to write with. They can carry their journals themselves, or you can carry students' journals and have them waiting for them. If you don't have journals, make sure you have paper, pencils, and something to write on, such as a clipboard or a piece of cardboard with a small binder clip attached.

Ecosystems, Matter, and Energy Theme Cards: Considerations and Special Instructions

- ***Put the mirror up to your mouth and breathe on it to fog it up.*** To use this card, you will need to place a small mirror next to it.
- ***The droplets you saw after breathing on the mirror are evidence that you lose water with every breath.*** You'll need a 1-quart water bottle filled ~¾ with water (1½ pounds).
- ***Take a drink of water from your water bottle.*** Students will need to be carrying their own water bottles for this one to work.

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- ***Look at a nearby leaf with your hand lens.*** Students will need their own hand lenses. Otherwise, you could change the card to: *Look closely at a nearby leaf.*
- ***Feel the weight of the carbon dioxide and other gases in the air.*** You'll need a 1-quart water bottle filled all the way (~2 pounds).
- ***Find a place to sit. In your journal, do one or both of these.*** This is meant to be the final station for students as they sit quietly near you while waiting for the other students to finish the Card Hike. Students will need to have their journals and something to write with. They can carry their journals themselves, or you can carry students' journals and have them waiting for them. If you don't have journals, make sure you have paper, pencils, and something to write on, such as a clipboard or a piece of cardboard with a small binder clip attached.

Conceptual Knowledge

Background Information Related to *Adaptations* Theme Cards

Adaptations are inheritable traits that improve the fitness of a population of organisms. In this case, fitness doesn't refer to how strong an organism is—it refers to how successful it is at reproducing. Evolution happens because some individuals in a population are more successful reproductively than others. The ability to run faster, be better at finding food, or avoid being eaten all increase an organism's reproductive success. That's because individuals that are better at surviving have better chances of reproducing than those that aren't. It's kind of difficult to reproduce when you're no longer alive!. Evolution is the process of change that takes place in populations over generations. Traits that improve fitness will be passed on to more offspring than traits that do not improve an organism's fitness, and these traits become more common in a population. This is how a population of organisms changes over time. If a population becomes so different from other members of the same species that it can no longer reproduce with them, then this population is considered a new species. This process is called speciation. Inheritable traits are the result of genetics. It's through DNA that these traits are passed on from one generation to the next.

Coloration as an adaptive trait. Coloration is an adaptive trait because certain kinds of coloration help some organisms survive and reproduce more successfully. Of course, color adaptations are only helpful when other organisms have eyes to see them. Color became important in adaptations as organisms evolved eyes about 550 million years ago. When organisms began to see color, new predator–prey dynamics arose. For example, predators could spot yellow prey against the blue background of the ocean a lot more easily. Then, a whole bunch of color-based adaptations arose—adaptations that made it so prey could hide from predators, or predators could sneak up on prey unseen—as well as adaptations that allowed organisms to use color to signal things such as, *Hey, I'm dangerous. Don't try to eat me!* Or, *Hey, look at me. I'd make a great mate!*

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TEACHING NOTES

Categories of Adaptive Coloration

- **Camouflage.** Camouflage includes a wide range of mechanisms that help organisms disguise themselves. Camouflage can help prey avoid being found by predators. On the flip side, camouflage can help predators avoid being seen by prey so they can sneak attack.
- **Warning colors.** Some organisms use bright colors and patterns to warn predators that they are poisonous (harmful if eaten or touched) or venomous (inject venom into other organisms) and not worth the risk of trying to eat them.
- **Mimicry.** Some organisms have evolved to mimic (imitate) other organisms. In some cases, predators have evolved to mimic harmless organisms. One example of this is flower mantises, which mimic flowers and can go unnoticed by prey and catch them more easily. In many cases of mimicry, harmless organisms have evolved to mimic harmful organisms, which can help them avoid being eaten.
- **Colors that attract.** Sometimes, organisms' colors and patterns are not useful for hunting or defense, but they can help attract mates. Often, one sex of a species is brightly colored, while the other is more dull and camouflaged. Many flowers also use color to help in reproduction—to attract pollinators.

VISTA = Variation, Inheritance, Selection, Time, Adaptation

VISTA is a helpful device for remembering important building blocks for understanding evolution and can guide how we teach students about the topic. However, it's only appropriate if you're teaching a whole sequence of activities meant to guide students to understandings about evolution, including natural selection, and if you're teaching older students (grade 6+).

- **Variation.** Genetic variation is the raw material for evolution. The processes that drive evolution are based on genetic variation among organisms of the same species. Individual organisms can vary in size, coloration, ability to fight off diseases, and in countless other traits.
- **Inheritance.** Knowing that characteristics are passed from parents to their young through genes will help students understand how adaptive traits are passed on to surviving generations. Understanding that new variations of organisms often form during reproduction helps lay a foundation for understanding that natural selection can only happen when there are new characteristics introduced into populations. This idea also helps combat the common misconception that variations happen as a response to changes in the environment. The variation is *always* there, but selective pressures, such as changes in the environment, select for certain traits to be more successfully passed on.
- **Selection.** For any new genes or traits to survive in a population of organisms, you need selection. Selection is not random in either artificial selection (guided by humans) or natural selection. You may hear people say that the complex features of living organisms could not have been produced by random events. They're right, because these events are

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TEACHING NOTES

not totally random. The mutation that produces these traits may be random, but the selection process is not. In natural selection, the traits that persist in a population of organisms are those that give an advantage in the organism's habitat. Selection is a pressure that selects for certain traits in a population by giving a survival advantage to organisms with that trait.

