Adaptation in Florida Scrub

The Process of Evolution

Environmental Education Activities for 3rd, 4th, and 5th grades

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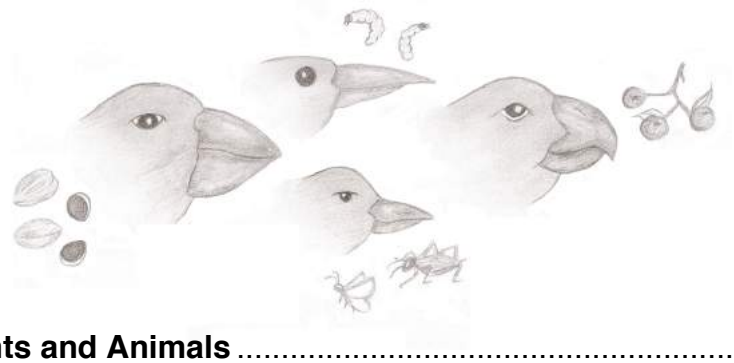
Acknowledgements
Unless otherwise noted, all illustrations were provided by Kendra L. Tatusko. The photos for the reptile relationships hypotheses and the 'How are Florida scrub organisms adapted to their environment?' exercise came from the Discovering Florida Scrub powerpoints. The photographs for the clue cards in the Reptile Family Tree exercise were provided by joanneJ at flickr.com (snapping turtle), Frank Peters at flickr.com (lizard with egg), Jonathan Crowe at flickr.com (snake with egg), and Chantal Argoud (fossil snake).

V. UNIT FIVE

ADAPTATION IN FLORIDA SCRUB:
THE PROCESS OF EVOLUTION

Objective: *To understand the components of evolution and the importance of evolution in changing the plants and animals of Florida Scrub.*



A. GROUPING PLANTS AND ANIMALS

Introduction

There are over eight million species of organisms on the planet that live in a variety of different environments such as the air, water, forests, and of course, Florida Scrub. One of the goals of biology is to identify and group these organisms and to understand how they are related to one another. This field of biology is called Taxonomy and it has a long history in biology. In 1735, Karl Linneaus proposed a way to formally name species that we still use today. For example, we might talk about gopher tortoises with our friends and family and call them gopher tortoises, but biologists would use the latin name *Gopherus polyphemus*. The first part of the name is the genus name and the second part is the specific name given to this species of tortoise. No other tortoise will have this name even though there may be other species that burrow in the ground like the Florida gopher tortoise. The name also gives clues to biologists about the shape and habits of the gopher tortoise. For example, the genus *Gopherus* is given to tortoise species that burrow and have specific traits such as elephant-like feet and living in a sandy environment. Just by seeing the name *Gopherus* we would have some idea of what to expect a species to look like.

Taxonomy is important because it lets us talk to one another about the kinds of organisms we see and study. We start with broad categories and then get more specific as we talk about a single type of organism. For example, everyone knows what a plant is and what a tree is. If we were talking about an oak tree in the Florida scrub, though, it would be confusing because there are many different oak species in the scrub. We would have to be more specific and say that we were talking about the scrub oak (*Quercus inopina*) or the sand live oak (*Quercus geminata*). Using unique latin names for each species is a way to reduce confusion when talking, writing, or reading about an organism.

Taxonomy also gives us a way to classify all organisms on Earth. This classification system is hierarchical, and as we move up the levels, each group gradually includes more and more species. If we consider the oaks, for example, *Quercus geminata* is one type of oak. This species is in the genus *Quercus* which includes many different oak species (*Quercus inopina*, *Quercus virginiana*, *Quercus laevis*, etc.). The genus *Quercus* is a member of the scientific family Fagaceae which includes oak trees as well as beech and chestnut trees. The family Fagaceae is a member of the kingdom Plantae which includes all plants. This hierarchical naming system is incredibly useful for

keeping track of the many diverse organisms on our planet. Here is an overview of the naming system:

Kingdom (largest group)
Phylum
Class
Order
Family
Genus
Species (smallest group)

Taxonomy in practice

The way that biologists classify organisms is by looking at their similarities and differences. They then try to figure out how similar organisms are related to one another. Biologists use a number of characteristics such as anatomy (body size, color, bone structure, leaf shape), physiology, and DNA sequences to compare organisms and to determine the pattern of relatedness.

Understanding the relatedness of organisms is important because it gives us a way to examine how evolution has changed organisms over time. Determining how some organisms are related can sometimes be tricky because very unrelated organisms may look similar. If you compare a shark and a dolphin for instance, they have the same body form, but one is a fish and the other is a mammal. They arrived at the same body form from very different starting points. Usually the more information you have, the better your understanding about how groups of organisms are related.

In the following exercises your students will first practice classifying pretend organisms and then they will apply their knowledge and experience to classify real organisms. Lastly, they will examine why very closely related organisms may sometimes look very different.

V.A.1. How and why do we put organisms into groups?

Concepts: Recognizing similarities and differences among organisms and that these characteristics can be used to group both imaginary and real organisms.
Skills: Cooperative learning, observation, identification, decision-making, discussion.
Time needed: Approximately 20 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.3, LACC.3.SL.2.4, LACC.3.SL.2.6, LACC.4.SL.1.1, LACC.4.SL.2.4, LACC.5.SL.1.1, LACC.5.SL.2.4, MACC.3.OA.1.3, SC.3.L.15.1, SC.3.L.15.2, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.5, SC.3.N.1.6, SC.3.N.3.1, SC.3.P.8.3, SC.4.N.1.2, SC.4.N.1.5, VA.3.O.2.1, VA.3.S.2.2, VA.3.S.3.1

V.A.1. Part One—Grouping Imaginary Organisms

The goal of this exercise is to use pretend organisms (e.g., candy, thread, writing instruments) to give your students practice classifying simple organisms. In the following exercises, the term "family" is used in the traditional sense, but you should stress to your students that scientists also use this term formally in the hierarchical classification of organisms.

Materials:

Each team of three students needs:

- 2 different colors of crayons or markers
- 1 pencil
- 2 different color pieces of thread
- 1 piece of twine
- 2 pieces of elbow pasta, different sizes or shapes
- 1 piece of bow tie pasta
- 1 Tootsie roll
- 1 Hershey's kiss
- 1 Starburst candy
- 1 plastic bag
- Student worksheet for part 1

Note—Alternative materials may be substituted, but we recommend using wrapped candy.

Instructions for the Teacher:

1. Fill each plastic bag with each of the listed materials. Each bag should contain twelve items.

2. Assign students to teams of three.

3. Introduce the idea that all organisms can be described by their traits or characters. Some traits of animals are number of legs, color of hair, whether or not they have hair, etc. Some traits of plants are number of leaves, flower color, and whether leaf edges are smooth or jagged.

4. Now ask the students to pretend they are space explorers and have landed on a new planet. They have found organisms on this new planet that they want to group into scientific families based on their traits.

5. Hand out the bags of objects and instruct students to empty the contents of the bags. Be sure to tell the students not to eat the candy.

6. Ask the teams to sort these strange alien organisms from their bag into 4 groups, with 3 items in each group, based on what their team thinks are similar organisms. Have the team write down their groupings and the traits they used to make their groupings on the student worksheet. For instance, they might sort their organisms by texture, shape, color or material. There is no wrong way.

7. *Once the teams have begun to select characters to use to group the organisms, you can ask them to think about how their groups might differ if they used other characters*.

8. Ask the students to now take each of the 4 groups and divide them into 2 subgroups: one subgroup with two items and the other with only one item. Have them write down their groupings and reasoning on the student worksheet again.

9. Invite a team to show the rest of the class their groups and share some of their reasons for making groups of objects the way they did. Ask if there were any teams that made different groupings. Invite them to share their groupings. And so on.

10. Once all the different groupings have been shared, as a class, decide the best way to assign the items into 4 groups and how to split each of these into the subgroups. See example sheet for a suggested grouping.

11. Have the students place the items back in the bag, with the exception of the candy, which can now be eaten.

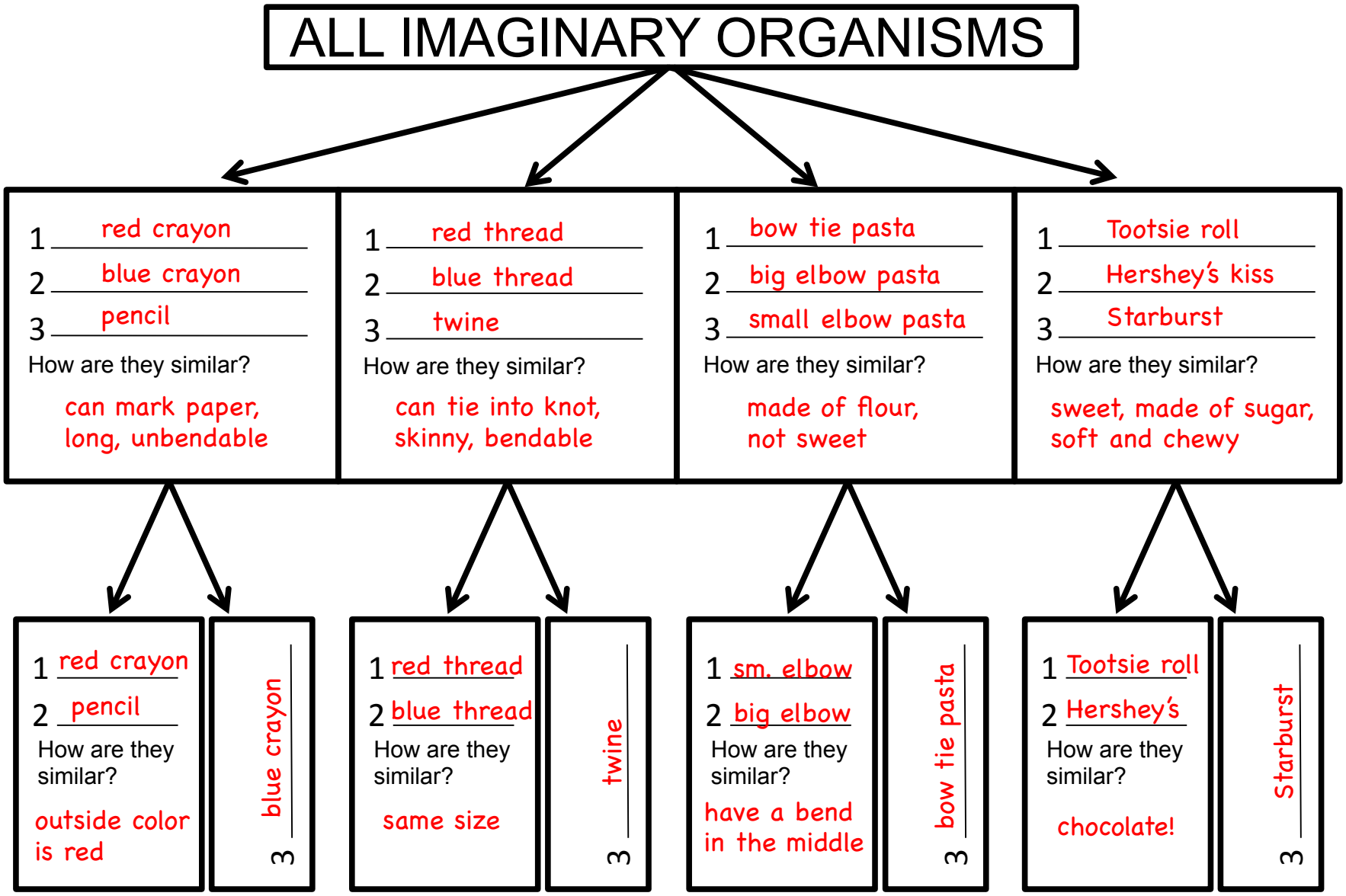
Results

After completing this activity your students should:

