Garden Pollinators

Third Grade Science Exploration

Examining the diversity of pollinators in the garden and their role in the ecosystem provides an excellent opportunity for students to learn about the mechanisms of adaptation.

Cultivating children's love of learning, healthy food, and nature through garden-based education.

LIFE LAB

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Garden Pollinators
Third Grade Science Exploration
Life Lab Science Program

Contents

Teacher Introduction

Any child who visits a garden will quickly discover that plants and animals there have special characteristics which distinguish them. Some of these features directly improve the organism's ability to survive. These features are examples of adaptations. Adaptations develop over time—sometimes millions of years—through a process of natural selection. Each individual of a species has slight differences from others in the same species. Some of these differences may increase an individual's chance to survive and reproduce in its environment. Those that survive sometimes pass on to their offspring the traits that enabled them to do well in their environment. Thus, generation after generation, characteristics that enhance survival become more common. In this way, the individuals that are better suited to an environment are "selected" and continue to change. Those less suited die out.

The relationships between plants and their pollinators give students an exciting opportunity to learn about adaptations in the garden. During this unit, students will learn to observe closely and ask questions. They will dissect flowers to understand how flowers have adapted to pollination by living and non-living forces. They will observe plant/animal interactions first hand, and compare their observations to what they have learned about pollination strategies. Finally, they will go on an adaptation scavenger hunt to find other examples of adaptations in the garden.

Science Standards

The California Science Standards listed below will be addressed during the Garden Pollinators Science Investigation:

Life Sciences:

3. Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

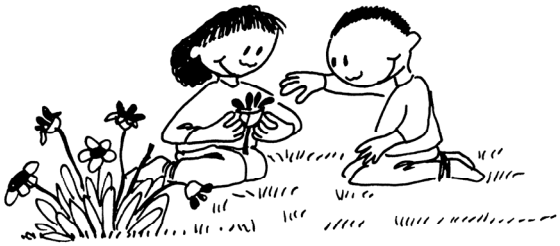
a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

d. Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

e. Students know that some kinds of organisms that once lived on Earth have completely disappeared and that some of those resembled others that are alive today.



Science Standards, continued

INVESTIGATION AND EXPERIMENTATION:
5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
b. Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
c. Use numerical data in describing and comparing objects, events, and measurements.
d. Predict the outcome of a simple investigation and compare the result with the prediction.
e. Collect data in an investigation and analyze those data to develop a logical conclusion.

Resources

Story Books

The Magic School Bus: Inside a Beehive. By Joanna Cole. Scholastic Press, 1998.

An Extraordinary Life: The Story of a Monarch Butterfly. By Laurence Pringle. Orchard Books, 1997.

The Hungry Hummingbird. By April Pulley Sayre. Millbrook Press, 2001.

Even more story books are found here:

The Good Kids' Book List, compiled by the The Junior Master Gardener Program and the American Horticultural Society, includes the top children's garden books of the last 100 years.

www.cfaitc.org/books/ California Foundation for Ag in the Classroom offers an extensive list of garden and nature based books for all grade levels.

Garden Songs

The Banana Slug String Band has an extensive collection of environmental ed and garden-themed songs, including one of our favorites, "Roots, Stems, Leaves." Find more at http://bananaslugs.bandcamp.com/album/singing-in-our-garden.

Hear Life Lab Staff singing garden related songs at our YouTube channel: http://www.youtube.com/lifelabvideos.

Master List For Garden Pollinators

What Do You Know About Adaptations?

- Copies of lab sheet: What do you Know About Adaptations?
- Chart paper labeled Adaptations

Sharp Eyes

- None

Birds and Bees

- Laminated Pollinator Cards
- Laminated Flower Cards
- Field Logs
- Field Guides to insects and birds
- Hand lenses

Flowery Investigations

For each group of 4:

- Plastic knife
- Tweezers
- Magnifying lens
- A variety of large flowers from the garden (one per student or one per pair)
- Glue or tape
- Cotton swabs

Adaptation Station

- Scavenger Hunt Cards
- Field Logs

Creature Features

For each student:

- 1 sheet of white paper, folded in thirds, accordion style (see drawing)
- Colored pencils or crayons
- Writing paper

What Do You Know About Adaptations?

(Pre-Assessment Activity)

Description

In this pre-assessment activity, students learn the meaning of the word adaptation and see how a human adaptation helps them survive.

Objective

To experience first hand the benefits of a certain adaptation.

Teacher Background

Adaptations are characteristics that help living things survive in their habitat. On a visit to the garden, the students can observe many adaptations which help plants and animals survive, such as a plant with thorns to avoid being eaten, or a gopher's strong front paws to tunnel in the soil. In this activity, students discover an adaptation of their own by comparing their ability to carry out simple tasks with and without opposable thumbs.

Materials

- Copies of lab sheet: What do you Know About Adaptations?
- Chart paper labeled Adaptations
- Stopwatches or a wall clock, visible to all students

Class Discussion

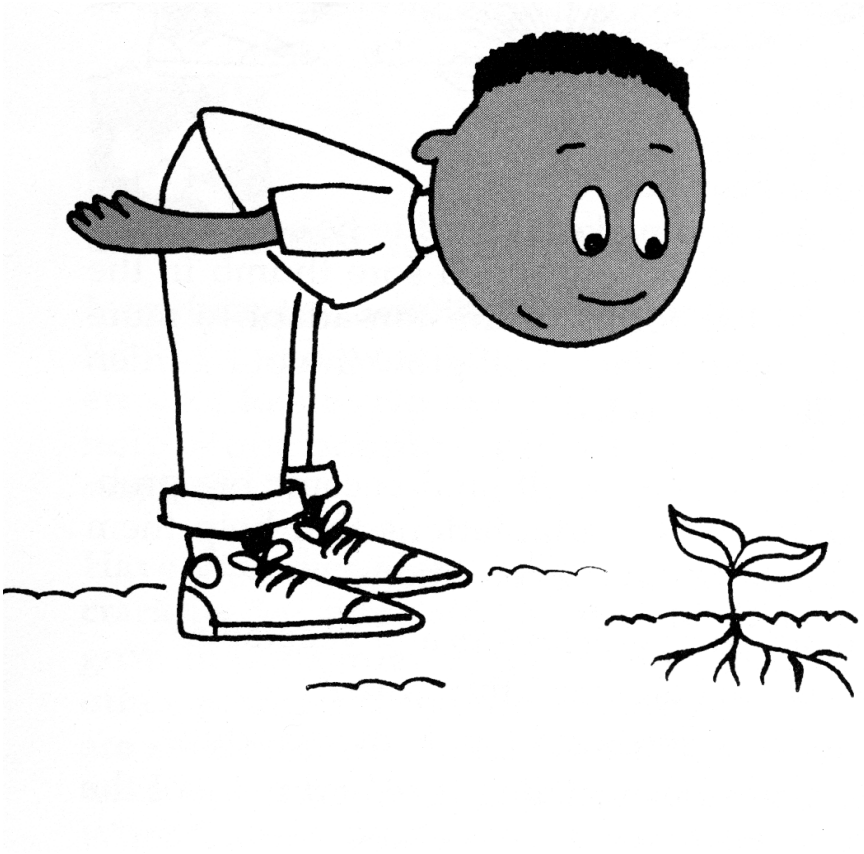
Discuss the meaning of the word adaptation. *Can anyone think of an adaptation that plants have to help them survive? How about animals? How about humans?* Invite students to take turns sharing their ideas. Record ideas on the chart labeled Adaptations.

Action

Divide students in to pairs. Distribute lab sheets to each student. Ask each pair to take turns doing the three tasks on the lab sheet while timing themselves with the classroom clock. Have them record their times on the lab sheet. Then have them repeat the tasks with their thumbs tightly pressed against their hands, and again record their times. Have them complete the lab sheet.

Wrap Up

How do our thumbs help us in daily life? What would we have to do differently if we didn't have thumbs? What other adaptations do we have as humans?



Sharp Eyes

Description

Students practice using their eyes as information gathering tools.

Objective

To develop the skill of observation.

Teacher Background

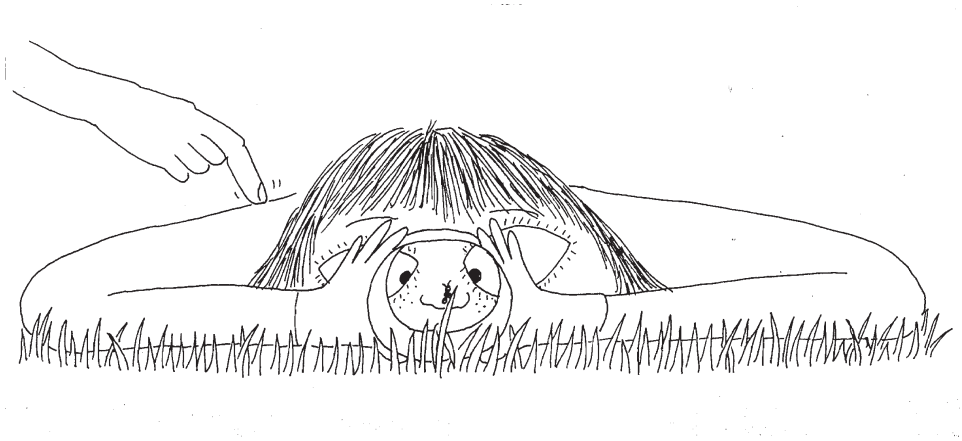
Students need regular practice in developing their ability to observe details in the world around them. Throughout their nature explorations they will need to focus on small details, such as the veins in a leaf or an insect in a flower. Often these small details can escape people's notice unless they are trained to look closely. In this activity students practice detailed observation.