- **Time.** Scientists don't actually know a typical rate for evolution because fossil evidence shows that changes in life forms have happened at different rates. Sometimes, these changes happen over very long periods of time (gradualism), but they also happen in shorter bursts after long periods with little change (punctuated equilibrium). Some big changes have been found in fossils dated less than 100,000 years apart. However, the most significant changes in organisms have happened over a very long time. Changes in populations of organisms usually happen over millions of years.
- **Adaptation.** Adaptations are the result of evolution in a species, not in a single individual. An organism does not decide to produce adaptations. Species do not develop adaptations because they want or need them. Certain genetic changes give organisms characteristics that help them survive and reproduce and to pass on these changes to future generations. These characteristics then become new adaptations of the species. Populations as a whole adapt as a result of changes in habitat or changes in the adaptations of other species in their habitat.

Relatedness of species. 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 (such as 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 by 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 in 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_2. Plants do the opposite. Animals and plants have eukaryotic cells (meaning that they have a nucleus and other organelles enclosed in a membrane). Bacteria and archaea are single-celled and have prokaryotic

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cells (meaning that they have 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 the 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 at people around you, you see that every human is unique. That diversity helps the species survive. If a serious disease came through, those without immunity would die. However, because there is diversity, some would likely survive to pass on their genes 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 help. Those that are beneficial can help an organism survive in its habitat, giving it a greater chance of having babies and passing on that mutation 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.

Common Relevant Misconceptions

Misconception. An individual organism can adapt.

More accurate information. This is the most common misconception about adaptations. In common English, the word *adapt* means something an individual does, such as *I moved to a new school, and I adapted by making new friends.* However, in scientific usage, populations of organisms adapt over generations, but individuals don't. Adaptations are inherited structures or behaviors—they're not things an organism gets during its lifetime. If a person works out a lot and develops big muscles, that person's children will not inherit big muscles, so it's not an adaptation. An adaptation must be something an organism is born with, such as long legs. If longer legs help organisms run faster, survive, and have more offspring than those with shorter legs, then longer legs may eventually become an adaptation and spread through the population.

Misconception. If a population or organism tries hard enough, it will adapt to its environment.

More accurate information. Adaptations come from random genetic mutations. While most genetic mutations are neutral, and some are harmful to organisms, every once in a while a mutation will help an

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TEACHING NOTES

organism have a survival advantage and produce more offspring. The offspring who inherit the beneficial trait will also have more offspring. Evolution does not happen because an organism *wants* an adaptation. It works through random trial and error. Genetic mutations randomly happen, and beneficial ones are passed on to the next generation.

Misconception. *Survival of the fittest* means that only the strongest organisms will survive.

More accurate information. In the context of evolution, the term *fitness* has nothing to do with physical strength. In biology, fitness refers to how successful an organism is at reproducing and passing on its genes. Fitness is more important than survival when we think about evolutionary success. Bacteria, mayflies, and mice are all examples of organisms with short life spans but high reproductive fitness. One way to think about survival of the fittest is the traits that improve an organism's fitness will survive in future generations of a species. Coloration is a good example of an adaptive trait that can increase fitness but has nothing to do with physical strength.

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. However, 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 placed together in the reptile group, biologists have learned that crocodiles are actually more closely related to birds than they are to lizards. Organisms that look very different from one another 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.

Background Information Related to *Ecosystems, Matter, and Energy* Theme Cards

Plants, animals, and breathing. Animals, including humans, breathe in oxygen and breathe out carbon dioxide (respiration). Overall, plants do the opposite. Plants "breathe in" carbon dioxide and "breathe out" oxygen (through photosynthesis). So animals and plants are partners who depend upon one another in their breathing patterns. What makes this more complex is that plants don't just photosynthesize—they also respire. Like animals, plants have processes that take in oxygen and give off carbon dioxide. However, the overall net effect of plants is that they mostly release oxygen and take in carbon dioxide.

Plants take in carbon dioxide through tiny holes in their leaves called stomata (stoma = singular). They release oxygen and water vapor through these same holes. Generally, plants don't use the oxygen that is part of that air passing in and out of the stomata. They mostly get oxygen for respiration through their roots. Of course, plant respiration can result in carbon dioxide leaving through

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the stomata, too. Many plants close down their stomata at night when they don't photosynthesize. When they are photosynthesizing, the oxygen that is released due to photosynthesis is mostly going out through the stomata.

Carbon dioxide and global warming. The amount of carbon dioxide in the atmosphere has naturally varied over the past 800,000 years between 170 parts per million (ppm) during ice ages to 300 ppm during warm periods. In recent decades, carbon dioxide has skyrocketed to over 400 ppm because **human activities now add 10 billion tons per year**. The added carbon dioxide comes mostly from burning fossil fuels for transportation, making electricity, heating homes, manufacturing, deforestation, and other activities. Due to natural changes, carbon dioxide has varied considerably over the last 800,000 years, but it has essentially never gone above 300 ppm. The net result of all the natural processes that give off and absorb carbon dioxide have resulted in variations over hundreds of thousands of years, but these variations have stayed within limits. Emissions caused by human activities have rapidly increased the amount to levels that we have not had on our planet for about a million years or more.

Carbon dioxide in the atmosphere radiates some heat back toward Earth. As human activities have increased carbon dioxide levels in Earth's atmosphere, more heat has been radiated back toward Earth, and Earth's average temperatures have been going up.

Matter

Matter is the "stuff" things are made of. Wood is matter, bones are matter, water is matter, and even air is matter. Matter takes up space, but it's difficult to feel that with air unless you capture some in a balloon or a bag. Matter also has mass (weight), but that's also difficult to feel with air because it has so little mass. We live in a "sea of air," so it can be difficult to feel the weight of air when you're surrounded by it on all sides.