- Recognize similarities and differences among (imaginary) organisms.
- Understand that characters (traits) can be used to group organisms.
- Understand that the traits used to group organisms can change the groupings.

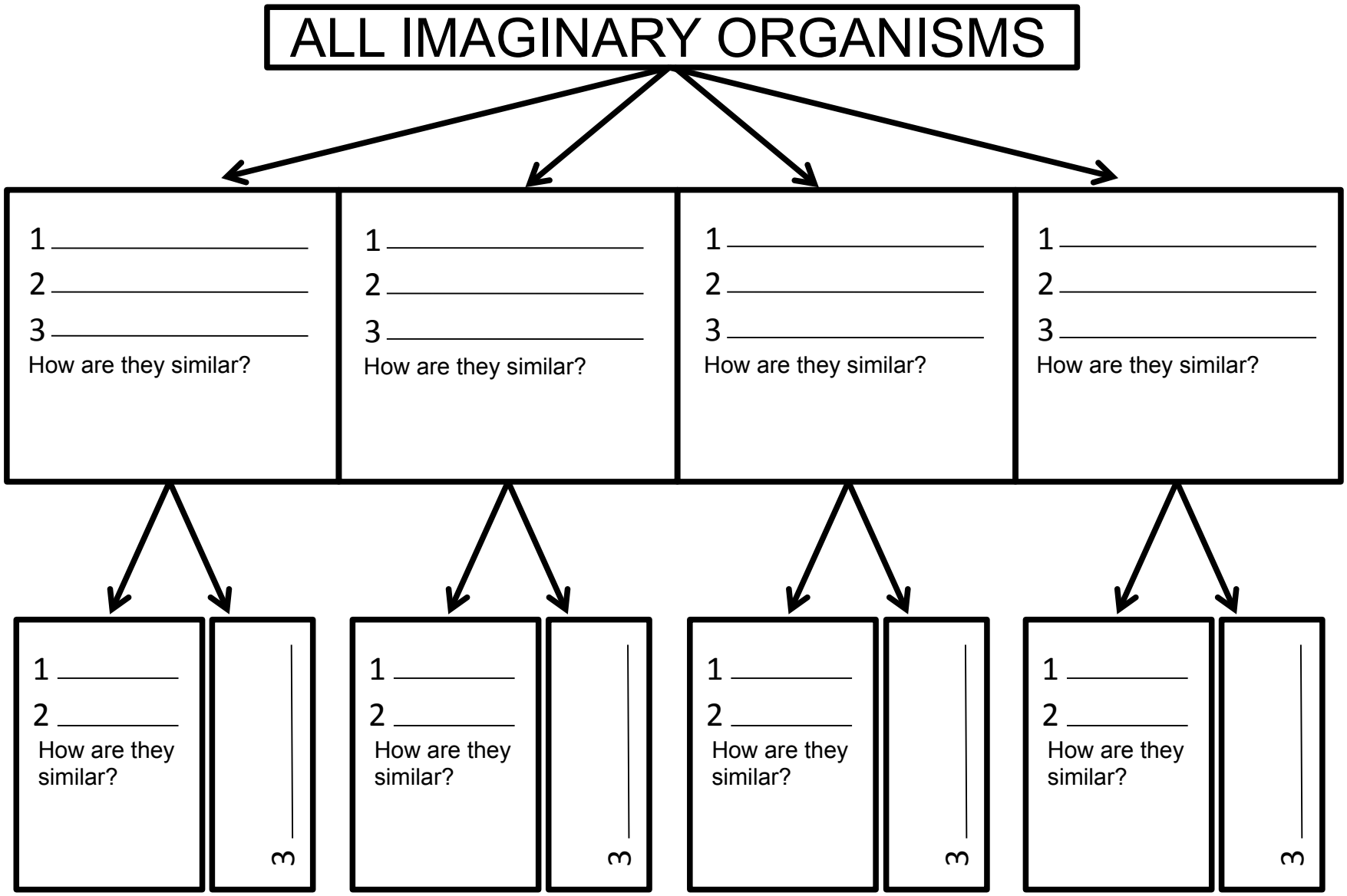
V.A.1 How and Why Do We Put Organisms into Groups?
Part One: Grouping Imaginary Organisms

Completed Worksheet Example



V.A.1 How and Why Do We Put Organisms into Groups?
Part One: Grouping Imaginary Organisms

Team members _____



V.A.1. Part Two—Grouping Organisms of the Florida Scrub

The goal of this exercise is to use organisms present in the Florida scrub to give your students additional practice classifying organisms.

Materials:

Each team of 3 students will need an 'organism card' of the following organisms living in the Florida Scrub:

- Florida scrub lizard
- Green anole
- Indigo snake
- Sand pine
- Slash pine
- Scrub palmetto
- Scrub jay
- Great egret
- White ibis
- Butterfly
- Antlion adult
- Housekeeping spider
- Student worksheet for part 2
- Colored pencils/crayons

Note—Organism cards are at the end of this exercise.

Instructions for the Teacher:

1. Ask the students to color the organisms on the index cards. You may wish to supply color pictures at the front of the class for students to mimic.

2. Ask the students to sort the organisms into 4 groups, with 3 items in each group, based on what their team thinks are similar organisms. Have the team write down their groupings and the traits they used to make the groupings. *Be careful to have students identify traits. For example, being a bird is not a trait, but having feathers and a beak are good traits that distinguish birds from other organisms. See the example sheet for other ideas of distinguishing traits.*

3. Ask the students to now take each of the 4 groups and divide them into 2 subgroups with two organisms in one subgroup and one organism in the other. Have the team write down their groupings and what traits they used to make the groupings.

4. Have each team show the rest of the class their groups and share some of their reasons for grouping organisms the way they did.

5. Have the class as a whole decide the best way to group the organisms into 4 groups and how to split the 4 groups into the subgroups (see completed sheet for correct groupings).

6. If there are different groupings proposed, make sure to highlight them and discuss how knowing how organisms are related helps in making the groupings. This will be a prelude to the next section.

Notes

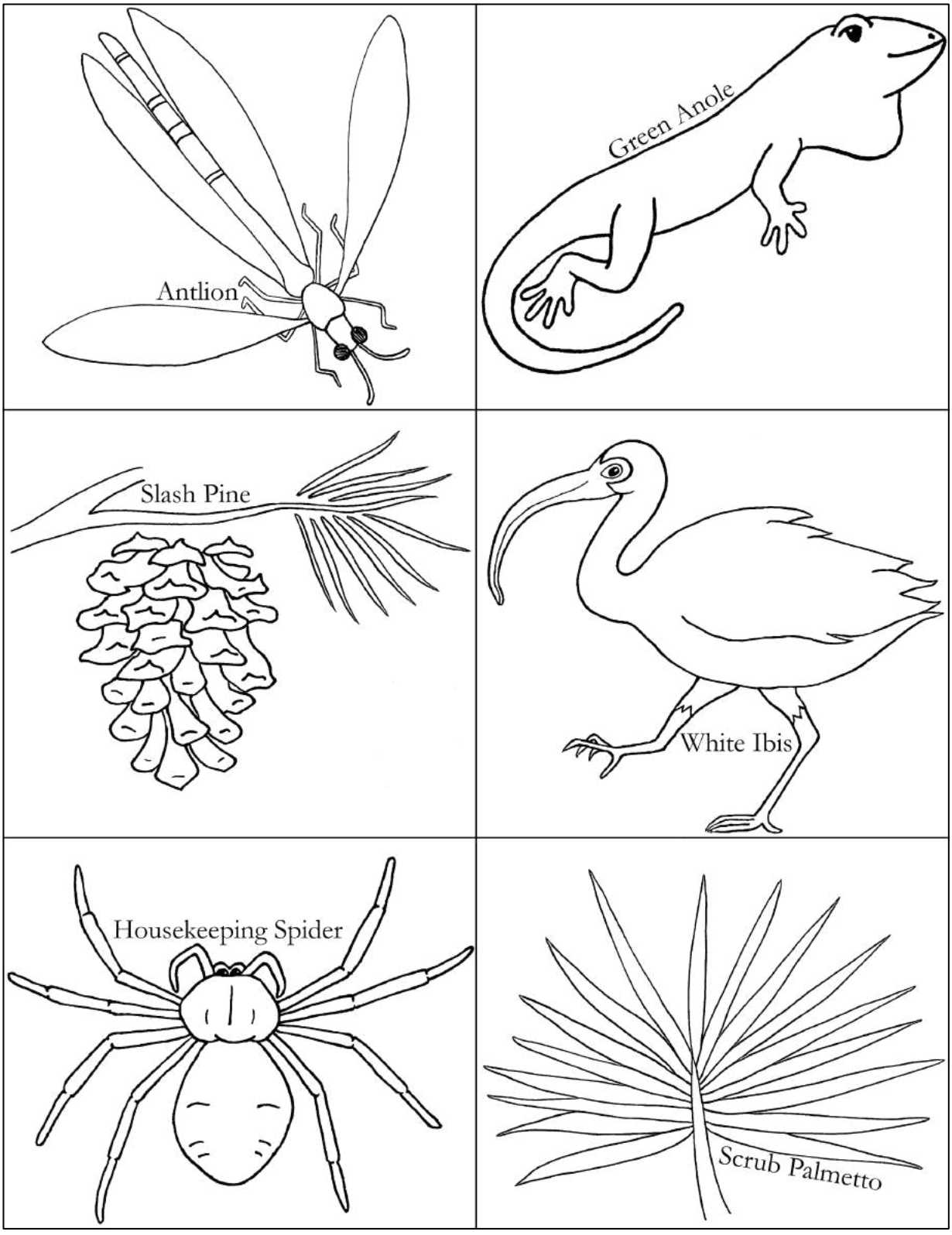
To shorten the time required for this exercise, you can skip the first step where the students color the organism cards.