Materials

- None

Class Discussion

As you explore the garden, you will be asked to pay attention to everything you see. Your eyes are your best tools for observation. *What do you observe about (choose a plant in the garden) this plant?*



Action

1. Have students form two lines facing each other. Each student should be standing directly opposite another.
2. Give the pairs time to carefully observe each other, noting color of clothing, rings, watches, buttons, etc.
3. After they have had sufficient time to observe, have students turn away from each other and change 3 things about their appearance, such as unbuttoning a button, untying a shoe, or moving a ring to another finger. Emphasize subtlety.
4. Have students face each other again, and take turns figuring out what the other person changed.

Wrap Up

Discuss the importance of observing. *How good were you at detecting the changes your partner made? How will this exercise help you in the garden?*

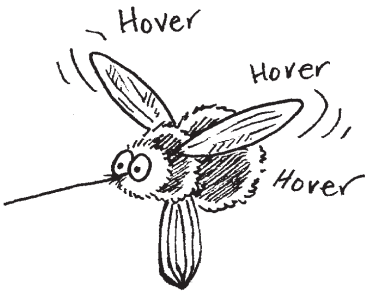
Birds and Bees

Description

Students match flowers to the kinds of pollinators they attract and then observe different shaped flowers in the garden and the animals that visit them.

Objective

To observe how flowers and their pollinators have adapted to meet each other's needs.



Teacher Background

Can you guess how many trips bees have to make to gather enough honey to fill a 12 oz. jar? It takes 80,000 trips, or a journey equivalent to going around the world twice! Bees travel incredible distances to and from flowers to obtain food and produce honey for their young, and in so doing, they unintentionally pollinate specific flowers as well.

Over millions of years, flowers have developed scents, colors, markings and shapes to attract certain pollinators, and certain pollinators have developed characteristics such as long tongues or beaks that enable them to reach the nectar in different shaped flowers. Today there are flowers that attract butterflies and moths, hummingbirds, beetles, flies and even bats.

A flower's shape, size, color and fragrance will determine what kind of animal will pollinate it. Although many flowers attract a variety of pollinators, some are very specialized and depend on certain types of birds, bats or insects. Conversely, some animals depend on certain flowers for food. Some flowers which are very nondescript are pollinated by wind or water.

Materials

- Laminated Pollinator Cards
- Laminated Flower Cards
- Field Guides to insects and birds
- Hand lenses
- Field Logs

Class Discussion

What does pollination mean? (The fertilization process of a plant which leads to production of fruit and seed). How do you think most plants are pollinated? (Most are pollinated by a variety of animal visitors, some are pollinated by wind and water.) How do you think flowers attract animal pollinators? What do the animals get out of the deal? (Nectar, pollen) What do the plants get? (Pollen from other flowers).

Action

1. Divide students into smaller groups of 2-4 students. Give each group one of the laminated Pollinator Cards.

2. Ask one person in each group to read their card aloud, and discuss what kind of flowers the pollinator(s) on the card are likely to go to.

3. Bring the smaller groups back together. Have one person from each small group share the information on their card with the larger group.

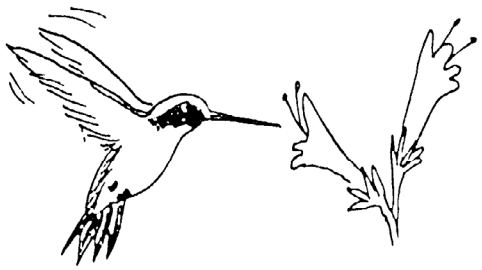
4. Hold up the laminated flower cards one at a time and ask the group to predict who or what pollinates it. Remember that there is not always one correct answer. Flowers often have a variety of different pollinators. Some flowers are pollinated by both wind and visiting animals. Help them refer to the pollinator cards to find a possible answer.

5. Distribute hand lenses and in small groups ask the students to examine flowers in the garden classroom and predict what kind of pollinators they might attract. In doing so they should look carefully at each flower for color, markings, small hairs, hidden nectar tubes, etc. They should also use their sense of smell and note if the flower is upright or hanging down. Have them draw at least one of the flowers in their Field Log, and record their predictions about what pollinates it.

6. Ask students to watch one of the flowers they observed for a few minutes to see if any pollinators visit it. Were they correct?

Wrap Up

Discuss interactions with the students. *What interactions did you see between the flowers and their pollinators? How do you think flowers and pollinators became adapted to help each other? What might happen if a plant had only one type of pollinator, and that species went extinct? What would happen to an animal that depended on one flower for its source of nectar or pollen, if that plant disappeared? What can we do to encourage more pollinators in our area?*



Flowery Investigations

Description

Students dissect a flower and learn about flower structure.

Objective

Students learn about the role of flowers in plant reproduction.

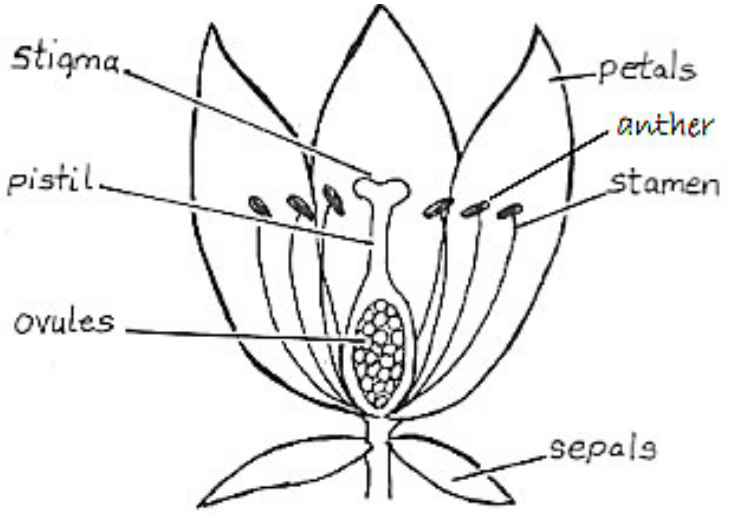


Diagram of a Simple Flower

Teacher Background

We are attracted to flowers because we enjoy their beautiful fragrance and bright colors. In the natural world, though, flower scents and hues help attract animals for a very specific purpose. Insects, birds and other animals are attracted to feasts of nectar and pollen, and as they dine they assist plants with reproduction.

Watch carefully as a bee visits a flower. As it gathers food to take back to the hive, the bee brushes against the stamens, the male structures. At the tips of the stamens are the anthers, where pollen is produced. For reproduction to take place, the pollen must land on the flower's female structure, the stigma of the pistil. As the bee visits a flower, pollen catches on the tiny hairs covering its body. At the next flower, some of this pollen will rub onto the stigma of that flower. Soon after, the flower begins to produce seeds.

Materials

For each group of 4:

- Plastic knife
- Tweezers
- Magnifying lens
- Glue or tape
- Cotton swabs
- A variety of large flowers from the garden, one per student or one per pair (avoid daisy-like flowers because their parts are difficult to identify)
- Field Logs
- Microscope (optional)

Class Discussion

What are flowers? What does the plant need them for? Do you think flowers interact with other living things? How?

Action

1. Divide students into pairs or groups of four. Give each group a flower to dissect.

2. Have each group explore the flower before they begin to dissect it. How many parts do they see? Have them use the hand lens to magnify parts, and the cotton swab to see if parts rub off. (A microscope is great for looking at different colors and shapes of pollen. Shake or rub the pollen on black paper first.)

3. Have each group draw a picture of their flower in their Field Log.

4. As they carefully take apart the flower, students may glue or tape each part in the field log.

5. Encourage students to talk in their groups about how each part might help the flower, and to write down their ideas in the Field Log. Students may give each part their own descriptive name. For example, sepals might be called Outer Green Covers.

6. Have students look for depressions at the base of the petals that are filled with a sugary solution called nectar.

7. If students have different types of flowers, ask them to compare parts for similarities and differences.

8. When students finish their dissection, show them the drawings of the flowers. Tell students the names that botanists use for various parts. Explain how the names come from words that describe what the part looks like or does, similar to the ones they made up.

Wrap Up

Ask students the following questions to help them relate the flower parts to what they know about pollination. *What parts did you find in your flower? Did you find anything resembling seeds or eggs? Are all flowers the same in certain ways? How are they different? What do flowers do for the plant? What is pollination? Which plant parts are involved in pollination? If a bee helps pollinate a plant, does it help the bee or the flower?*

Adaptation Station

Description

Students go on a scavenger hunt in the garden to find plant and animal adaptations.

Objective

To observe how adaptations help animals and plants survive in their habitats.

Teacher Background

The garden provides a natural laboratory for studying plant and animal adaptations. Besides pollination adaptations, there are many other adaptations that are easy to observe in the garden. Plants compete with others for space, they grow spines to keep from being eaten, they grow tiny leaves to conserve against water loss, or grow giant leaves to reach the sun. Some have developed amazing methods of seed dispersal such as clinging to animal fur or parachuting away from the plant. Others have developed tendrils for gripping so that they can climb upward, sometimes right over other plants.

Animals in the garden have developed many adaptations to eat and avoid being eaten, and others for finding shelter, for locomotion, and for attracting mates. Some are swift footed to escape predators, while others burrow into the ground to hide. Still others have developed camouflage to avoid being seen. They may have strong jaws to crack nuts, or poison to kill prey. Birds can have pointy beaks to drill into trees, or cone shaped-beaks to break open seeds.

Materials

- Scavenger Hunt Cards
- Field Logs

Class Discussion

Look at one plant together; a thorny rose or a succulent are good options. Brainstorm a list of things this plant needs to survive (nutrients, sunlight, water, protection from pests). Define adaptation for students as any behavior or physical feature that helps a living thing survive in its habitat or home.