Energy

Energy is much harder to define than matter and has different definitions depending on the branch of science. In this context, *energy* can be defined simply as what organisms get from food that allows them to do things. If you're introducing students to the term *matter*, *energy* can also be partially defined as "not matter." Unlike matter, energy doesn't take up space or have mass. If you want to go deeper, read on. Energy has no physical form; it's not a substance. When we say that energy is transferred from one organism to another, we're not talking about a physical thing being passed from place to place; rather, we're talking about transferring the capacity to do things—for example, living and growing. Weird and confusing, huh? Want more? Well, alright then.

Energy can be described as being in two different categories: the energy of motion (kinetic energy) and the energy of position (potential energy). Light, sound, heat (thermal) energy, as well as the movement of objects, are all examples of the energy of motion. Chemical, gravitational, elastic, and

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TEACHING NOTES

nuclear energy are all examples of potential energy. Since potential energy does not involve detectable movement or sensation, these types of energy are commonly unrecognized. The greater the potential energy, the more capacity there is for something to happen. You want even more? Seriously? Okay then.

Energy is a measure of how much change can happen in a system—so it's typically represented with a number. It's a quantity that's always conserved; it's neither created nor destroyed. Something needs to happen for any type of energy to be released or transferred. In other words, energy is released or transferred during interactions. As a result of an interaction, energy can transform from one type to another, and the amount of energy associated with an object can change. These changes are what are being taken into account as we track the flow of energy through a system. Understanding energy flow and redistribution throughout a system is often a key to understanding the functioning of the system as a whole.

Food

Food provides all organisms with chemical energy and matter needed to live and grow. Food needs to be digestible by the organism to provide both matter and energy for the organism to live, build its body parts, and grow. Organisms also need other kinds of matter to survive, such as water, oxygen, CO_2, nutrients, and vitamins. However, these substances are not considered food. Plants "package" energy and matter into food substances through photosynthesis, and all plants consume the food they make. The typical convention used in drawing food webs is to draw the arrows between organisms pointing toward the organism that consumes the food. The arrow indicates the direction of the flow of matter and energy.

Food substances (carbohydrates, fats, sugars, and proteins) are specific kinds of molecules that are broken down in the body through digestive processes. All organisms (including plants, animals, and fungi) grow by breaking down food (including sugars made by plants and ingested by animals and fungi) and assembling the broken down products into their body structures. After food is broken down into sugar (glucose), it enters the organism's cells and goes through a series of chemical reactions producing ATP (adenosine triphosphate), which is the process by which all cells obtain energy. In this way, food serves as a fuel to do things and also provides the molecules and building materials needed by organisms. That's why it's useful for students to think of food as a package of matter and energy.

Common Relevant Misconceptions

Misconception. Organisms convert matter into energy.

More accurate information. This is a very common misconception, even among adults. Matter is not converted into energy in life systems on Earth. Matter changes into other forms of matter, but it remains matter. When organisms eat food, energy is used to do things and can be released as heat to eventually drift off into space, but the matter in food is released as CO_2 in breath, H_2O in breath and sweat, and organic matter in feces and urine. Even though chemical energy in matter can be transformed into usable energy by organisms, the matter in food

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does not turn into energy. Remember that energy is not a substance. The chemical substances in food are transformed into new substances (through chemical reactions), but there are no new atoms created or destroyed in the process. Under usual circumstances (certainly in all ecosystems and food webs on Earth), matter does not turn into energy. Try to avoid using language that might support this misconception..

Misconception. Energy from the sun is captured by Earth and keeps cycling round and round in ecosystems.

More accurate information. Eek! If that were true, Earth would be a hot planet. Matter cycles through ecosystems here on Earth and does not usually leave the planet—some air molecules are lost into space, and sometimes a spacecraft flies away. A large amount of energy flows to Earth from the sun in the form of light energy and is captured by plants and "packaged" with matter in the form of food. However, at every link in a food chain or food web, approximately 90% of the energy is lost from the ecosystem when it is released into the atmosphere as heat and eventually drifts into outer space. About 10% of the energy is passed on to the next organism that eats it. So there is a constant flow of energy from sunlight into Earth's systems (during the day) and a constant flow out of the systems into space. This is why it's important to keep these ideas separate and *not* combine energy and matter into one driving force that cycles through all the systems on Earth. For example, by including the sun in food webs (sometimes done to try to simplify energy flow and matter cycles), this can reinforce the inaccurate idea that energy is constantly cycling through Earth systems. By teaching students that food is energy *and* matter and that *matter cycles* and *energy flows*, we can give students a more accurate picture. Sometimes, it can be less confusing to focus first on matter and then introduce the more abstract concept of energy later.

Misconception. Most of the mass of plants comes from soil and water.

More accurate information. This is also a very common misconception, even among science educators. Soil does *not* provide food for plants, but it provides them with essential nutrients, similar to vitamins. A tiny fraction of the mass of a plant comes from soil, but most of the mass comes from carbon dioxide and water that are chemically rearranged into glucose through the process of photosynthesis.

Connections to Next Generation Science Standards (NGSS)

Many BEETLES activities are three-dimensional learning experiences that engage students in NGSS Science and Engineering Practices and help them apply Crosscutting Concepts in order to develop understanding of Disciplinary Core Ideas. *Card Hike* is not a three-dimensional learning experience on its own; it is a great activity for the end of a longer three-dimensional learning experience focused on concepts of matter, energy, and ecosystems interactions or adaptations and structure and function of organisms.