Results

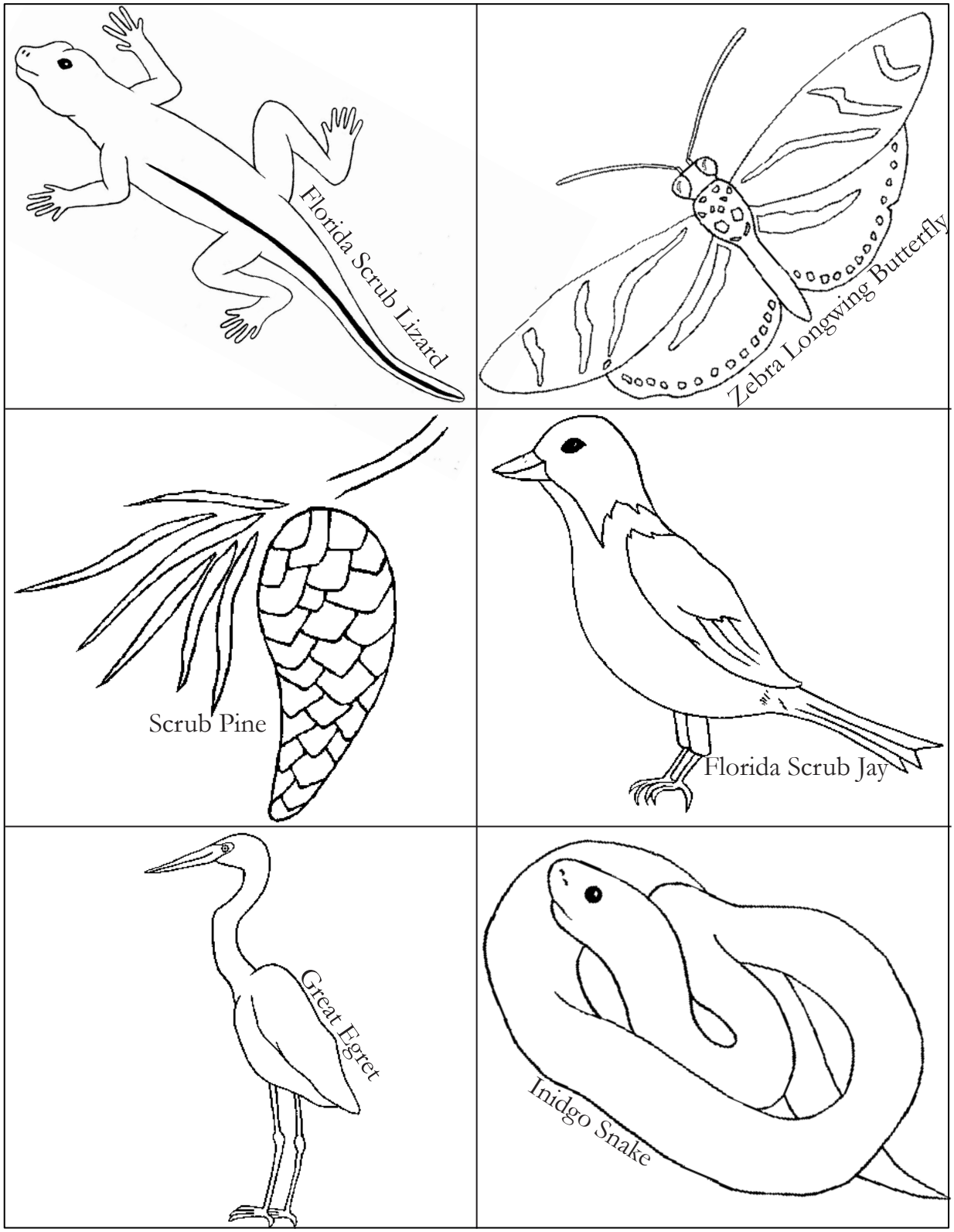
After completing this activity your students should:

- Understand how we use characters (traits) to group organisms.
- Identify some of the key characters in each group of organisms.