Action

1. Divide students into groups of 3-4 people.

2. Distribute one scavenger hunt card to each group.

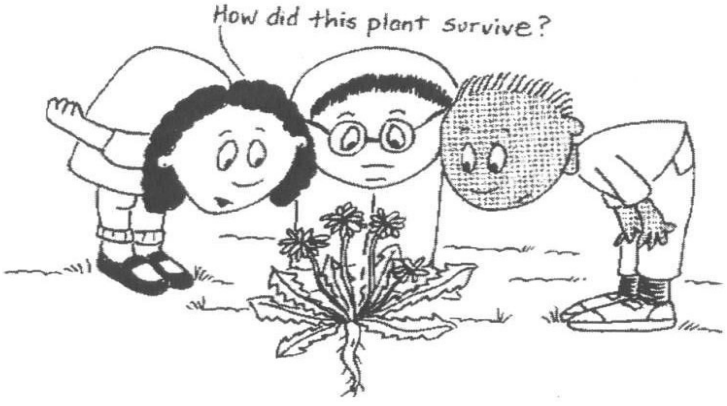
3. Tell the students that they may go anywhere in the garden (give them boundaries) to find the items on their cards. Remind them that this is not a race, and that the goal is for each group to find everything on their card. Ask them to share ideas for how their group can work together. When they find one of the animals or plants on their list, they should note the name of it or write a description of it in their Field Logs.

4. Give the groups a time limit and send them on their way. Monitor groups to see how they're doing, and give them hints if they are having trouble finding an answer.

5. Bring the groups back together and have each group share their list and what they found.

Wrap Up

Discuss adaptations with the students. *Was it easy to find plants or animals that had the adaptations you were looking for? What are some ways animals and plants work together in a garden? How do adaptations help them survive? What adaptations do people have for surviving? How do we interact with plants? Animals?*



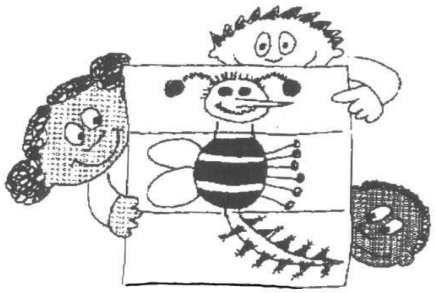
Creature Features

Description

Students invent a new kind of animal with adaptations to live in an imaginary environment.

Objective

To use what they have learned about adaptations to create a new being.



Materials

For each student:

- 1 sheet of white paper, folded in thirds, accordion style (see di
- Colored pencils or crayons
- Writing paper

Class Discussion

What are some of the adaptations you observed in the garden? How did those adaptations help the plants and animals to survive?

Action

1. Divide the class into groups of 3 students.

2. Explain to the students that they are going to be creating new kinds of creatures, adapted for life in a specific environment. In their minds they should think about what their animal eats, how it protects itself, gets around, avoids being eaten, etc. Give them a minute to think about what adaptations their creature will have.

3.Distribute a folded piece of paper to each student.

4. Each child should begin at the first fold of the paper for being adopted to a specific environment. They will draw the head (heads?) of their creature including all the features a head might have. They can ONLY use the first third of the paper. They should end their head and make marks to show the neck going slightly over onto the next third. Then they should fold their head drawing under, and pass the drawing clockwise to the next student.

5. Now without looking, each student should draw the body of their creature, including legs, wings, fins, scales, fur—whatever features the creature has. Again they should extend the body slightly into the next segment, fold the section under, and pass it on.

6. On the last third, the students should draw the tail part of the creature. This might include stingers, fins, more scales or fur, feathers etc.

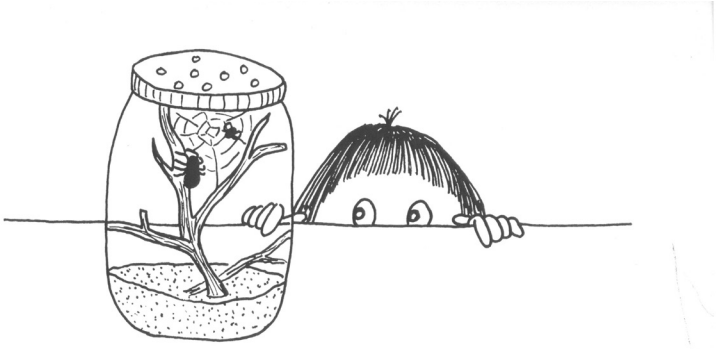
7. Have the students pass the completed drawing back to the person who began it. Each student should have a creature drawing to open.

8. Ask the children to study the new creature and examine its adaptations. *What environment is it suited for? How will it survive?* Students can write a paragraph describing the natural history of the new creature, and give it a name.

Collate the drawings and descriptions together into a book for the class library.

Wrap Up

For the teacher:
How do the drawings reflect what the class knows about adaptations? Return to the Adaptations list and add any new ideas the class suggests. Review the Science Standards in the Introduction to Garden Pollinators. *Are there any of the standards that they do not understand? What questions do they still have? What ideas do they have for investigating further?*



Reading about Adaptations

(Post-Assessment Activity)

Description

Students reflect on group readings about adaptations in this post-assessment activity.

Objective

To further discuss student's ideas about adaptations.

Teacher Background

After their visit to the garden, your students should have a lot of new ideas about adaptations, and probably some new questions too. The attached readings will give them further insight into examples of adaptations in the world. You may want to take several days to complete this activity, choosing one reading for each day. Or, you can have small groups read different activities and share what they learned with the whole class.

Materials

- Adaptation chart from "What Do You Know About Adaptations?" lesson activity
- Copies of attached Life Lab readings, either one per student or one per small group.
- Field Logs

Action

1. Have the students read the selected readings as a group, individually, or you can read them aloud.

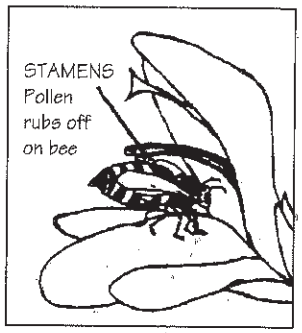
2. Allow them some time to reflect on the readings in their Field Logs. *What do they wonder about how adaptations work? What examples of adaptations did they see in the garden?*

3. Ask students to share their ideas aloud, and add both ideas and questions to the Adaptations chart.

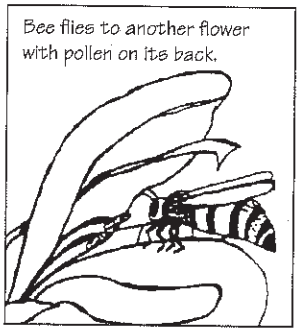
Wrap Up

For the teacher:
What have your students learned about adaptations? What do they still want to find out? How can the class pursue these questions?

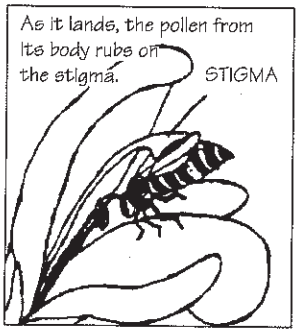
AMAZING ADAPTATIONS
Pollination Partnerships



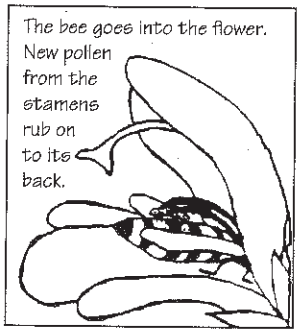
Buzzz. Coming in for a landing! Bright markings on the flower petal guide Mrs. Bee to a landing. She follows the petals' markings toward the sweet nectar pool deep inside the flower. To get there, she has to squeeze past pollen-covered blobs.



Whap! She's bopped on the head by a blob of pollen. She drinks up some nectar and backs out of the flower. Dusted with golden pollen grains, she flies to the next flower. As she works her way into the second flower, pollen from the first flower pollinates the second one. The pollination partnership has paid off!



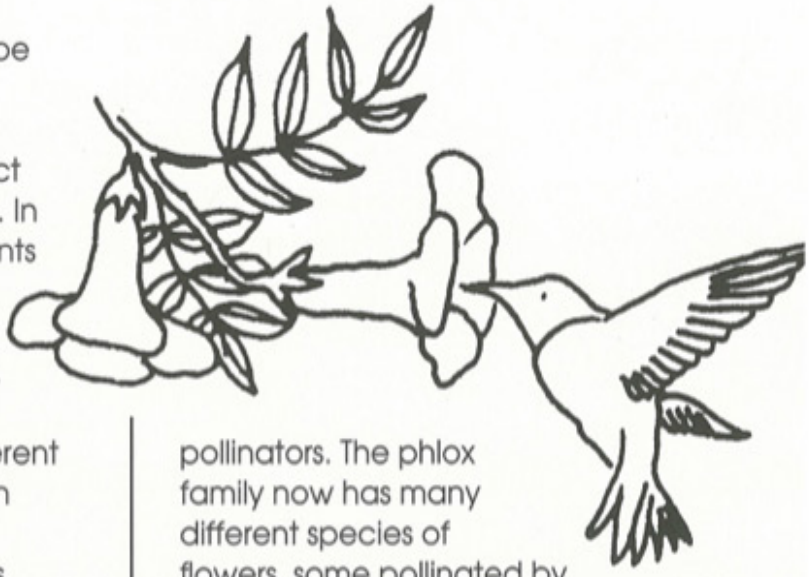
All flowering plants need to be pollinated before they can make seeds. Each flower makes its own pollen. But most flowers need pollen from another flower of its own type to actually be pollinated. (That's where the bees and other pollinators come in.) Look at a flower and you might only notice its bright petals or flashy sepals. But these are just the advertisements that attract the pollinators. The key parts for reproduction are the less flashy stamens and pistils.



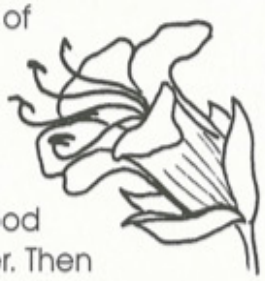
The wind was the first pollinator of ancient plants. It is still the main pollinator for many grasses, trees, and crops like corn. You may not think of these plants as having flowers, but look again! Think of the tassels on corn plants. These flowers are tiny and plain because they don't need to attract animal pollinators. Wind-pollinated plants make huge amounts of pollen to ensure that they get pollinated. At certain times of the year, the air is loaded with pollen from trees and grasses—just ask anyone who gets hay fever!