The quotes and prompts on the cards give students the opportunity to think about and apply content they may have engaged with in an earlier part of the learning experience. The information on the cards references science concepts

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or features of the natural environment in order to highlight real-world examples of ideas that students have thought about or to take their thinking a little deeper by introducing new content. Card Hikes can help students build some foundational understanding of the following Disciplinary Core Ideas if they are part of a longer, three-dimensional learning experience:

***Adaptations* Theme Card Set**

- **LS1.A:** Structure and Function
- **LS2.C:** Ecosystem Dynamics, Functioning, and Resilience
- **LS4.C:** Adaptation

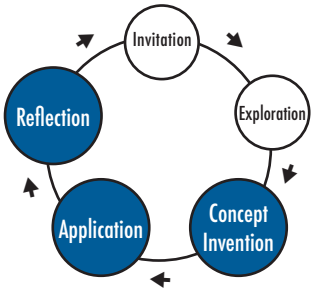
***Ecosystems, Matter, and Energy* Theme Card Set**

- **LS2.A:** Interdependent Relationships in Ecosystems
- **LS2.B:** Cycles of Matter and Energy Transfer in Ecosystems
- **LS1.C:** Organization for Matter and Energy Flow in Organisms

Activity Connections

For *Adaptations* Theme Cards: *Whacky Adapty*, *Adaptations Intro–Live!*, *Structures and Behaviors*, *Blending In and Standing Out*, *Related and Different*, *Mating and Cloning.*

For *Ecosystems, Matter, and Energy* Theme Cards: *Food, Build, Do, Waste*; *Decomposition Mission*; *What Lives Here?*; *You Are What You Eat*; *Case of the Disappearing Log.*



Learning cycle. If *Adaptations* Theme Cards or *Ecosystems, Matter, and Energy* Theme Cards are used, this activity falls into the Concept Invention, Application, and Reflection stages of a longer learning experience.

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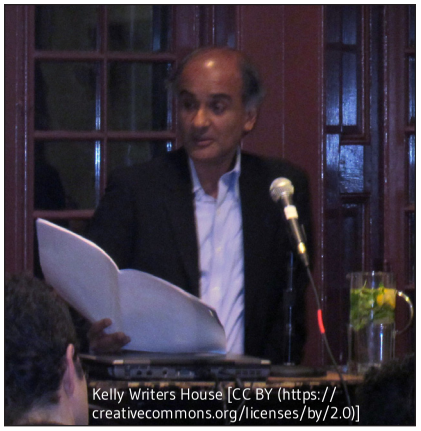
"In an age of acceleration, nothing is more exhilarating than to go slow.

In an age of distraction, nothing is more luxurious than to pay attention . . . ."

—Pico Iyer



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Adaptations Theme Cards

If you want, take off your shoes and socks and walk to the next card barefoot.

As you walk, pay attention to what the ground feels like.

Archenbridge Universities at English Wikipedia. [CC BY-SA (http://creativecommons.org/licenses/by-sa/3.0/)]

Adaptations Theme Cards

Look at your bare feet.

- How do they help you survive?
- What advantages do feet have over paws?
- What advantages do paws have?

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Adaptations Theme Cards

Adaptations, like human feet, are structures (body parts) or behaviors (things an organism does) that an organism is born with that help it survive.

What other human adaptations can you think of?

Adaptations Theme Cards

Adaptations Theme Cards

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Adaptations Theme Cards (continued)

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Plant adaptations can be:

- **structures**, such as plant leaves.
- **behaviors**, such as how plants lean toward the sun.

Find 3 plant adaptations as you walk to the next card.

Adaptations Theme Cards

What does *adaptation* mean?

- **Everyday use:** Humans adapt to weather by deciding what to wear.
- **Science use:** when a type of organism changes over many generations

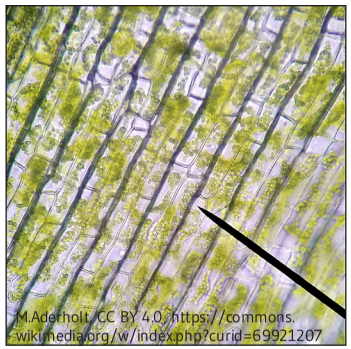
Adaptations Theme Cards

Look at this plant.

As you walk to the next card, think about what you and this plant have in common.

Adaptations Theme Cards

Like all living things, you and plants are made of cells, and all cells use oxygen to get energy from food.



plant cells

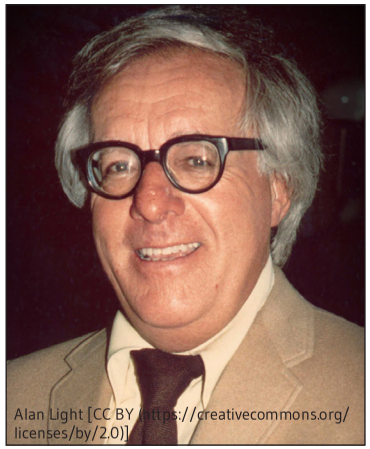
All living things are related.

Quietly say, "Hey cuz!" to a plant.

Adaptations Theme Cards

"Stuff your eyes with wonder . . . live as if you'd drop dead in ten seconds. See the world. It's more fantastic than any dream made or paid for in factories."

—Ray Bradbury



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Adaptations Theme Cards

What organism that lives in this area might be the most closely related to humans?

Adaptations Theme Cards

Find an organism nearby that is *very* distantly related to humans.

Adaptations Theme Cards

Look at all the _____s. They each have mutations that made them different in some way.

If a mutation helps one survive better, it's an adaptation.

That one will probably have more babies.

Over many generations, the whole population might have that adaptation.

Give a silent appreciation for diversity.

Adaptations Theme Cards

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Adaptations Theme Cards (continued)

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"A lot of people think that evolution is 'survival of the fittest' . . . Survival, in evolutionary terms, is important only insofar as it allows you to reproduce. Reproduction is what it's all about, because that's how you get your genes into the next generation."