ORGANISM CARDS

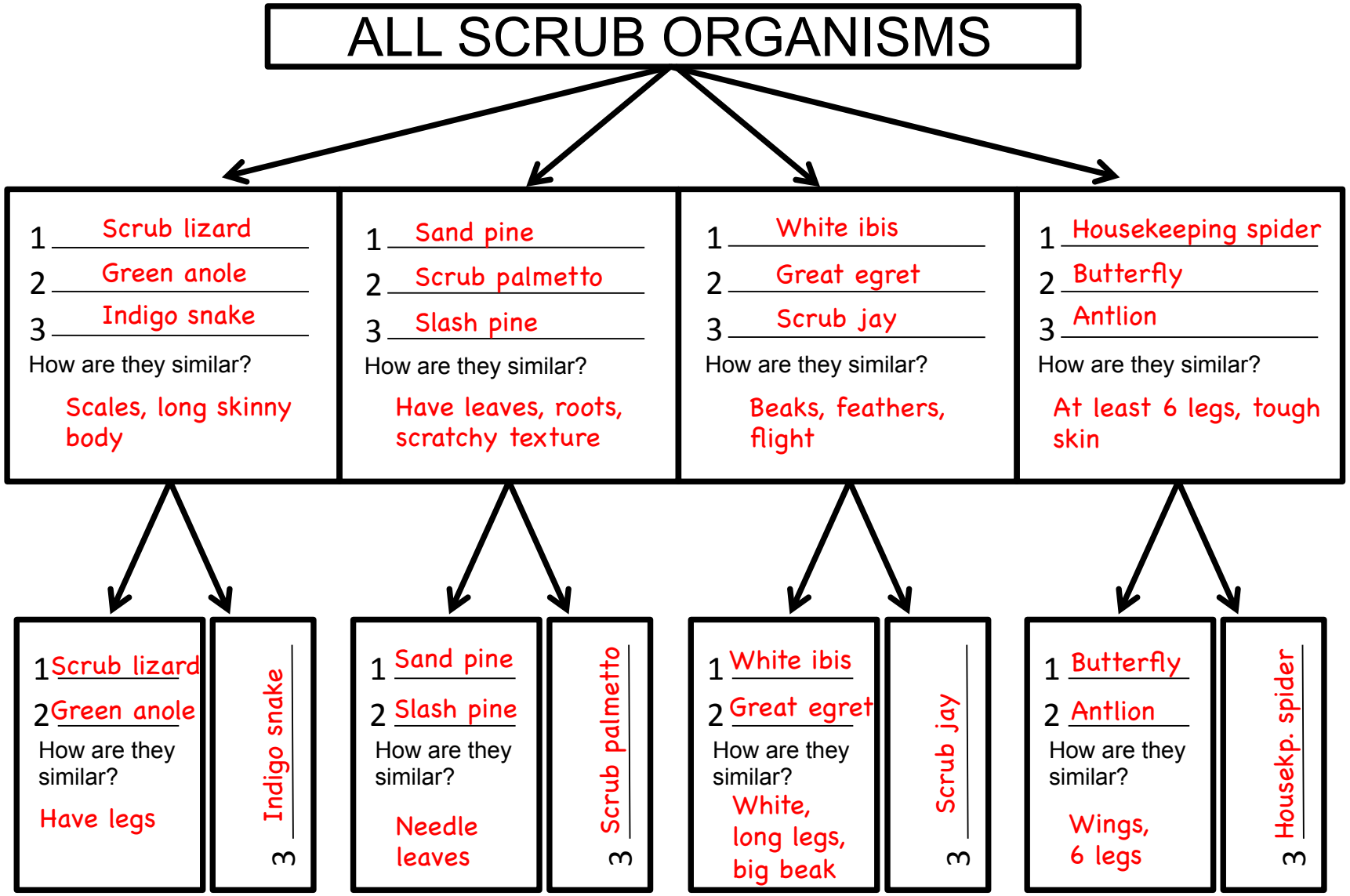


ORGANISM CARDS



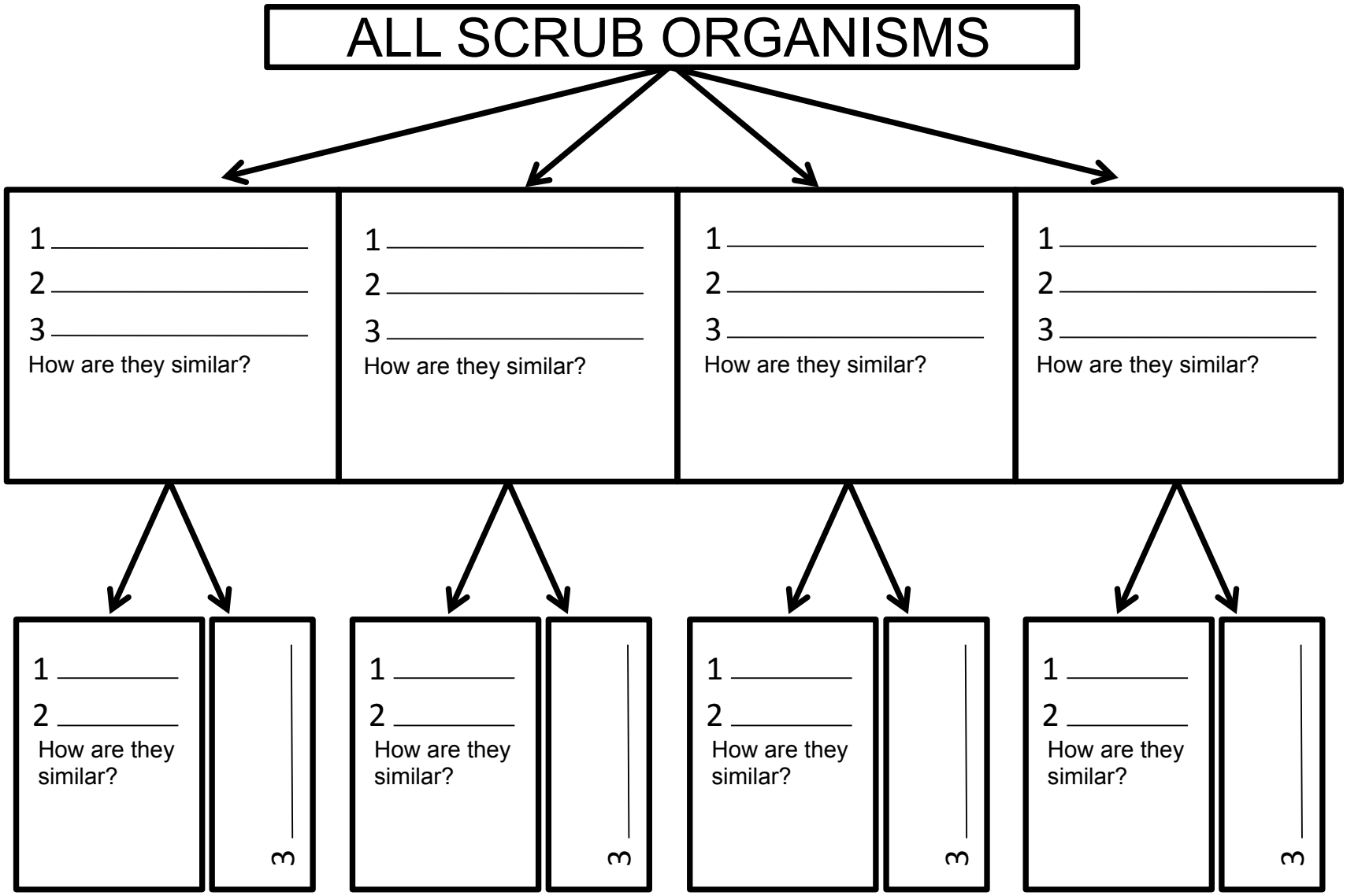
V.A.1 How and Why Do We Put Organisms into Groups?
Part Two: Grouping Organisms of the Florida Scrub

Completed Worksheet Example



V.A.1 How and Why Do We Put Organisms into Groups?
Part Two: Grouping Organisms of the Florida Scrub

Team members: _____



V.A.2. Organisms Have Relatives!

Concepts: Recognizing the importance of relatedness to an organism's characteristics, and organisms have adaptations to live in specific environments.
Skills: Cooperative learning, identification, observation, question formulation, discussion.
Time needed: Approximately 30-45 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.1, LACC.3.SL.1.3, LACC.3.SL.2.4, LACC.3.SL.2.6, LACC.3.W.1.1, LACC.4.SL.1.1, LACC.4.SL.2.4, LACC.4.W.1.1, LACC.5.SL.1.1, LACC.5.W.1.1, SC.3.L.15.1, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.5, SC.3.N.1.6, SC.3.N.3.1, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.3, SC.4.N.1.4, SC.4.N.1.5, SC.4.N.1.7, SC.5.L.17.1, SC.5.N.1.1, VA.3.S.1.1, VA.3.S.2.1, VA.3.S.3.1, VA.4.C.2.3, VA.4.S.1.3

V.A.2 Part One—Family Trees

The goal of this exercise is to have the students understand the link between families and relatedness. They will construct a family tree of an imaginary student, and by discussing this family tree, will learn that just like our families, organisms also have relatives that look similar to one another. This similarity is caused by relatedness (heredity).

Materials:

Each student will need:

- A family tree worksheet
- Colored pencils/crayons
- A copy of a completed student worksheet from V.A.1 Part Two

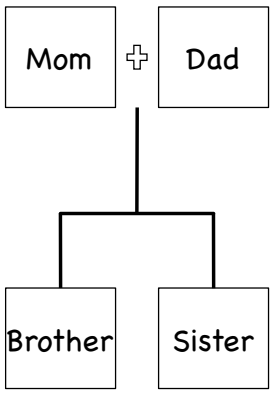
Instructions for the Teacher:

1. Explain to the class that you are going to talk about relatives and what it means to be related to others.

2. Pass out the family tree worksheets.

   Explain that you will be building a family tree of an imaginary student named "Toni". A family tree is a picture that shows relatedness among people.

   Explain that the plus signs mean that two people have children together. The horizontal lines connect brothers and sisters. The vertical lines connect parents and their children. You may wish to draw an example on the board such as the one to the right.



3. Instruct students to write the names listed at the bottom of the worksheet in the appropriate squares on the worksheet. Cross out each name as you add them to the tree.

4. Once the students have finished putting the names in the boxes, have them draw pictures of how they imagine these people to look.

   Remind them that close relatives usually look very similar.

5. When students have finished their family trees, you can fill out a tree together as a class on an overhead or the chalkboard to make sure everyone has a tree that makes sense.

6. Lead a class discussion by asking:

   Is Toni more closely related to Toni's sister or to Aunt Joan's son?
   Is Toni more closely related to Mom or grandpa?
   Which people do you expect Uncle Mark's daughter to look most similar to?

   Add additional questions if you have time.

7. Then show the students a copy of a student worksheet from *V.A.1 Part Two: Grouping Organisms of the Florida Scrub*.

8. Explain *"When scientists put organisms into groups like 'families', organisms aren't only grouped together because they look similar, but also because they are closely related. All the organisms in a family have the same great great great great x (millions) grandparents that lived millions of years ago. If you were to build a family tree of all the organisms in the Florida scrub, it would look something like the completed worksheet!"*

9. Ask similar questions as in #6. *For example, is the scrub pine more closely related to the indigo snake or the scrub palmetto?*

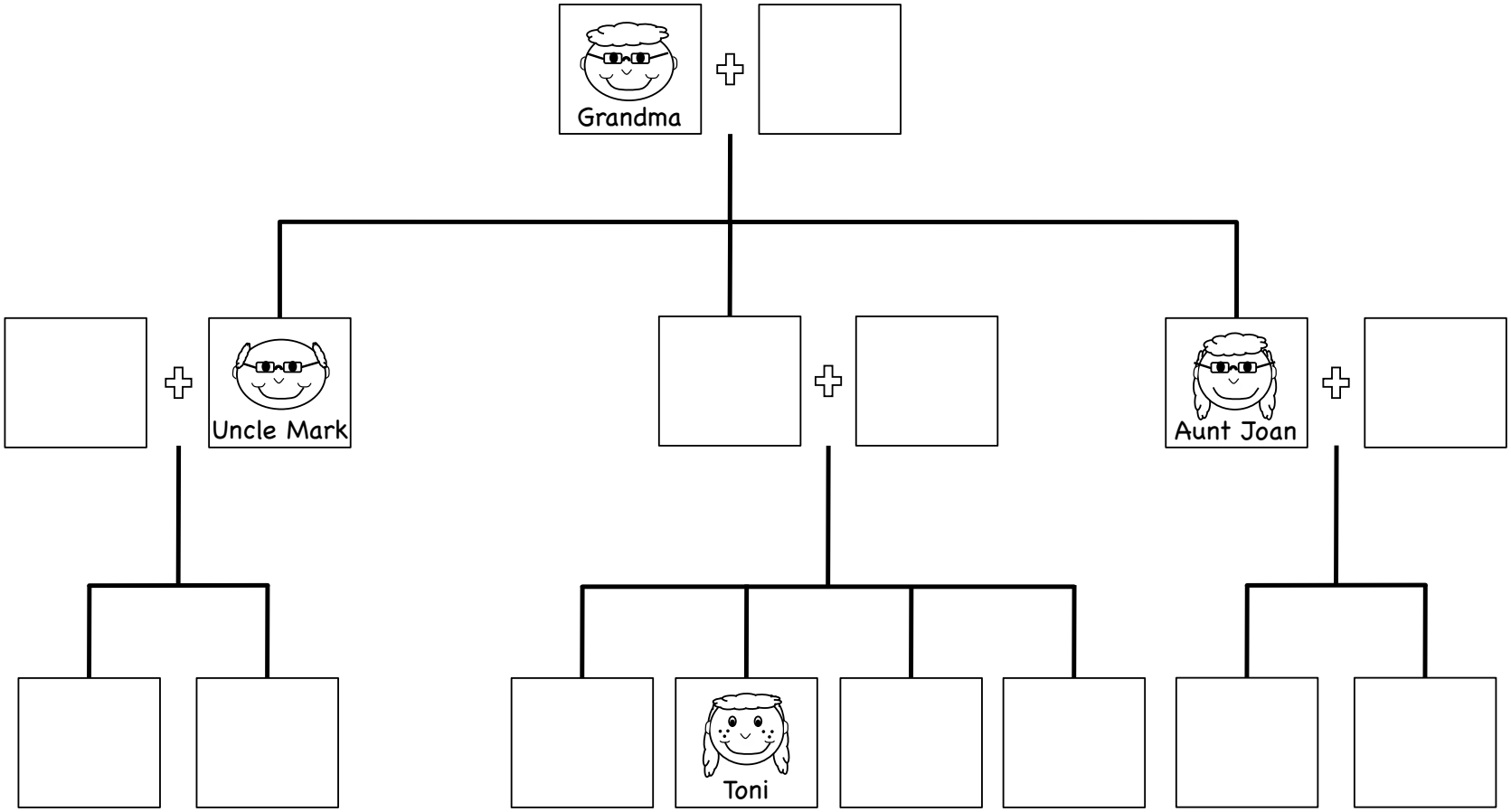
Results

After completing this activity your students should:

- Understand that organisms are related
- Identify closely related organisms and distantly related organisms
- Be able to construct a family tree

V.A.2 Organisms Have Relatives!
Part One: Family Trees

Name: _____



~~Toni~~
Toni's sister
Toni's big brother
Toni's little brother

Mom
Dad
~~Grandma~~
Grandpa

~~Uncle Mark~~
Uncle Mark's wife
Uncle Mark's son
Uncle Mark's daughter

~~Aunt Joan~~
Aunt Joan's husband
Aunt Joan's daughter
Aunt Joan's son

V.A.2 Part Two—A Reptile Family Tree

In this exercise, students will use clues to evaluate three different ways that reptiles might be related. The goals are to reinforce the idea that organisms are related, that they can be grouped into families, and to introduce hypotheses.