The first fossils of flowering plants date back to around 136 million years ago. Millions of years of evolution have formed some amazing pollination partnerships between certain flowering plants and the animals that pollinate them. Think about what a variety of flowers there are. Some are flashy and bright, some have fancy shapes, some

are simple but good smelling. Each type of flower attracts a certain kind of pollinator. Flowers vary because they have adapted to attract different pollinators. In fact, flowering plants and their pollinators evolved together, or *co-evolved.*



For millions of years, different animals have gotten food from certain flowers and, in return, have done the service of pollinating them. The flowers, meanwhile, adapted forms, colors, shapes, and smells to attract and feed only their most reliable pollinators. Neither the flower nor the pollinator made any of these adaptations on purpose, of course. A flower became more suited for a particular pollinator. The pollinator became more suited for getting food from that particular flower. Then both the flower and the pollinator passed these traits on to their next generations. This is how the pollination partnerships co-evolved by tiny steps over millions of years.



A great example of how pollinators and flowers co-evolved can be seen in the phlox flower family. Millions of years ago there was only a simple phlox flower that was pollinated by bees. Flowers that attract bees often smell sweet and can be purple, blue, yellow, or white (bees can't see red!). Some "bee" flowers have colored markings that guide bees to the nectar and pollen.

Over millions of years, different variations of this simple phlox flower evolved that attracted other pollinators. The phlox family now has many different species of flowers, some pollinated by moths and butterflies, some by hummingbirds, some by flies, some by beetles, and some even by bats.

The phlox family's "moth" flower is long and thin with the nectar hidden deep inside it. Moths have long tongues to reach nectar at the base of tubes. The moth flowers open at night when the moths are active. Their sweet smell and light color allow moths to find them in the dark.

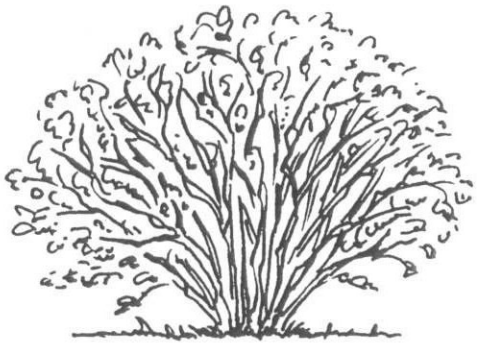
Some of the phlox family flowers have evolved into a tube shape suitable for hummingbird pollination. "Hummingbird" flowers don't need to smell good because hummingbirds have a poor sense of smell. These flowers are often bright red or orange (remember, bees can't see red!). In Europe, where there aren't any hummingbirds, there also aren't any native orange or red tube-shaped flowers!

AMAZING ADAPTATIONS

Plant Invaders from Foreign Lands

Sometimes the amazing adaptations of one species can mean trouble for other species. The tamarisk is a large, wispy bush that has become a problem in wetland habitats around the country. The problem is that the tamarisk is so well adapted for survival that it's taking over!

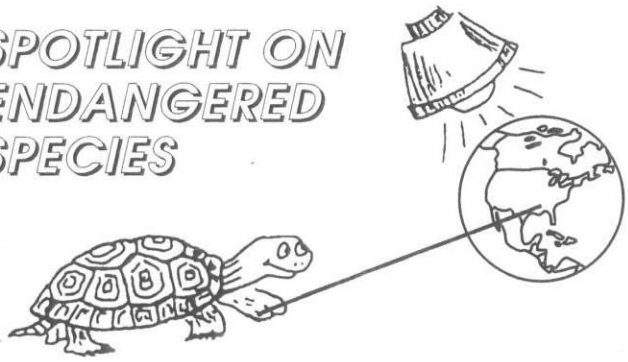
Originally from eastern Asia and countries near the Mediterranean Sea, the tamarisk is well adapted to dry climates. One of the tamarisk's adaptations is its amazing root system. When the Suez Canal was dug just north of Egypt, tamarisk roots were discovered some 30 meters (99 feet) down. These deep roots can tap into ground water sources. This allows the tamarisk to survive through times of drought. The tamarisk also has a thick mat of shallow roots that drink up huge amounts of rain water. These water guzzlers can use up to 50 liters (13 gallons) of water a day.



Tamarisk was brought to this country in the 1800s by settlers who wanted to use these hardy plants as windbreaks for their farm fields. But its special adaptations have helped it spread rapidly into wild areas. This plant invader has moved into many river ecosystems and other wetland areas around the western United States The tamarisk has even adapted to life in saltwater marshes. Salt glands on the leaves of the plant allow it to remove salt from the water it takes in.

In parts of Death Valley, the tamarisk has sucked up so much water that it affects the wildlife that lives there. At Eagle Borax Springs, for example, the tamarisk had dried up the habitat so much that migratory water birds no longer stopped there to rest and feed. The National Park Service spent 10 years and a lot of money to remove the tamarisk. Now that the tamarisk is gone, migratory water birds have returned to the Eagle Borax Springs habitat.

SPOTLIGHT ON ENDANGERED SPECIES



The Bug Juice Trap

Bug juice for dinner? That's what the green pitcher plant makes when it lures a bug into its liquid trap. These plants can actually digest animals inside their strange hollow leaves. In a few months, one leaf may trap thousands of insects and even an occasional scorpion or lizard!

Here's how the bug juice trap works. Ants and other insects come to the pitcher

plant to dine on its sweet nectar. As the insect tries to get the nectar, it slips down into the waiting pool of meat-digesting liquid. Now trapped, the insect dies and is soon turned into bug juice to feed the pitcher plant.

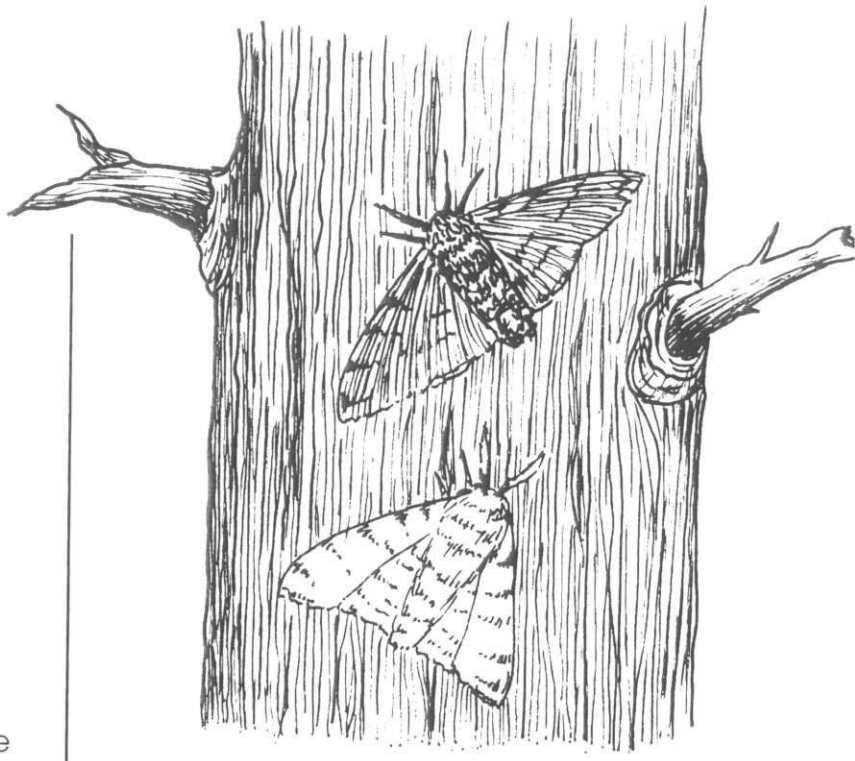
The odd meat-eating ways of the pitcher plant are actually a special adaptation to its habitat. The green pitcher plant lives in the wetlands of Alabama, Georgia, and Tennessee. These wetlands have poor soil that doesn't contain very many nutrients. The bug juice trap is an adaptation that allows the pitcher plant to get extra nutrients. This adaptation was needed for the plant to survive in its wetland habitat.

Today, due to changes in the wetlands, the green pitcher plant is an endangered species. Water has been drained from some wetlands so that the land can be used for farming, homes, or industry. Other wetlands are harmed by water pollution. As the wetlands go, fewer and fewer pitcher plants can be found. Because these plants are so specifically adapted to a wetland habitat, they can't grow just anywhere. Biologists say that in order to save the green pitcher plant, the wetlands must be preserved. Today, people in Alabama are working to maintain the wetlands and keep them from becoming polluted.

TIME MACHINE
The Peppered Moth Story

Most species of animals and plants change so slowly that new adaptations are rarely seen in a human's lifetime. Some species have gone unchanged for thousands of years. But in the case of the English peppered moth, change came quickly.

Let's zip back to England in the early 1800s to find out more about the peppered moth.



We'll look for the moths in this stand of trees. Can you see them against the light-colored tree trunk? These light-gray, speckled moths are well camouflaged against the tree trunk. They look much like the lichen—the gray and white plant-like organism, which is actually a combination of an algae and a fungus living together—growing on the trees. There are dozens of moths on these trees. But I'll bet you that the birds will still have a hard time finding one for lunch.

But look! There's one dark-colored moth on the tree. This moth's dark coloring is the result of a mutation. A mutation occurs when an individual is born slightly different than other members of its species. Against light tree-trunks, the black moth sticks out like a sore thumb. It won't be long before a bird gobbles it up.