—Maydianne Andrade

Adaptations Theme Cards

"The secrets of evolution are death and time—the deaths of enormous numbers of life-forms that were imperfectly adapted to the environment; and time for a long succession of small mutations."

—Carl Sagan

Adaptations Theme Cards

Find a nearby spider web.

How is being able to build a web like that an adaptation that helps the spider survive in its ecosystem?

Adaptations Theme Cards

"One way to open your eyes is to ask yourself, 'What if I had never seen this before? What if I knew I would never see it again?'"

—Rachel Carson

Adaptations Theme Cards

Look at the organism in the container.

What adaptations does it have that help it survive in this ecosystem?

Adaptations Theme Cards

"Research is formalized curiosity.
It is poking and prying with a purpose."
—Zora Neale Hurston

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Adaptations Theme Cards

Get down and try to see the world from an insect's point of view.

There are fossils of insects the size of birds.

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Can you think of any explanations for why only small insects survive today?

Adaptations Theme Cards

Listen to the creek for 30 seconds.

What are some adaptations organisms need to survive in water, such as a creek or a pond?

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Adaptations Theme Cards

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Adaptations Theme Cards (continued)

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Check out this fungus!

It may be secretly "holding hands" with a plant underground.

90% of plants can't survive without fungi to help get water and nutrients into their roots.

Relationships between organisms can be adaptations, too.

Adaptations Theme Cards

How do you think the color of this organism helps it survive in its ecosystem?

Adaptations Theme Cards

Millions of years ago, the only trees on Earth were short.

How do you think tall trees like the ones around you evolved over millions of years?

Adaptations Theme Cards

If a mutation—such as being a little bit taller—helps a tree survive better, it will probably have more "babies," and they are likely to be taller.

That's how, over many thousands of years, a type of tree can become taller and taller.

Adaptations Theme Cards

Listen for bird calls for 30 seconds.

How do you think bird calls help birds survive?

Adaptations Theme Cards

"The thing that I always have to remember is the mystery in nature."

—Carolyn Finney

Peter Forbes

Adaptations Theme Cards

Flowers are reproductive organs of plants. (So are seeds, nuts, spores . . .)

When flowers are pollinated, a male cell and a female cell combine to make a new "baby" plant. The new plant is similar to its "father" and similar to its "mother," but it's unique.

Find a reproductive organ of a plant nearby.

Adaptations Theme Cards

Look in the mirror.

You are similar to your birth father and mother, but you are unique.

Adaptations Theme Cards

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Adaptations Theme Cards (continued)

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"It's a crazy world out there. Be curious."

—Stephen Hawking


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Adaptations Theme Cards

Adaptation: pollination

Some plants need a pollinator (such as a bee) to carry pollen from one flower to another.


US Fish and Wildlife Service/Ryan Hagerty

- **How is that helpful to the pollinator?**
- **How is that helpful to the flower?**

Adaptations Theme Cards

Find a leaf that has an adaptation to protect itself.

Adaptations Theme Cards

Find a leaf that is photosynthesizing right now.

Adaptations Theme Cards

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What do you notice about the leaves around you?

How do you think each different leaf shape helps each plant survive in this ecosystem?

Adaptations Theme Cards

"When you look at the incredible diversity of the plant world . . . None of this happens by chance. Shape and texture are the response of the plant to dissipate the strength of the wind, reduce or increase the transpiration, fight off the pests, evacuate or capture more or less light or water, or maybe dust. Everything has a little magic. Yet, everything has a meaning." —Carlos Magdalena

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Adaptations Theme Cards

Look at the moss.

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Millions of years ago, there were forests of giant mosses.

What changes in the environment do you think made only small mosses survive?

Adaptations Theme Cards

This type of plant has been around for millions of years.

It was one of the **first land plants**. But they were much bigger back then. Imagine what it might be like to be in a forest of these.

Adaptations Theme Cards

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Adaptations Theme Cards (continued)

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"Evolution has no long-term goal . . . although human vanity cherishes the absurd notion that our species is the final goal of evolution."

—Richard Dawkins

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Adaptations Theme Cards

"All living organisms are but leaves on the same tree of life."

—Albert Szent-Gyorgyi

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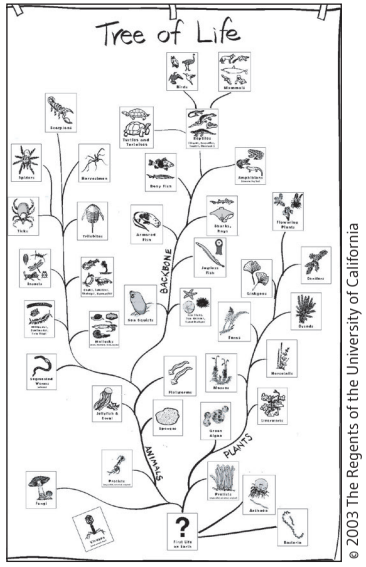

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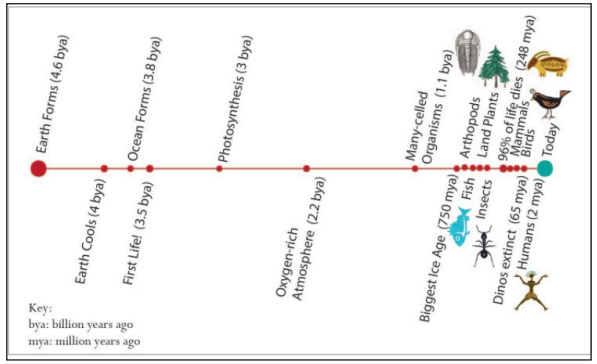
Adaptations Theme Cards

Which do you think is the most successful organism ever?