Materials:

Each group of three students will need:

- A set of hypothesis worksheets
- A set of clue cards
- Colored pencils/crayons

Instructions for the Teacher:

1. Reintroduce the family tree. You can use the student worksheet from V.A.2 Part One to do so.

   Point out that relatives that were alive before you were are your **ancestors**. We may have ancestors that are still alive, like our parents, grandparents and even great grandparents. But most of our ancestors lived LONG ago and are no longer alive. *The same is true for all living organisms.*

2. Tell the students that you will be looking at the family tree of some reptiles (snakes, lizards and turtles). Because reptiles have not kept written records of who their ancestors were (like people do), scientists have to use other clues to figure out the reptile family tree.

3. The first step is to make an educated guess or **hypothesis** ('hypotheses' is the plural form of hypothesis). Hand out the three reptile family tree hypotheses to each group of students. Tell them that these are three *possible* family trees for reptiles. Only one of these three hypotheses can be true! Ask them to take some time (5 minutes) to look at the different hypotheses and describe how they are DIFFERENT. Have students write their ideas on a piece of paper.

   <u>Together as a class, identify the differences:</u>
   Hypothesis #1: lizards and turtles are the closest relatives
   Hypothesis #2: lizards and snakes are the closest relatives
   Hypothesis #3: snakes and turtles are the closest relatives.

4. Have each student in a group choose one of the hypotheses. Now point out the empty boxes on the family trees. These boxes are the ancestors of snakes, lizards and turtles. These ancestors are no longer alive, so we have to guess what they might have looked like. Instruct the students to draw what they think the ancestors on their family tree looked like. For example, what do you think the

great great great grandparents of all turtles, lizards and snakes looked like? Did they have scales? …legs? …shells? …wings? …tails?

5. Once the students are finished with their drawings, explain that scientists examine clues in order to decide which hypothesis is closest to the real family tree of reptiles.

7. Tell your students "*Scientists look at similarities and differences in the bodies and behavior of organisms in order to determine which are most closely related"*. Now introduce Clue #1 (all reptiles lay eggs).

   Have the teams discuss if the clue supports/fits each of the three possible family trees. Does it fit better with one hypothesis than the others? This clue shouldn't, but allow students to offer arguments why it might.

   Clue #1 does not help the students to identify which hypothesis is best, although it does tell them that all lizards, snakes, and turtles share the trait of egg laying which makes them different from other types of organisms like humans.

8. Next, tell the students "*Scientists also look at fossils to decide which family tree is best. Fossils show us what some of the ancestors that lived long ago looked like*."

   Introduce Clue # 2 (old snake fossil has leg bones). Have students discuss in groups if the clue supports/fits any of their family trees. Does it fit better with one hypothesis than another?

   The students might pick up on the idea that a snake-like animal with small legs might fit with an ancestor of snakes and lizards. They might not, which is okay. Allow them to discuss why or why not the clue supports their hypotheses.

9. Finally, tell the students *"Scientists also look at DNA to decide which family tree is best. In every cell of our bodies, we have tiny instructions on how our bodies are built. These instructions are called **DNA** and are organized in little instruction 'booklets' called **genes**. We get our genes from our parents and so do all other living organisms. Organisms with more genes in common are more closely related. DNA clues are the most reliable evidence for scientists building family trees."*

   Introduce Clue #3 (snakes and lizards share more genes). Have students discuss in groups if the clue supports/fits with any of their family trees. Does it fit better with one hypothesis than another?

Clue #3 along with Clue #2 should direct students to Hypothesis #2 as the family tree that best fits the scientific evidence.

9. As a class, have the students offer their ideas on which hypothesis fits the clues best. Have them explain how the three clues support their hypothesis.

Notes

It is okay if students do not come to the "correct" answer. The most important part of this exercise is for students to understand how evolutionary biologists consider different ideas (hypotheses) regarding relatedness of organisms and choose the one that best fits the evidence.

Additional questions for the class:

What new evidence would make you change your mind about your decision? Can you think of a fossil that, if discovered, would make a different hypothesis seem better? (For example, a fossil of a snake with a shell.)

Do you think scientists all agree on the best family tree of all animals? Why or why not? Do you think that we have fossils for all the ancestors of animals? (We don't and this makes it harder to figure out which tree is best)

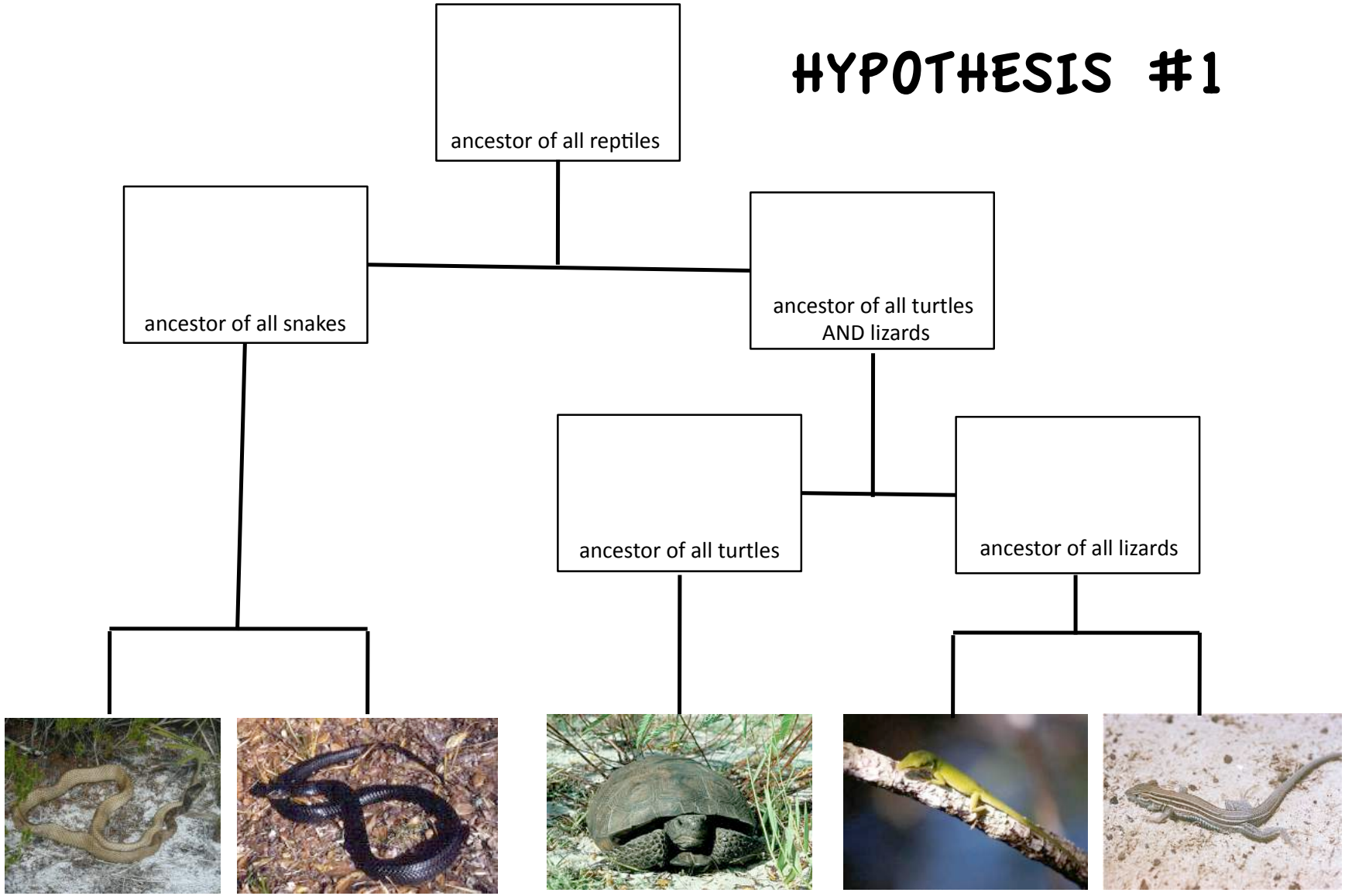
Clue #1 said that all reptiles lay eggs. Did this help you decide which reptiles were most closely related? (Because this clue tells us that turtles, snakes, and lizards lay eggs, it doesn't help us figure out which two groups are more closely related.) Does this clue tell you which animals might be most closely related to reptiles? What other kinds of animals lay eggs? (BIRDS! In fact, based on DNA evidence, scientists now consider birds to be a special kind of reptile!)