Let's zip ahead in time to the turn of the century. In the late 1800s, more and more factories were built around England. The soft coal they burned caused the air to become heavily polluted. The sooty pollution killed the lichen on the trees and darkened the countryside.

We've returned to the same stand of trees, but now they are dark. And guess what! Now the moths are mostly dark, too! What happened? The moths adapted to their changed environment. Once the trees darkened, the dark-colored moths survived long enough to lay eggs and produce more dark-colored moths. Against the darkened tree trunks, the dark moths are now the hard ones to find. Look, here comes a bird. It's found a light moth and snatched it up for lunch.

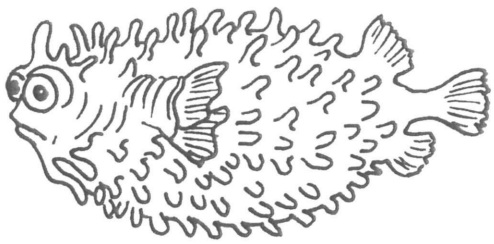
Let's zip forward again to present day England. English factories now burn cleaner fuels. The lichen has grown back on trees and rocks around the countryside. Now the moths have adapted again to a changing environment. Can you guess what color most of the moths are now?

VOYAGE OF THE HMS BEAGLE

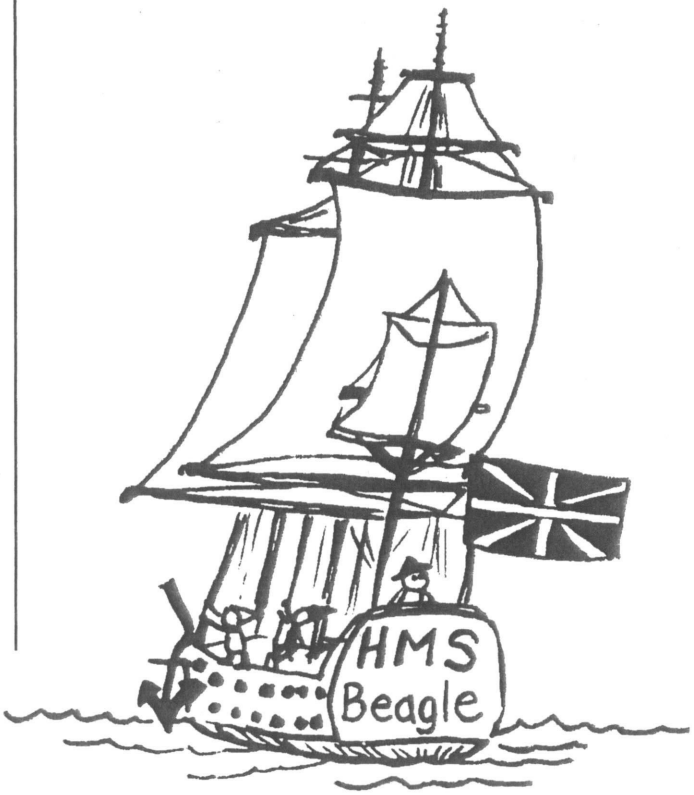
Darwin's Geography Riddle #2

On February 28, 1832, Darwin's ship, the HMS *Beagle,* landed on the coast of a major continent. Darwin explored the warm sea waters along the shore. There he discovered a bridled burrfish. It could puff itself up like a balloon by taking in air and water. In this balloon shape, the bumps on its skin would stiffen into sharp prickles. It also defended itself by squirting out a dark red stain. If that wasn't enough protection, it had very sharp teeth that it could use to bite its way out of the stomach of a shark.

Darwin wondered why the bridled burrfish had so many strange features. He figured



that these features were adaptations that helped the fish survive in its environment. Other types of fish had evolved the ability to swim quickly away from predators. But the bridled burrfish had evolved several features that allowed it to fight back rather than flee.



A Habitat is Where...

What Do You Know About Adaptations?

Name(s) _____ Date _____

Adaptations are characteristics that help a plant or animal survive in its habitat. A skunk in danger protects itself from other animals by spraying a smelly perfume. A plant in a dry climate may grow long roots to reach deep moisture. These adaptations help both the skunk and plant survive.

1. Complete these familiar tasks while a partner times you.

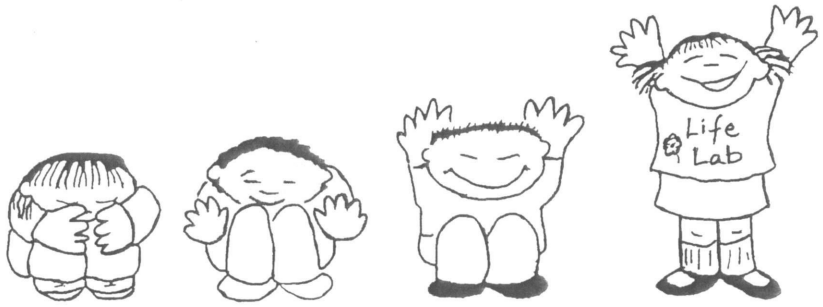
Task	Time
Write your full name 5 times.	
Unbutton and button 2 buttons on a shirt.	
Untie and tie your shoe laces.	

2. Look at your hands, palms up. Squeeze your thumb against the side of your index finger. Imagine that your thumb and finger have always been connected. They cannot be separated. Try the activities again.

Task with Thumb and Finger Together	Time
Write your full name 5 times.	
Unbutton and button 2 buttons on a shirt.	
Untie and tie your shoe laces.	

3. What did you notice when you weren't able to use your thumb?

_____



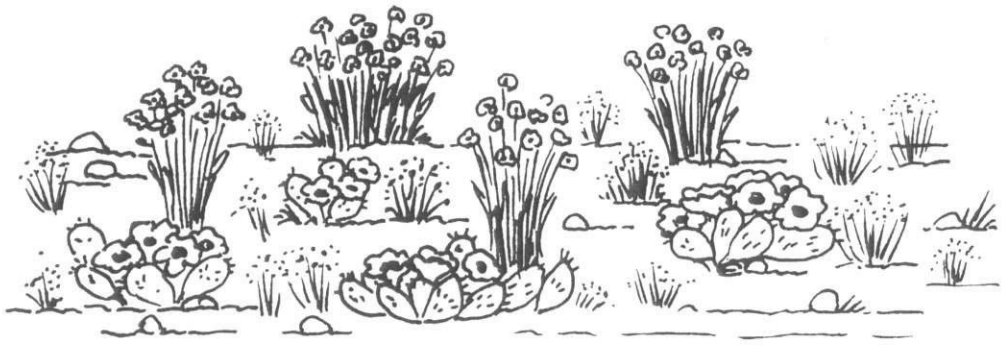
4. What would happen if you needed your thumbs to get food but you didn't have any, and others did?

_____

_____

5. Name three plants or animals and an adaptation that helps each one survive.

Plant or Animal	Adaptation	How Adaptation Helps Survival

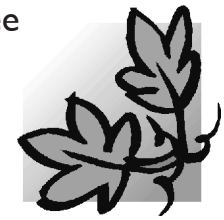


Scavenger Hunt Cards

Find an **animal** (or sign of an animal) that escapes being eaten by burrowing in the ground.

Find a **plant** that has developed tiny leaves to conserve water.

Find signs of an **animal** that drills in tree bark to find food.



Card #1

Find a **plant** that has spines to keep from being eaten.

Find a **plant** that can climb up another plant to reach the sun.

Find an **animal** that basks in the sun to keep warm.

Card #2

Find a non-human **animal** that uses its voice to communicate with others of its kind.

Find an **animal** that uses pollen from flowers for food.

Find a **plant** that is covered with tiny hairs to keep it from drying out.

Card #3

Find a **plant** that can grow with very little soil.

Find an **animal** that can eat your garbage.

Find an **animal** that uses bushes for protection.

Card #4

Find a **plant** with giant leaves to collect sunshine.

Find an **animal** that walks on two feet.

Find a **plant** adapted to live in water.

Card #5

Bee Trivia

1. How many flowers must honey bees tap to make one pound of honey?
Two million.

2. How far does a hive of bees fly to bring you one pound of honey?
Over 55,000 miles.

3. How much honey does the average worker honey bee make in her lifetime?
1/12 teaspoon.

4. How fast does a honey bee fly?
About 15 miles per hour.

5. How much honey would it take to fuel a bee's flight around the world?
About one ounce (or two tablespoons).

6. Why are honey bees sometimes called "white man's flies"?
North American natives called honey bees this because they were brought to North America by European colonists.

7. What is mead?
Honey wine.

8. How long have bees been producing honey from flowering plants?
10-20 million years.

9. How many sides does each honeycomb cell have?
Six.

10. What is the annual U.S. per capita consumption of honey?
1.1 pound.

11. What state is known as the beehive state?
Utah.

12. How many wings does a honey bee have?
Four.

13. How many beekeepers are there in the United States?
An estimated 211,600.

14. How many honey-producing colonies of bees are there in the United States?
The USDA estimates that there are approximately 3 million honey producing colonies in the United States. This estimate is based on beekeepers who manage five or more colonies.