Why?

Adaptations Theme Cards

Look at this time line of Earth's history.



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- What organisms around you can you find on the time line?
- What surprises you about when different life-forms arrived?

Adaptations Theme Cards

Adaptations Theme Cards (continued)

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In your journal, draw a nearby tree.

What are 3 structures that tree inherited that help it survive in its ecosystem?

Can you think of an ecosystem where that tree would be unlikely to survive?

Adaptations Theme Cards

"The more I wonder, the more I love."
—Alice Walker

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Ecosystems, Matter, and Energy Theme Cards

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If you want, eat a piece of this edible plant.

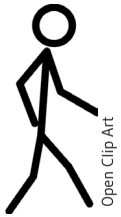
Food gives your body matter to build and repair itself and energy to do things.

Ecosystems, Matter, and Energy Theme Cards

Matter: Check out your fingernails, skin, hair—your whole body! It's all made from matter from food you have eaten.

Ecosystems, Matter, and Energy Theme Cards

Energy: As you move to the next station, see how many different things you can do at the same time, using energy from food you ate earlier—walk, think, dance, wiggle fingers, hum, etc.



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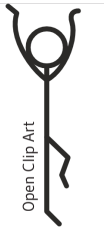

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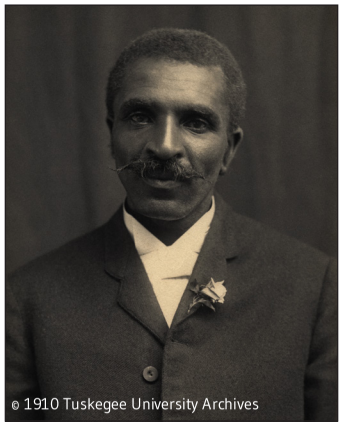
Ecosystems, Matter, and Energy Theme Cards

"Reading about nature is fine, but if a person walks in the woods and listens carefully, [they] can learn more than what is in books . . ."

—George Washington Carver



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Look and listen carefully as you walk to the next card. What can you learn?

Ecosystems, Matter, and Energy Theme Cards

Print this page in color and cut along the lines. See the Materials and Preparation and Instructor Support sections for more information on using these Card Hike *cards.*

Pick up this rock and feel its mass (weight).

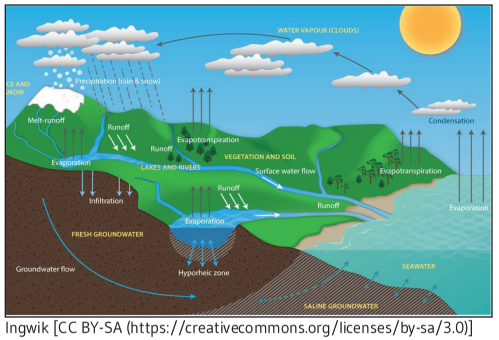
Now, feel the sunlight (if there is any).

Anything with mass, such as the rock, is matter. Things such as light and heat don't have mass and are not matter. They are forms of energy.

Ecosystems, Matter, and Energy Theme Cards

Feel the liquid water.

Water is matter, and it cycles through the ecosystem, atmosphere, and land.



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What other types of water has this been (solid ice, water gas, clouds, etc.), and what might it turn into next?

Ecosystems, Matter, and Energy Theme Cards

There is lots of water in this ecosystem that you *can't* see because it's in other things.

Look around you and find 5 things that might have water *in* them.

Ecosystems, Matter, and Energy Theme Cards

Put the mirror up to your mouth and breathe on it to fog it up.

Where do you think the water on the mirror might have come from?

Ecosystems, Matter, and Energy Theme Cards

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Ecosystems, Matter, and Energy Theme Cards (continued)

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The droplets you saw after breathing on the mirror are evidence that you lose water with every breath.

You **release about 1½ pounds of water per day through breathing and sweating.**
That's a lot of water!

That's about the same as the weight of this water bottle.

Ecosystems, Matter, and Energy Theme Cards

Plants use roots to get water and minerals (which are like vitamins to them) from soil.

Check out roots you see and imagine what all the roots in the area might look like if the soil was removed.


Mark Kent. https://www.flickr.com/photos/flamesworddragon/8851953277/

Ecosystems, Matter, and Energy Theme Cards

Take a drink of water from your water bottle.

Give a silent appreciation for something that drinking water does for your body.

Ecosystems, Matter, and Energy Theme Cards

The same molecules in the water you just drank have been cycling through plants, clouds, the ocean, dinosaurs, ice, even saliva!

Matter cycles! Think back on all the places the water you just drank has been.

Ecosystems, Matter, and Energy Theme Cards

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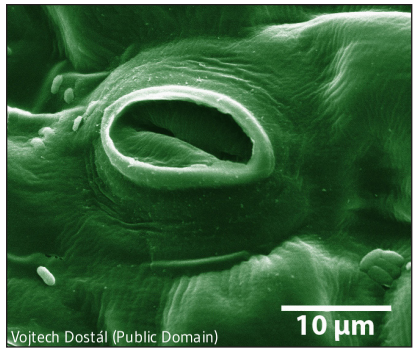
Look at a nearby leaf with your hand lens.

What do you notice?

Ecosystems, Matter, and Energy Theme Cards

If you had a microscope to look at that leaf, you'd see tiny holes like this.



The plant "breathes in" carbon dioxide through these holes.

It uses that carbon dioxide to make food.

Ecosystems, Matter, and Energy Theme Cards

Think about some of the big differences between the spring and the fall.

Do you think those differences might affect how much carbon dioxide plants take in? Why or why not?

Ecosystems, Matter, and Energy Theme Cards

Take a deep breath in and out.