Results

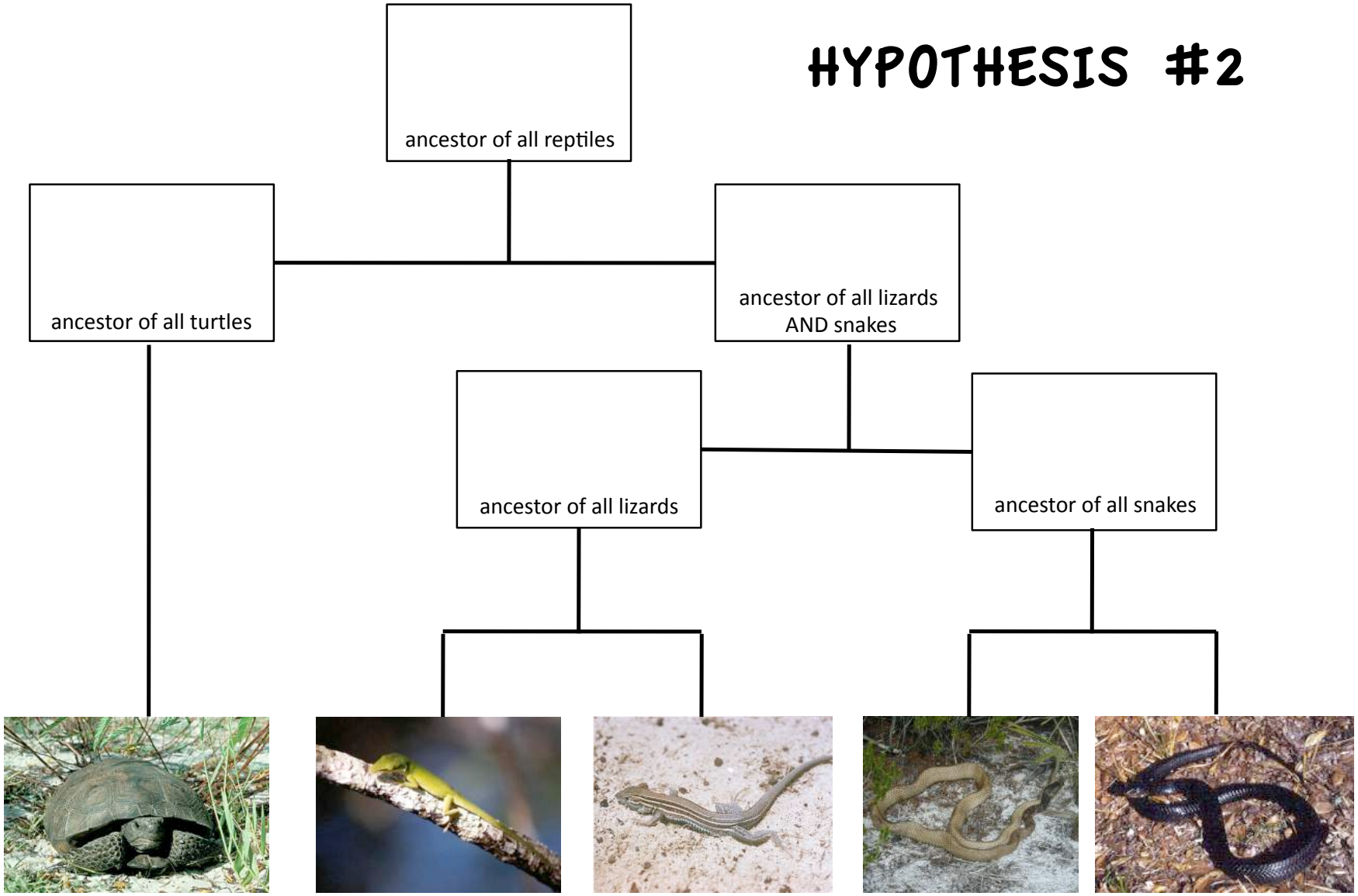
After completing this activity:

- Students will understand that organisms are related
- Students will have experience evaluating alternative hypotheses based on evidence
- Students will be able to defend their ideas with supporting evidence

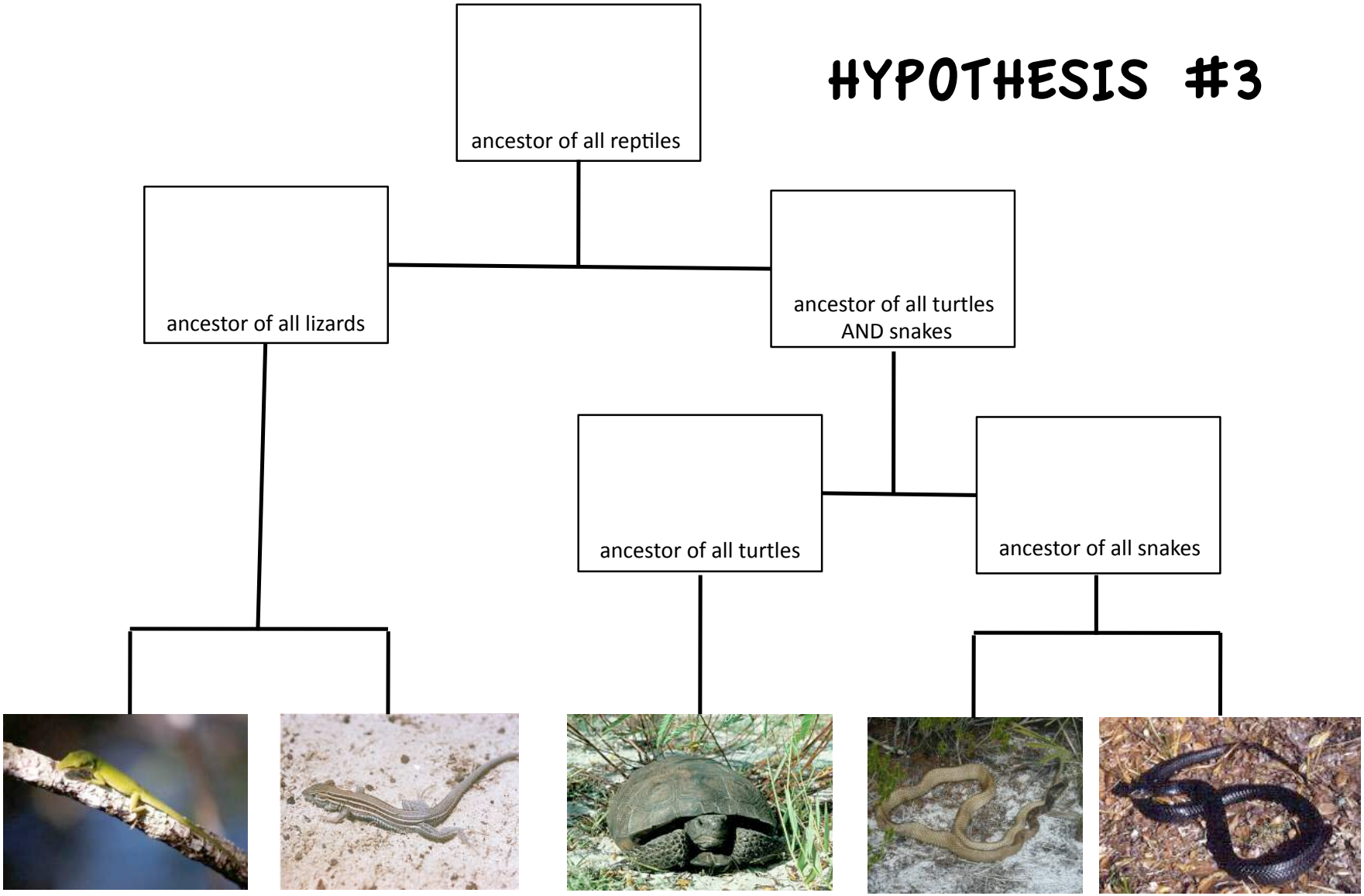
HYPOTHESIS #1



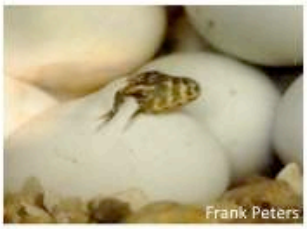
HYPOTHESIS #2



HYPOTHESIS #3



CLUE #1 : Similarities



All reptiles lay eggs.

CLUE #2 : Fossils

A very old snake fossil has small leg bones!

CLUE #3 : DNA

Snakes share more genes with lizards than turtles.

V.A.2 Part Three—Do Closely Related Organisms Always Look the Same?

The goal of this exercise is to demonstrate that although two organisms may appear to be very similar, that doesn't always mean that they are each other's closest relatives. Sometimes when organisms share a common environment, they evolve similar adaptations to live in that environment. In this example, glass lizards are legless and more closely resemble snakes, but glass lizards are actually more closely related to other lizards than they are to snakes.

Materials:
Each team of 3 students will need index-card sized color pictures of the following organisms living in the Florida Scrub, or use the provided powerpoint slide:

- Florida scrub lizard
- Eastern glass lizard
- Indigo snake

Do not put the names of the organisms on the cards or slide.

Instructions for the Teacher:

1. Without telling the students the names of the organisms, assign one student in each team to each of the organisms.

2. Have each student write down how they think the organism moves through the environment.

3. Have the groups compare the three organisms. Ask each group to identify which two organisms are most similar.

4. Ask each group to share their groupings and the traits that they used to make the grouping.

5. Now give the names of the organisms to the class.

6. As a class, come up with an appropriate grouping based on relatedness (scrub lizards and glass lizards are more closely related to each other than either is to indigo snakes).

7. Ask each group to brainstorm about why the scrub lizard and glass lizard look so different even though they are both lizards and are close relatives.

8. Introduce the concept of **adaptation** to the class—moving in sand (glass lizard) requires a different type of locomotion than moving on top of the sand (scrub lizard). Adaptations are traits that help organisms survive (or reproduce) better in a particular environment.

Results

After completing this activity your students should:

- Understand that closely related organisms can look very different if they are adapted to different environments.
- Understand that distantly related organisms can look very similar if they are adapted to the same environment.
- Understand that adaptations help organisms to survive in a particular environment.

Additional examples for further discussion

There are many examples of distantly related organisms that have evolved similar traits for living in particular environments. Here are a few additional examples that you can discuss with your class:

- Bats and birds both have evolved wings for flight. Being able to fly allows them to escape predators and catch prey such as insects.
- Mole crickets and moles have evolved digging forelimbs that allow them to quickly scoop away soil.
- Fish and whales have evolved fins and aerodynamic bodies that allow them to move quickly through water.

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students, and if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. How do scientists group organisms?

   Scientists use traits or characteristics of organisms to group them based on similarity. More similar organisms are often placed into the same group.

2. List two traits of birds that help identify them as the same group.

   Feathers, beak, eggs, wings

3. What is a hypothesis?

   A hypothesis is an educated guess about a pattern or how something works.

4. Imagine three organisms: Organism 1 is blue and hairy, Organism 2 is blue and hairless, and Organism 3 is pink and hairless. Use this information to answer the following questions.

   What trait would you use to group these organisms?
   How would you group them?
   How would the grouping differ if the other trait was used?

   Students may choose to group the organisms based on either color or hair traits. If they use color, they should group Organism 1 & 2 together, and if they use hair, they should group Organism 2 & 3 together. Their grouping would change drastically based on the trait chosen.

5. Draw a family tree for your family, starting with your grandparents and ending with you.

   Depending on which family members are included, the tree should roughly resemble that of Toni's family tree above.