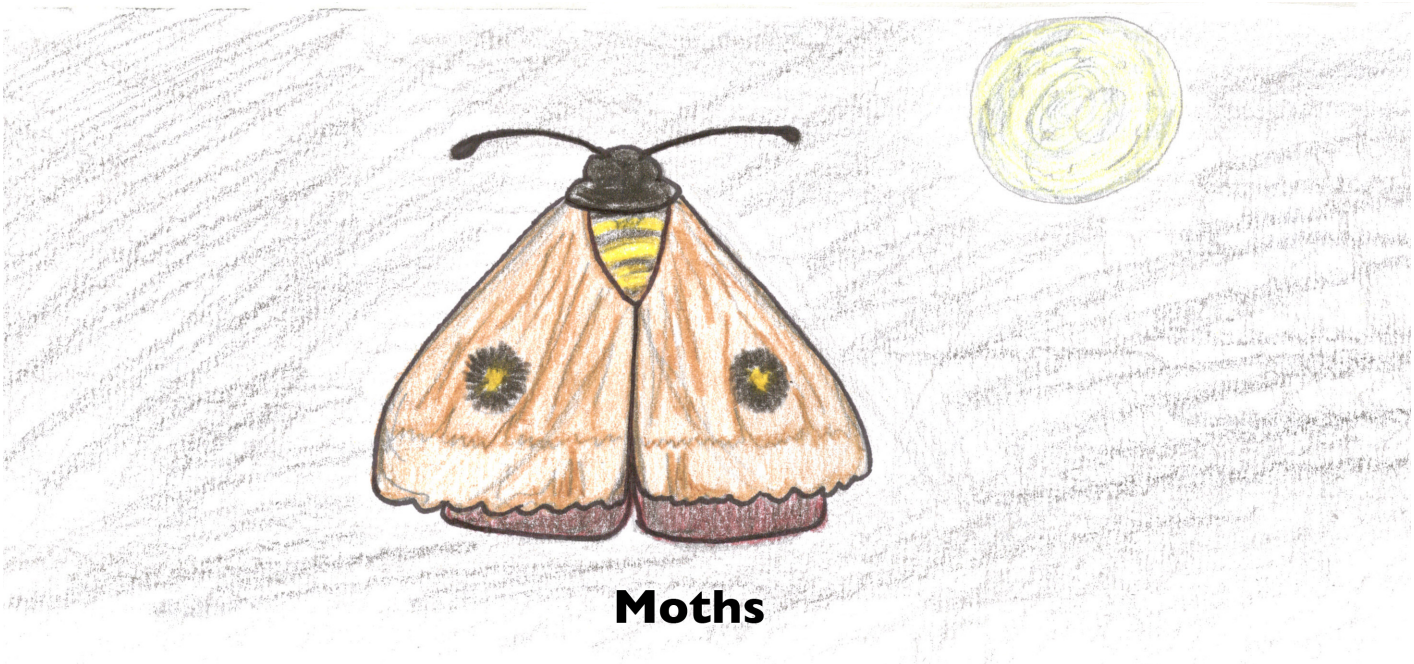
Bee Trivia (continued)

15. How many flowers does a honey bee visit during one collection trip?
50-100.

16. How do honey bees "communicate" with one another?
"Dancing." Honey bees do a dance which alerts other bees where nectar and pollen is located. The dance explains direction and distance. Bees also communicate with pheromones.

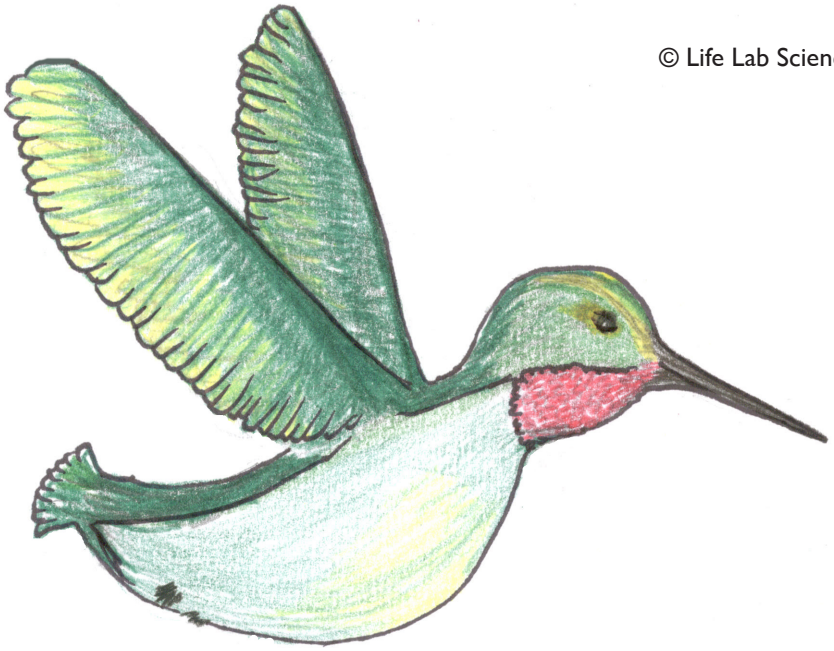
17. What does "super" mean to a beekeeper?
The super is the hive box in which honey is stored.

Pollinator Cards (for "Birds and Bees")



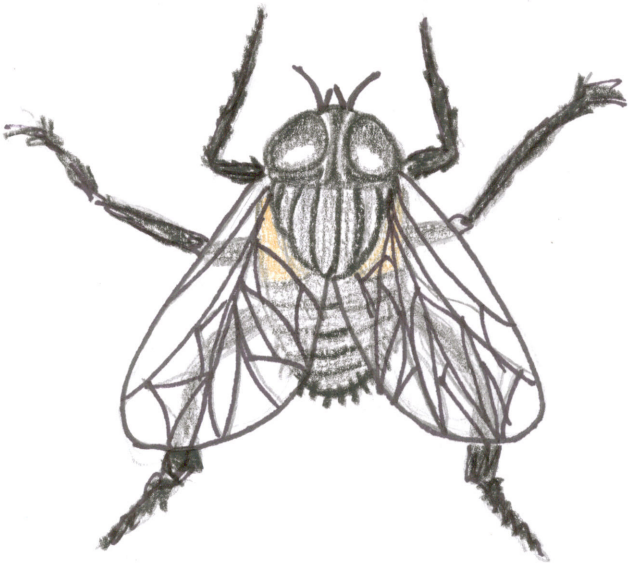
Moths

Moths pollinate sweet-smelling white or yellow flowers because these flowers are easy to find at night.



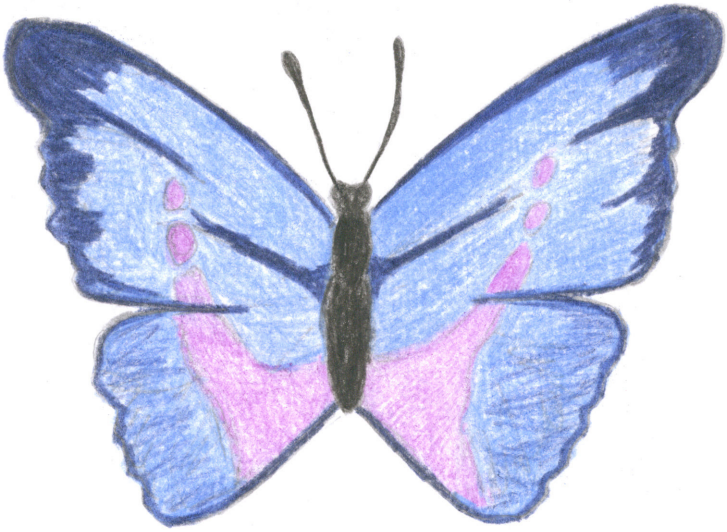
Birds

Birds, such as hummingbirds, pollinate flowers that are bright red or yellow, and that have a long tube-like shape. The flowers pollinated by birds also tend to have very little scent.



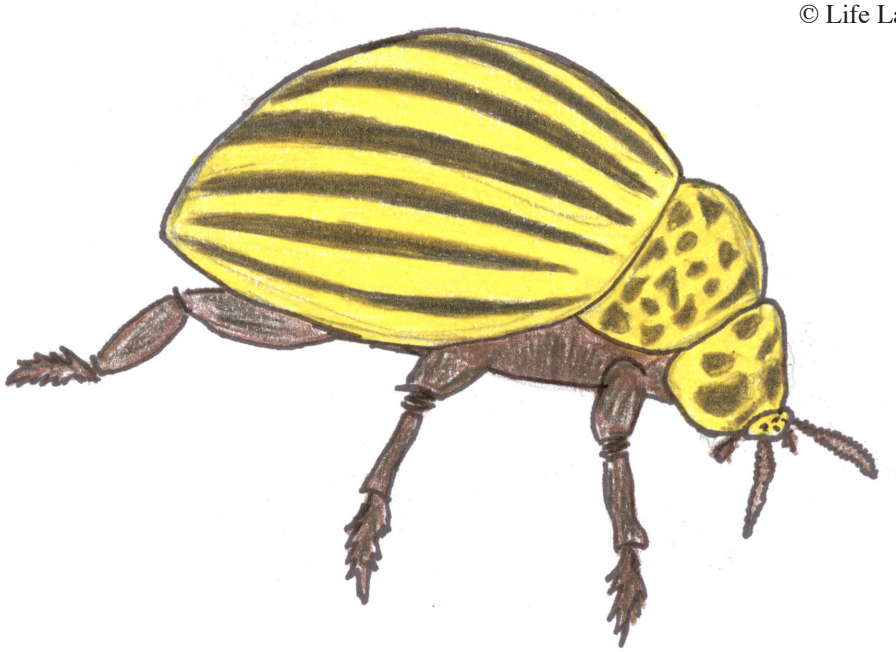
Flies

Flies pollinate reddish flowers that
smell like rotten meat.



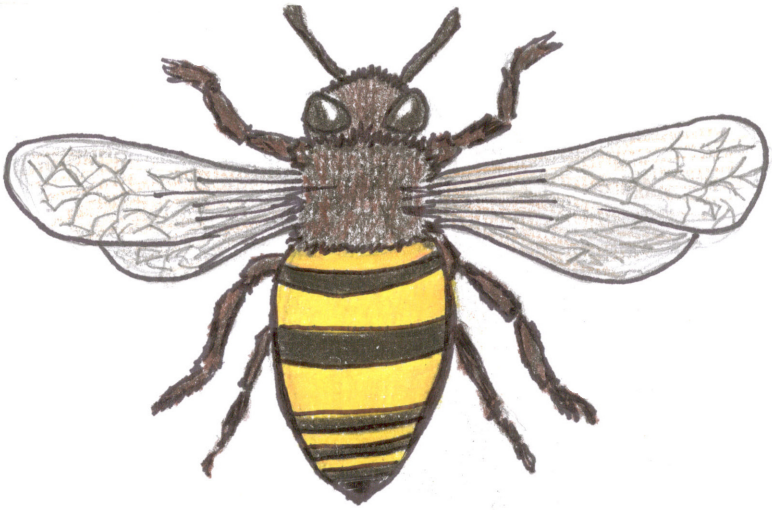
Butterflies

Butterflies pollinate bright-colored,
sweet-smelling flowers.