You just breathed in some oxygen and breathed out some carbon dioxide.

This plant is doing the opposite. It is taking in carbon dioxide and releasing oxygen.

It's one way that plants and animals are connected

Ecosystems, Matter, and Energy Theme Cards

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Ecosystems, Matter, and Energy Theme Cards (continued)

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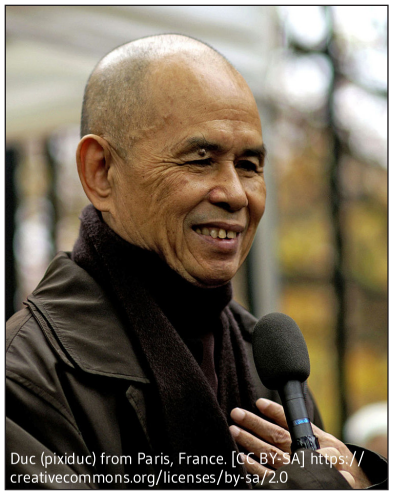
"We inter-breath with the rain forests, we drink from the oceans. They are part of our own body."

—Thich Nhat Hanh



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Ecosystems, Matter, and Energy Theme Cards

This plant, like all plants, uses energy from sunlight, water, and carbon dioxide from air to make its own food. This is called photosynthesis.

The plant uses matter from the food it makes to build its parts and for energy to do things.

What are some parts the plant might use matter to build?

Ecosystems, Matter, and Energy Theme Cards

"Sometimes I wish I could photosynthesize so that just by being, just by shimmering at the meadow's edge or floating lazily on a pond, I could be doing the work of the world while standing silent in the sun."

—Robin Wall Kimmerer

Ecosystems, Matter, and Energy Theme Cards

Look at how many leaves there are on the trees around you. All those leaves take in a lot of carbon dioxide from air.

One growing pine tree can take in about 80 pounds of carbon dioxide a year.

Imagine how many tons of carbon dioxide are taken in by the whole forest in a year!

Ecosystems, Matter, and Energy Theme Cards

Check out this burnt wood.

When the wood was burning, it released energy as heat and light.

The wood matter became carbon dioxide, other gases, and ash. But the amount of matter was the same.

Matter is never destroyed. Even when energy is released, the amount of matter stays the same.

Ecosystems, Matter, and Energy Theme Cards

"In nature, nothing is perfect and everything is perfect. Trees can be contorted, bent in weird ways, and they're still beautiful."

—Alice Walker

Virginia DeBolt [CC BY-SA (https://creativecommons.org/licenses/by-sa/2.0)]

Ecosystems, Matter, and Energy Theme Cards

Feel the weight of the carbon dioxide and other gases in the air. It's hard to feel it, but air has mass (weight).

Just by breathing, you lose about 2 pounds of weight every day from the carbon dioxide you breathe out. You gain that carbon dioxide in the food you eat.

That's about the same weight as this full water bottle. Pretty weird, huh?

Ecosystems, Matter, and Energy Theme Cards

"The brain will not grow without productive struggle."

—Zaretta Hammond

Ecosystems, Matter, and Energy Theme Cards

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Ecosystems, Matter, and Energy Theme Cards (continued)

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"The trees act not as individuals, but somehow as a collective. Exactly how they do this, we don't yet know. But what we see is the power of unity. What happens to one happens to us all. We can starve together or feast together."

—Robin Wall Kimmerer

Ecosystems, Matter, and Energy Theme Cards

"I am never not thinking about nature, because I don't understand a way we can be honest about who we are without understanding that we *are* nature."

—Camille T. Dungy

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Ecosystems, Matter, and Energy Theme Cards

Listen carefully for 30 seconds.

Do you hear any animals?

Those animals are taking in water and oxygen and breathing out water and carbon dioxide into the atmosphere.

Ecosystems, Matter, and Energy Theme Cards

Check out this animal track.

How big do you think the animal that made it was? Which direction was it going?

Animals are often moving toward food and/or water.

Is there food or water in the area where you think the animal may have been going?

Ecosystems, Matter, and Energy Theme Cards

Check out this hole.

How big do you think the animal that made it was? What kind of animal(s) do you think might live in it?

Those animals take in water and oxygen and breathe out water and carbon dioxide into the atmosphere.

Ecosystems, Matter, and Energy Theme Cards

"In nature, nothing exists alone."

—Rachel Carson

US Fish and Wildlife Service (Public Domain)

Ecosystems, Matter, and Energy Theme Cards

Check out this scat.

What size animal do you think made it? Do you see evidence in the scat of what the animal ate?

Some of the scat will become soil.

A lot of the scat will be eaten by bacteria and released as carbon dioxide into the air.

Matter cycles!

Ecosystems, Matter, and Energy Theme Cards

"We are a part of the Earth and it is a part of us . . . for all things are connected."

—Ted Perry, inspired by Chief Seattle

Henry Raschen (Public Domain)

Ecosystems, Matter, and Energy Theme Cards

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Ecosystems, Matter, and Energy Theme Cards (continued)

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Think of something from nature that you are grateful for.

If you want, take a strand of hair or a piece of a fingernail and bury it in the soil.

Like all matter, your hair or fingernail will cycle through the ecosystem.

You are part of this ecosystem.

Ecosystems, Matter, and Energy Theme Cards

"I know that nothing is destructible; things merely change forms . . . The stuff of my being is matter, ever changing, ever moving, but never lost . . ."

—Zora Neale Hurston

Library of Congress (Public Domain)

Ecosystems, Matter, and Energy Theme Cards

"If you breathe air—and most people I know do breathe air—then that makes you part of the environment, and if you're concerned about that air being clean, I would consider you an environmentalist . . . you just may not know it."