6. Why are family trees important? Put a check beside any answers below that are true:

   ___ *family trees tell us how organisms are related*
   ___ *family trees tell us how people are related*
   ___ family trees tell us Aunt Lisa's favorite color
   ___ *family trees tell us which organisms we expect to look most similar*

7. True or False (T or F)

   Having the same trait always means that two organisms are close relatives. *F*
   Adaptations help organisms survive in an environment. *T*

8. What types of information do scientists use to decide which family tree is best? Put a check beside any answers below that are true:

   ___ *an organism's appearance*
   ___ *DNA evidence*
   ___ *traits*
   ___ *fossils*
   ___ *genes*

B. THE ENVIRONMENT SHAPES PLANTS AND ANIMALS

Introduction

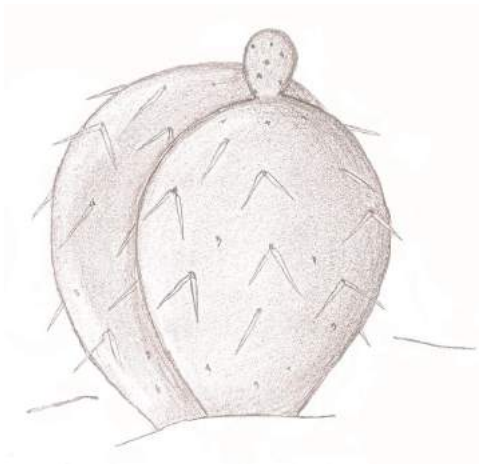
Organisms need to survive and produce young, and those that are not successful will fail to pass their genes to the next generation. The environment is the place in which organisms exist and have to meet these two demands. Because of this, organisms that are better at living in a specific environment are more likely to survive and produce young. Many of the characteristics that we observe in organisms have arisen as a means to live in a specific environment (i.e., **adaptations**). Think about the differences in organisms living on land, in the air, or in the sea. Each environment (habitat) has different physical properties that determine which type of form might work well.

Spatial Scale

When we think about the environment, there are many different spatial scales to consider. For example, the seasons of the year each represent a different environment that affects a very large area of the globe. At the other extreme, an environment might be represented by a single cell that is used by different types of parasites such as a virus living within it.

Abiotic and Biotic Components

The environment is usually represented by both abiotic and biotic components. Abiotic components are things such as temperature, humidity, amount of sunlight, and different types of minerals, whereas the biotic component includes all the organisms in an area that interact with one another. Organisms have to contend with both the abiotic and the biotic parts of the environment. Cacti represent a very good example of how both abiotic and biotic components of an environment have been important in shaping the form of a cactus. The prickly pear cactus in the Florida scrub has a very thick waxy covering that prevents water loss during the dry season. Also, the cactus' stem is very thick and succulent and is used as a way for the plant to store water. Because of this, the stems are strongly attractive to scrub mammals such as deer that would like to eat it. The cactus, however, also has spines (which are modified leaves!) that deter animals from feeding on it. Imagine what would happen to a very juicy and nutritious plant that did not have any defenses against herbivores. It wouldn't last long in the scrub environment because it would get eaten. Also imagine what would happen if you tried to plant a cactus in Alaska!



Evolution and the Red Queen

The environment is the stage on which organisms continually evolve. Evolution continually favors organisms that are better adapted to their environment. In many cases it is easy to understand how a certain environment will favor certain forms of organisms, but in some cases the environment may vary from year to year and no one form continually does the best. Biologists commonly use the analogy of the Red Queen character in Lewis Carroll's *Through the Looking Glass*. In the book, the Red Queen grabs Alice by the hand and they run and run as fast as they can, but when they stop, Alice finds herself in exactly the same place as when they began. Similarly, organisms are constantly evolving to do well in their environments, but those environments may also be changing too. Thus, no organism can be perfectly adapted to an environment, and evolution is a continuous, on-going process. This fact, coupled with the many different types of environments that exist, is one of the reasons that there are so many different kinds of organisms. The latest estimate ranges between 5 and 10 million different species of organisms on the planet—that includes everything from bacteria to blue whales!

In the following exercises your students will explore the different types of environments present in the Florida scrub, and how organisms are adapted to them. They will then discover what causes the seasons and will think about how organisms have adapted to seasonal changes.

V.B.1 Organisms Adapt to Their Environment

Concepts: Identifying habitats in Florida, associating organisms with the appropriate habitat, understand that adaptations help organisms live in a specific environment.
Skills: Cooperative learning, discussion, description
Time needed: Approximately 30-45 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.3, LACC.4.SL.1.1, SC.3.N.1.1, SC.3.N.1.3, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.4, SC.5.L.15.1, SC.5.L.17.1

V.B.1 Part One—What Are the Different Types of Habitats in Florida?

The goals of this exercise are to have students identify some of the different types of habitats in Florida and to think about the types of adaptations that organisms may have evolved to cope with each habitat.

Materials:

- Powerpoint slides of different Florida habitats such as:
  - -Scrub
  - -Hammock
  - -Swamp
  - -Mangrove
- Habitat worksheet

Note—Different habitats can be used or additional ones added to this list. We recommend using habitats that are familiar to the students.

Instructions for the Teacher:

1. Introduce the idea that all organisms have a specific environment that they need to survive and produce young. This environment is called a **habitat**. Use an example such as, *"Imagine how a fish would do on land in comparison to water."*

2. Show the students a slide of each of the habitats and ask how many students have visited each one. List the different habitats on the board. Have the students brainstorm about the characteristics of each of the habitats. Write down the characteristics that the students identify.

   For example, students might identify some of the following characteristics:

Scrub	Hammock	Swamp	Mangrove
dry	damp	wet (water)	near ocean
sandy	very shaded	muddy	salty
fire	humid	shaded	densely overgrown

3. Now have the students list a few of the common organisms that live in each habitat.

   For example, students might list these organisms or many others:

Scrub	**Hammock**	**Swamp**	**Mangrove**
Lizard	Live oak	Bald cypress	Mangrove tree
Black bear	Cabbage palm	Alligator	Cormorant
Snake	Skink	Wading birds	Fish
Gopher tortoise	Woodpecker	Strangler fig	Crocodile
Oak tree	Orb weaver	Florida cooter	Great Blue Heron

4. Next, ask the students *"How 'big' is a habitat?"* As mentioned in the introduction to this section, habitats can be as small as single cells or as big as continents. *How large are the habitats of the organisms that are listed on the board?*

   What factors might make some organisms have smaller habitats than others?

   Habitat size will depend on the organism. Often smaller organisms have smaller habitats, although this is not always the case. For example, a small migratory bird may have a huge habitat spanning multiple continents!

5. Give each student a copy of the Gopher Frog Worksheet. Read the following to the students:

   Gopher frogs are scrub animals that need burrows to survive. They are called 'gopher' frogs because they often live in burrows of other animals such as the gopher tortoise, although they can live in other types of burrows too, such as crayfish or pocket gopher burrows.

   All frogs have skin that dries out quickly especially in environments with high temperatures. Because gopher frogs live in a desert-like environment, the humidity inside their burrows helps them to avoid drying out. Their burrows also provide protection from predators and fire.

   Fire is especially important to gopher frogs. Fire burns plants that shade the temporary ponds they breed in. Shading can reduce food for tadpoles and can also reduce the number of burrows in areas near the ponds.

6. Have the students complete the Gopher Frog Worksheet on their own. Then have the students compare their answers to come to the best solution for each question.

7. Now explain to the students how organisms are adapted to their habitat. *"Organisms that have evolved adaptations to cope with a particular environment will be better equipped to survive and produce young in that environment. For example, gopher frogs have evolved the behavior of living in burrows to avoid drying out, predators and fire."*

8. Ask the students whether organisms adapted to live in one environment could live in another (Could a bald cypress live in scrub? Could prickly pears survive in a swamp?). Why or why not?

9. Return to the list on the board and have the students give some adaptations of the organisms to each habitat. Use the introductory material from the *Discovering Florida Scrub* powerpoint slides and/or the provided slides to aid your discussion.

Results

After completing this activity your students should:

- Recognize the diversity of habitats in Florida
- Understand how conditions differ among habitats
- Recognize that different organisms often live in different habitats
- Understand that adaptations help organisms live in specific environments

Gopher Frog Worksheet

Answer sheet

Gopher Frog

Gopher Tortoise Burrow

1. What is the habitat of the gopher frog?

   Gopher frogs live in burrows near temporary ponds in scrub.

2. Are there characteristics of the habitat that are important for gopher frogs?

   Burrows are needed which also means that other burrow digging animals are needed.
   Temporary ponds are needed.
   Fire is needed to burn away plants that shade the habitat.
   Humidity, protection.

3. How 'big' is this habitat? Do you think it is bigger or smaller than a gopher tortoise's habitat?

   This is a fairly small habitat. It includes the pond and the area around it.
   Gopher tortoises probably have a larger habitat.

Gopher Frog Worksheet

Name: _____

Gopher Frog

Gopher Tortoise Burrow

1. What is the habitat of the gopher frog?

2. Are there characteristics of the habitat that are important for gopher frogs?

3. How 'big' is this habitat? Do you think it is bigger or smaller than a gopher tortoise's habitat?

V.B.1 Part Two—How Are Florida Scrub Organisms Adapted to Their Environment?

In this exercise, students will brainstorm about the habitats and adaptations of several scrub organisms. This exercise will also help students to recognize that even within an ecosystem such as Florida scrub, there are many different types of environments called **microhabitats**.

Materials:

Each student needs:

- Handouts of organisms in Florida

Instructions for the Teacher:

1. Re-introduce the idea of **habitats**. *"Habitats are specific environments that an organism needs to survive and produce young. Habitats can be really big or very small and they can have many different kinds of characteristics like being wet and muddy or dry and sandy.*

   Organisms have evolved adaptations to live in their habitats. For example, the gopher frog has evolved to live in burrows that other animals dig. Living in burrows helps them to avoid drying out."

   Now introduce the idea that habitats such as Florida scrub also have smaller habitats within them. These are sometimes called **microhabitats**. *"Although gopher frogs live in scrub, they can only exist in scrub areas with temporary ponds that have been burned often. This is called a microhabitat and is a very specific environment where gopher frogs can survive. Even in Florida scrub there are many types of environments and microhabitats."*

2. Discuss with your students a few types of microhabitats within scrub. Put them on the board and list a few descriptive characteristics of each one. Here are a few suggested microhabitats and their characteristics:

Open, Sandy Areas	Temporary Ponds	Leaf Litter	Closed Areas with Many Plants
Sunny	Moist or Wet	Cool	Shaded
Hot	Few tall plants	Moist	Tall plants present
Dry	Muddy	Decaying Matter	Short plants present
Few plants		Covered	Cooler

3. Divide the students into groups of 2-3 students. Give a copy of the handout to each student and instruct the teams to work together to complete it.