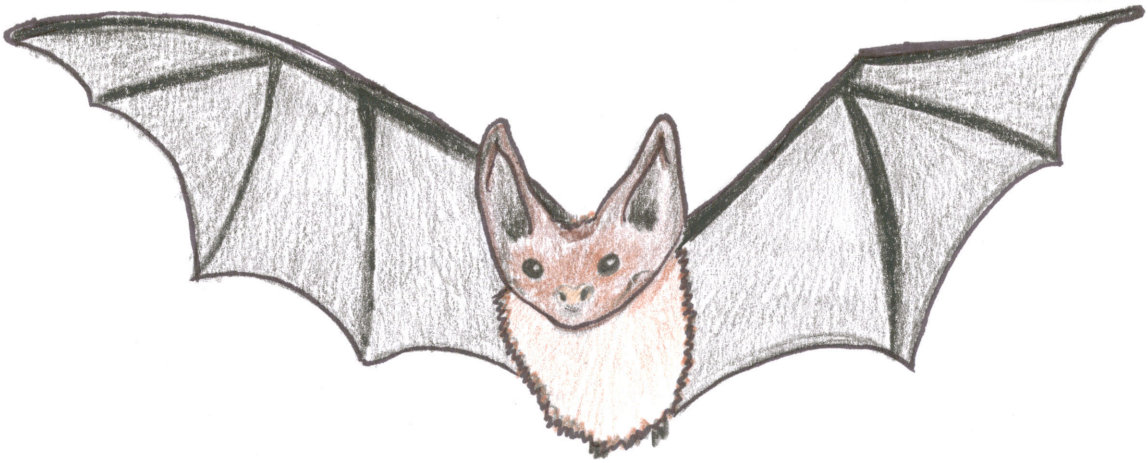
Beetles

Beetles pollinate small, white or light green flowers
that don't smell strongly and hang down near the ground.



Bees

Bees like to pollinate flowers that smell sweet
and are bright yellow or blue



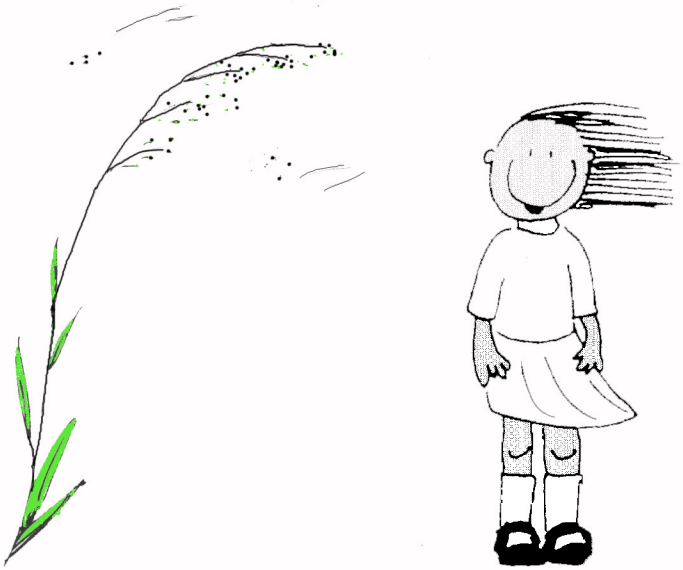
Bats

Bats pollinate large, sweet-smelling, white flowers that bloom at night. Bats pollinate many tropical and desert plants.

Wind and Water

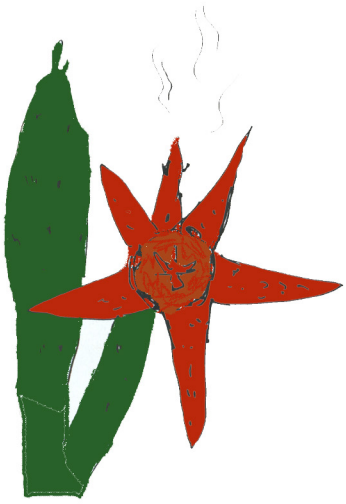
Wind and water pollinate too. Wind carries pollen through the air. Some plants like corn and wheat have special parts made for catching pollen in the air. Pollen can also float in water from one flower to another.

Flower Cards (for "Birds and Bees")

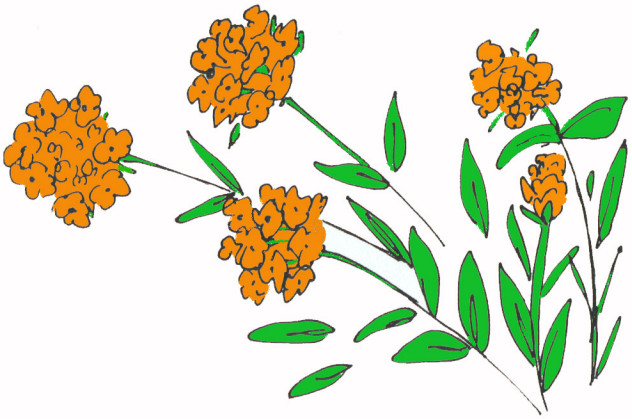


These flowers are tiny and have no smell.

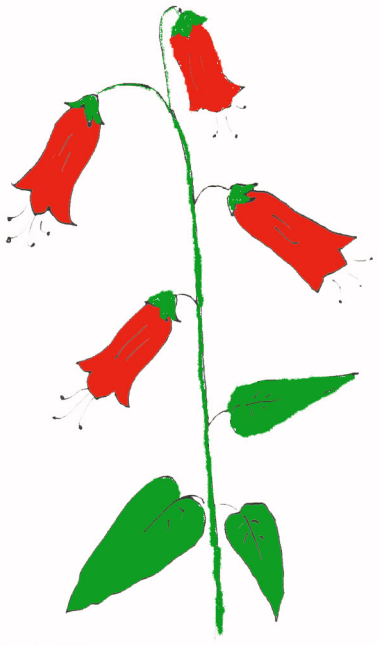
These white flowers bloom at night
and smell sweet.



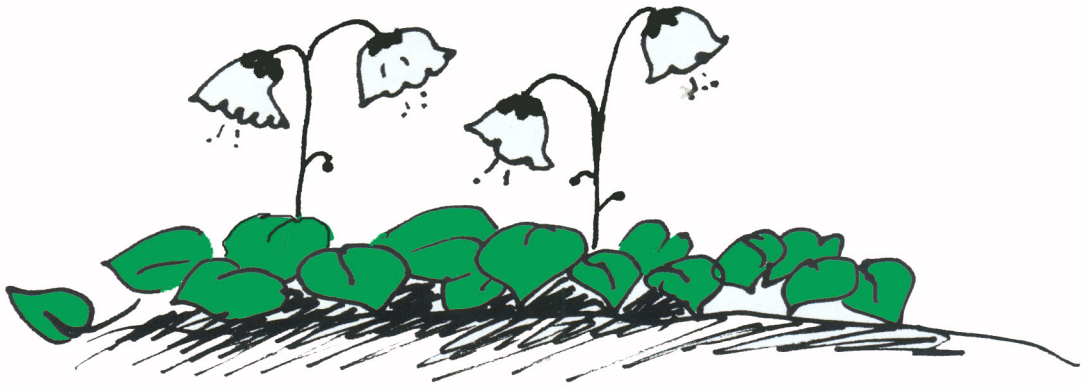
This reddish flower stinks!



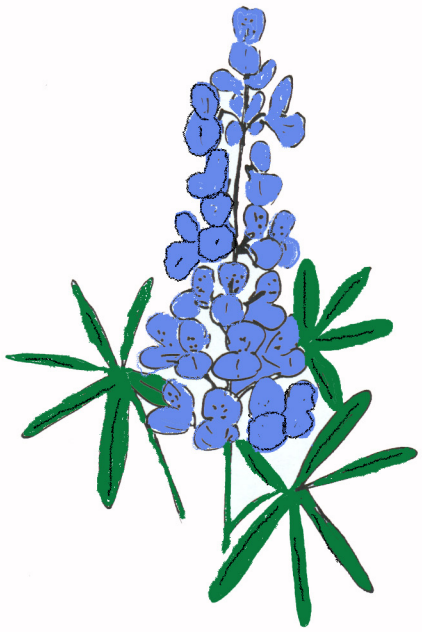
These colorful orange flowers have a sweet smell.



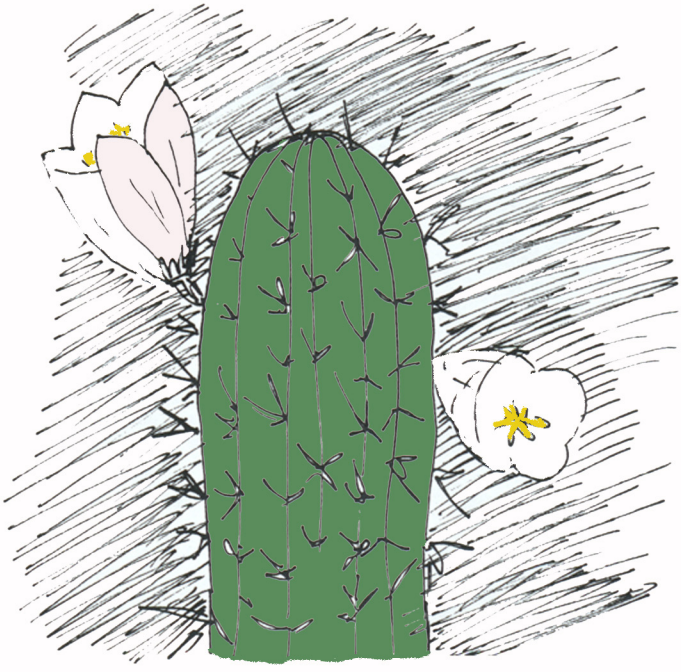
These bright red flowers have no smell.