—Bob Bullard

Dave Brenner [CC BY [https://creativecommons.org/licenses/by/2.0)]

Ecosystems, Matter, and Energy Theme Cards

"There is no real aloneness. There is solitude and the nurturing silence that is relationship with ourselves, but even then we are part of something larger."

—Linda Hogan

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Ecosystems, Matter, and Energy Theme Cards

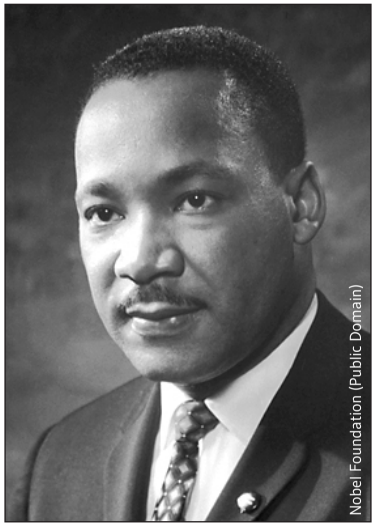
Print this page in color and cut along the lines. See the Materials and Preparation and Instructor Support sections for more information on using these Card Hike *cards.*

Just by breathing, you are a part of this ecosystem!

Ecosystems, Matter, and Energy Theme Cards

"In a real sense all life is inter-related."

—Dr. Martin Luther King, Jr.



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Ecosystems, Matter, and Energy Theme Cards

The amount of carbon dioxide released into the atmosphere is about the same as is taken out by natural processes such as by plants and the ocean.

But human activities **now add 10 billion tons more carbon dioxide per year**.

More carbon dioxide in the atmosphere is causing average global temperatures to rise.

Ecosystems, Matter, and Energy Theme Cards

"Uh huh. Uh huh. Okay. Um, can you repeat the part of the stuff where you said all about the . . . things? Uh . . . the things."

—Homer Simpson

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Ecosystems, Matter, and Energy Theme Cards

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Ecosystems, Matter, and Energy Theme Cards (continued)

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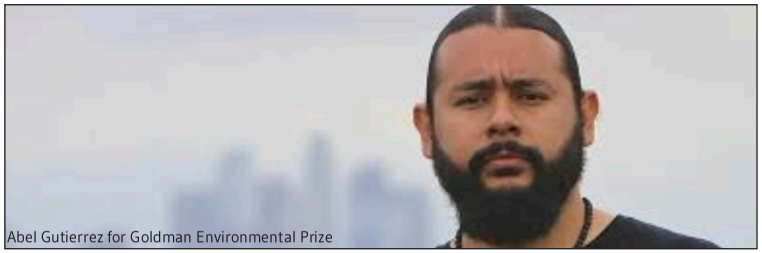
"No single organism will thrive in this planet without the interaction with other ones."

—Carlos Magdalena

Ecosystems, Matter, and Energy Theme Cards

"Going outdoors is about reconnecting."

—mark! Lopez



Ecosystems, Matter, and Energy Theme Cards

Find a place to sit. In your journal, do one or both of these:

- Write any interesting thoughts the Card Hike made you think of and anything you want to remember.
- Draw some parts of this ecosystem, with you in it, and some of the connections you know about.

Ecosystems, Matter, and Energy Theme Cards

Ecosystems, Matter, and Energy Theme Cards

FIELD CARD

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

Card Hike

Introducing the Activity

1. Share the goal of the activity: safe alone time with others nearby.
2. Set the tone for an unhurried exploration and explain the procedure.
   - ▶ *We've been spending a lot of time exploring, thinking, and discussing. Now, this is your chance to do something really cool! You'll get to go slow, get distracted if you want, look at things, and get some quiet time. You will have a chance to move along the trail by yourself, following cards that I lay on the ground.*
3. Introduce rules and offer guidelines.
   - Spend time with each card.
   - ▶ *Think about each card or try to answer what's written on each card. If the card says to do something, do it! Don't worry. No one will be watching you.*
   - Keep your distance.
   - ▶ *It's not a race. In fact, it's the opposite. Moving through quickly makes it difficult to get the full benefit of the experience. Don't move on to the next card if you can see the person in front of you. If you do get close enough to see the person in front of you, don't wait impatiently. Follow their lead by slowing down. Give them space and pause and check out what is around you while you wait for them to move on.*
   - This is a silent activity.
   - ▶ *There are times when we've been exploring and sharing ideas with one another, and we can do that more later. But for this activity, we're going to be quiet. Experiencing nature without human voices or interaction can be magical and really fun! Please respect others' experiences by staying quiet.*
   - Look around and allow yourself to get distracted.
   - ▶ *If you keep your senses open, there's no telling what you'll notice. Take in what's around you, or get down low to check out small things.*
   - Safety protocols. Tell students to follow the cards, stay on the trail, and to leave cards as they found them. Explain your site's protocol for what students should do if they need help, end up on the wrong trail, or off trail altogether.

Setting Up the Card Hike

1. Set clear expectations for adults staying behind: Set up a simple, quiet activity; after 10 minutes, send each student 2 minutes apart; then go last on the trail, picking up the cards and gear.
2. [Optional] If students will be using journals for an activity before or after the Card Hike, share a suggested way for carrying them.
3. Start hiking and set out cards.

Students Follow the Card Hike

1. Students follow card.
2. As students finish the Card Hike, invite them to do an end-of-hike activity.

Reflecting and Wrapping Up

1. Invite students to *Thought Swap* (formerly known as *Walk & Talk*) or *Think-Pair-Share* about the questions below.
   - ▶ *What was your experience like?*
   - ▶ *What surprised you on this hike?*
   - ▶ *What was a favorite card or memorable moment?*
2. [Optional] Use the Dominoes Discussion Routine.

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