These small white flowers are only a few inches tall and have no smell.



These blue flowers smell sweet.



This cactus flower blooms at night
and smells sweet.

Addendum
Additional Pollination Resources

Story Books

Honey Bees. By Deborah Heiligman, illustrated by Carla Golembe. A fun and beautifully illustrated book about the life cycle of the honey bee including bee biology and the role of honey bees as pollinators in the garden.
Becoming Butterflies. By Ann Rockwell, illustrated by Megan Halsay. Walker & Co., 2002. Picture story about a class raising and releasing monarch butterflies.
Wacky Plant Cycles. By Valerie Wyatt, illustrated by Lilith Jones. Mondo Publishing, 2000.
Butterflies in the Garden. By Carol Lerner. Harpercollins Juvenille, 2002. Full color illustrations show how to plant a butterfly garden as well as illustrate the life cycle of a butterfly.
Jack's Garden. By Henry Cole. Mulberry Books, 1997. A beautifully illustrated story about the evolution of a garden from soil to seeds, sprouts, flowers, pollination, predators and beyond. This story makes the many stages of a garden's growth come alive!
The Moonflower. By Peter and Jean Loewer. Peachtree Press, 1998. A beautifully illustrated story of the night-blooming moonflower and it's nocturnal pollinators.
From Seed to Plant. By Gail Gibbons. Holiday House, 1993. An illustrated look at pollination from seed to flower and back to seed.
The Magic School Bus: Inside a Beehive. By Joanna Cole, illustrated by Bruce Degen. Scholastic Trade, 1998
An Extraordinary Life: The Story of a Monarch Butterfly. By Laurence Pringle. Orchard Books, 1997.
The Hungry Hummingbird. By April Pulley Sayre, Millbrook Press 2001.

Websites

All About Butterflies http://www.enchantedlearning.com/subjects/butterflies/allabout/. This Enchanted Learning site is a colorful combination of textual information and clearly labeled diagrams and pictures providing data on topics such as anatomy, species, senses, differences between butterflies and moths, and more. Especially useful is the illustrated dictionary of butterfly terms.

Butterflies of North America http://www.npwrc.usgs.gov/resource/distr/lepid/bflyusa/bflyusa.htm. The U.S. Geological Survey's Children's Butterfly Site provides photo galleries organizing butterfly species by the continent they inhabit, coloring pages, frequently asked questions and answers, a place to ask questions, a listing of books and videos, and links to other sites.

Nature: Alien Empire www.thirteen.org/nature/alienempire/multimedia/hive.html
This PBS Online site shows a terrific diagram of a worker bee that allows you to click on various body parts, both inside

Garden-Based Learning Resources

Life Lab Science Program

LIFE LAB
www.lifelab.org

Watch learning come to life in the garden!.

Since its inception in 1979 Life Lab Science Program has been a leader in Garden-Based Education. Training thousands of teachers across the nation, creating the Garden Classroom, a nationally recognized model school garden and training center, and publishing curriculum and activity guides are a few of Life Lab's accomplishments.

Life Lab teaches people to care for themselves, eachother and the world through farm- and garden-based programs.

Learn more and order online at lifelab.org

Professional Development Workshops

Life Lab has developed a wide selection of garden-based learning workshops, available at our Garden Classroom Training Center or at your school site. Consulting services and/or specialized workshops are also available. Contact education@lifelab.org or visit the professional development page at www.lifelab.org.

Creating and Sustaining School Gardens

In this one day workshop you'll learn how to take the first steps of creating a living laboratory, including setting goals for your site, gathering input from users, making a fundraising plan, finding volunteers and donors, publicizing your garden and connecting to academic standards.

The Growing Classroom

This two-day workshop is ideal for those interested in supplementing their existing science program with garden-based learning. Using The Growing Classroom activity guide for grades 2-6, you'll experience hands-on activities aligned with CA State Science Standards, learn basic science concepts and gardening techniques, and develop planning and management strategies for a school gardening program.

Life Lab Science

This two-day workshop uses Life Lab's K-5 core curriculum- Life Lab Science to teach earth, life and physical science using the garden.

Discovering the Garden in Early Childhood Education

Spend a day looking at the garden through the eyes of a pre-schooler. Sample many activities that encourage young children to learn about their world using all their senses.

Plant It!, Grow It!, Eat It!

Make the connection from seed to table in this fun and delicious workshop. Explore ways to teach nutrition through gardening, harvesting and meal preparation while integrating with core academic subjects.

Math and Science in the Garden

This is a one-day workshop for upper elementary and middle school teachers who want to use the garden to enhance math and science learning.

Creating A Waste Free School

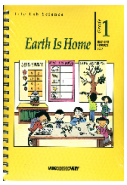
Learn how to reduce the amount of waste your school sends to the landfill while you reduce the amount of money you are literally throwing away.

Consultation & School Gardens Tour

Life Lab was founded in 1979 at Green Acres Elementary School in Santa Cruz. Since that time, Life Lab Science Program has been a leader in the school garden movement, helping to create thousands of school gardens across the U.S. Life Lab will lead your garden team on a tour of thriving school gardens in and around the Santa Cruz area. Gain ideas on design, educational uses, management and nutrition education.

Garden-Based Learning Publications

Life Lab Science K-5 Curriculum



Recognized by the Smithsonian Institute as an "outstanding curriculum", Life Lab Science is a garden-based, and grade level specific (K–5) curriculum. Teacher instructional manuals include pre- and post- assessment, unit planners, parent letters, and suggested connections to language arts, math and social studies. Also available: student activity guides and Spanish blackline masters for grades first through fifth, and music CD. Downloadable California State Science Standards matrix available at www.lifelab.org

Life Lab Science K-5 Curriculum

Kindergarten: Great Explorations
Teacher Resource Book $75.95

1st Grade: Earth Is Home
Teacher Resource Book $79.95

2nd Grade: Change Around Us
Teacher Resource Book $79.95

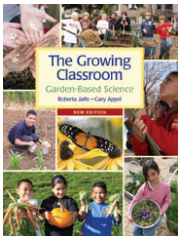
3rd Grade: How Things Work
Teacher Resource Book $79.95

4th Grade: Connections
Teacher Resource Books with Lab Materials $189.00

5th Grade: Change Over Time
Teacher Resource Books with Lab Materials $189.00

More Resources

The Growing Classroom: Garden-Based Science and Nutrition Activity Guide



The Growing Classroom is our award winning resource book containing step-by-step instructions for setting up a garden-based science program and many outdoor classroom activities. Topics include working together in the garden, growing, nutrients, garden ecology, climate, nutrition, gardening tips and food choices. Downloadable CA State Science Standards matrix available at www.lifelab.org. 464 pages. **$39.95**

Kids' Garden Activity Cards - 40 Fun Indoor and Outdoor Activities and Games

This boxed card set makes a great gift for any child or family ready to create and explore the garden. These activities come in a set of 40 beautifully illustrated double-sided activity cards. Activity themes include:

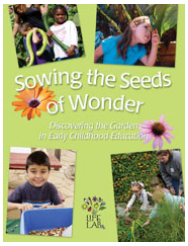
* Exploring the Garden
* Planting and Growing
* Having Fun With Plants
* Discovering Garden Critters
* Creating Garden Art

The box also includes a garden instruction leaflet providing tips for gardening with kids. **$19.99**

Getting Started: A Guide for Creating School Gardens as Outdoor Classrooms

This 50-page guide that asks and answers most questions you need to consider for creating an outdoor classroom garden. **Free download at www.lifelab.org**

Sowing the Seeds of Wonder: Discovering the Garden in Early Childhood Education



Through hands-on activities preschool-age children will engage all of their senses as they discover the joys of gardening. Sowing the Seeds of Wonder is an educator guidebook that provides insight and lessons for educators to help students develop a lifelong connection to the outdoors. Lessons guide young students to dig into the soil; observe birds, insects, and other critters in the garden; and enjoy the tastes of fresh fruits and vegetables they plant, harvest, and prepare. **$16.95**

Popcorn/Maize

Activities help raise awareness about the diversity of local and national food production, introduce components of farming and demonstrate basic ecological concepts related to growing food sustainably. **Popcorn (lower grades)/ Maize (upper elementary and middle grades) $19.95each**

Create from Waste

K-7 activity guide for engaging students in community based ecology and waste reduction.
75 pages, **$19.95**

Away with School Waste

A teachers guide to starting school waste reduction, recycling, and composting program. 17 pages, **$19.95**

Banana Slug String Band CD Singing In Our Garden_

Teach ecology, science and nature with the Banana Slug String Band. A collection of Banana Slug favorites including: Roots, Stems Leaves; I'm A Tree; Dirt Made My Lunch; Soil, Sun, Water and Air; Water Cycle Boogie; and Decomposition. This CD accompanies our curriculum. **$15.00, Singing In Our Garden Lyrics $9.00**

Garden Signs

Created by the Life Lab Garden Classroom Staff and Design Science Graphics these garden themed signs will turn your garden plot into an interpretive site. Themes: weather, habitat, plant's needs, investigating the garden, plant adaptations, vermi-composting and composting. Have your sign professionally manufactured at esigns.com. **$20/design, order online to download PDF files**

Life Lab cultivates children's love of learning, healthy food, and nature through garden-based education.

For more information, please contact Life Lab (831) 459-2001
www.lifelab.org