2. Students should write down the microhabitat that each organism occurs in, keeping in mind that some of these organisms can exist in several microhabitats. They should also write down at least one adaptation of that organism. For example, the deer mouse lives in burrows, forages at night to avoid predators, and it has a very good sense of smell to find food.

3. After the teams have completed the worksheet, ask them to share what they wrote down. There could be many different answers for adaptations. This will help demonstrate that there are many ways organisms are adapted to their environments and that some organisms are highly specialized to one microhabitat whereas others are not.

Results

After completing this activity your students should:

- Associate organisms with their respective microhabitats
- Describe adaptations that organisms have to their habitats

Scrub Microhabitat Answer Sheet

Prickly Pear Cactus
(Opuntia humifusa)

Microhabitat(s): Open, sandy areas

Adaptation: Spines (keeps predators away)

Saw Palmetto
(Serenoa repens)

Microhabitat(s): Open, sandy areas

Closed areas

Adaptation: Resprout from roots after fire

Deer Mouse
(Peromyscus floridanus)

Microhabitat(s): Closed areas

Adaptation: Lives in burrow (protection), nocturnal

Florida Scrub Jay
(Aphelocoma coerulescens)

Microhabitat(s): Closed areas

Open, sandy areas

Adaptation: Lives in burrow (protection)

Scrub Microhabitat Answer Sheet

Scrub Wolf Spider
(Opuntia humifusa)

Microhabitat(s): Leaf Litter

Open, sandy areas

Adaptation: Camouflage, burrows

Gray Fox
(Urocyon cinereoargenteus)

Microhabitat(s): Open, sandy areas

Closed areas Temporary ponds

Adaptation: Den, climbs trees, nocturnal

Sundew Plant
(*Drosera* species)

Microhabitat(s): Temporary ponds

Adaptation: Eat insects (live in nutrient poor soil)

Florida Scrub Lizard
(Scleroporus woodi)

Microhabitat(s): Leaf Litter

Closed areas Open, sandy areas

Adaptation: Hides in leaf litter, camouflage

Scrub Microhabitat Worksheet

Prickly Pear Cactus

(Opuntia humifusa)

Microhabitat(s):_____

_____

Adaptation: _____

Saw Palmetto

(Serenoa repens)

Microhabitat(s):_____

_____

Adaptation: _____

Deer Mouse

(Peromyscus floridanus)

Microhabitat(s):_____

_____

Adaptation: _____

Florida Scrub Jay

(Aphelocoma coerulescens)

Microhabitat(s):_____

_____

Adaptation: _____

Scrub Microhabitat Worksheet

Scrub Wolf Spider
(Opuntia humifusa)

Microhabitat(s):_____

_____

Adaptation: _____

Gray Fox
(Urocyon cinereoargenteus)

Microhabitat(s):_____

_____

Adaptation: _____

Sundew Plant
(*Drosera* species)

Microhabitat(s):_____

_____

Adaptation: _____

Florida Scrub Lizard
(Scleroporus woodi)

Microhabitat(s):_____

_____

Adaptation: _____

V.B.2 Organisms Adapt to the Seasons

Concepts: Recognizing different environments and their effect on organisms.
Skills: Cooperative learning, observation, deductive reasoning, discussion, data recording, interpretation, creative thinking.
Time needed: Approximately 45-60 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: SC.3.E.5.2, SC.3.E.6.1, SC.3.L.17.1, SC.3.L.17.2, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.3, SC.3.N.1.6, SC.3.N.3.2, SC.3.P.11.1, SC.4.E.5.3, SC.4.L.17.1, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.4, SC.5.L.15.1, SC.5.L.17.1, SS.3.G.3.1, SS.4.G.1.1, SS.4.G.1.3, VA.3.S.2.2, VA.3.S.3.1

V.B.2 Part One—Earth's Energy

The goal of this exercise is to learn the main source of Earth's energy by building models of the Earth and Sun.

Materials:

Each student needs:

- Two 3-inch Styrofoam balls
- Paint (yellow, brown, blue, green, red, orange)
- Paint brushes
- Newspaper to protect desks
- Clean up supplies (soap, water, sponges)

Instructions for the Teacher:

1. Introduce the idea of **energy**. *"Energy is the ability of something to do work. It can come in many forms. Can you name one form of energy?"*

   Students may recognize that light, heat, and electricity are all forms of energy. Write their ideas on the board. Now ask the students how these forms of energy allow us to do 'work'. Write these ideas down under each form of energy.

2. Now ask if anyone can think of a HUGE source of energy for Earth. Lead them towards the correct answer. Once they've realized that it is the Sun, ask them what forms of energy the Sun gives us (heat and light).

3. Give each student one Styrofoam ball and the painting supplies. Have them put down the newspaper first to protect their desks. Ask them to create a life-like model of the sun. You may wish to provide a several pictures of the sun at the front of the room.

4. Once they have finished their Sun models, have the students imagine what Earth would look like if they could stand on the Sun and look at it. What does Earth look like from space? They should answer that it is blue and green with white swirly clouds over it (maybe a bit of brown). Ask them what the blue and green parts of the planet are. Why is the land green?

   Now that the students have recognized that plants make Earth green from space, discuss how plants get energy. *"Plants take light energy from the Sun and turn it into food. This food is used by the plants to grow and produce offspring. Other organisms such as humans, eat plants and get the energy that plants have trapped from the sun."*

5. Give each student another Styrofoam ball and have them create a model of Earth. You may wish to provide them with globes and/or pictures of Earth from space.

Notes

It is important that the students create relatively accurate Earth models (roughly correct continent outlines). These models will be used in V.B.2 Part Two to think about how the seasons change in Florida.

Results

After completing this activity your students should:

- Understand that energy comes in many forms
- Recognize that the Sun is a main source of energy for Earth
- Understand that plants trap energy from the Sun to make food

V.B.2 Part Two—What Causes the Seasons?

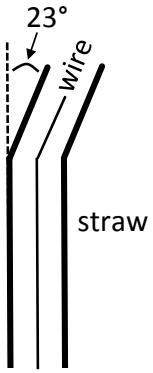
The goal of this exercise is to demonstrate why we experience seasonal changes in temperature. This information will be used in the next exercise on adaptations to seasons.

Materials:

Each team of 3-4 students needs:

- A wreath approximately 18 inches in diameter with four equidistant holes numbered 1 through 4.
- One 3-inch Styrofoam Earth model (from V.B.2 Part One)
- One 3-inch Styrofoam Sun model (from V.B.2 Part One)
- 4 pieces of 16 gauge wire the same length as the straws
- 4 flexible straws
- A sewing pin or push-pin

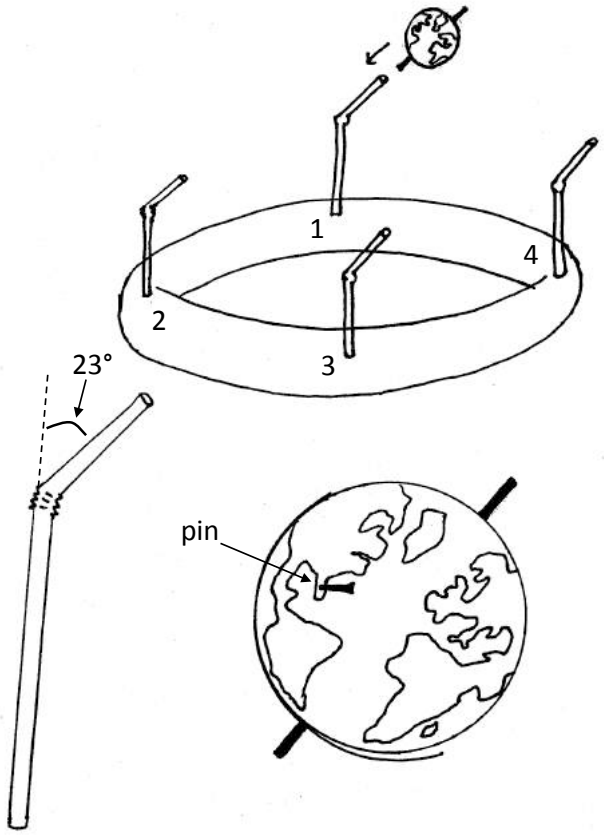
Note—Alternative materials may be substituted. Students in groups can also each place their Earth model at one of the four positions around the ring.



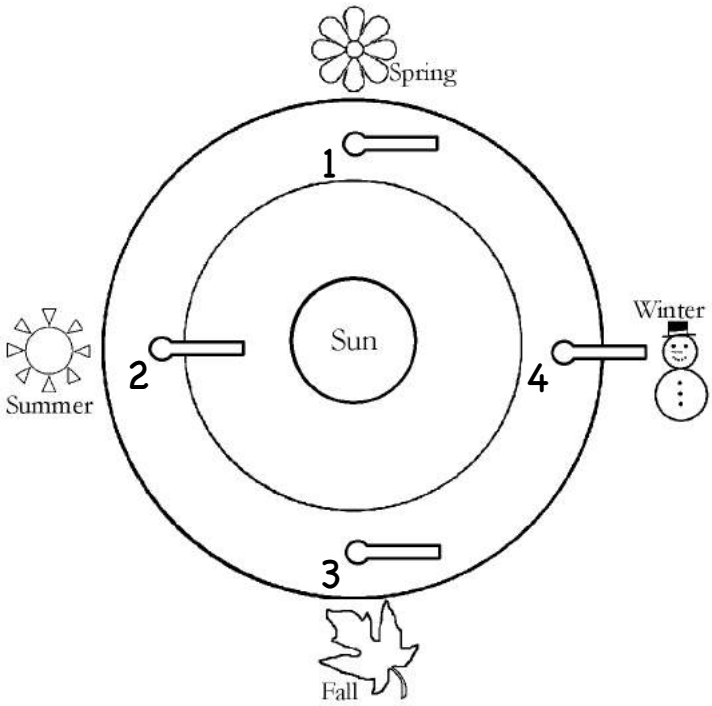
Instructions for the Teacher:

1. Have the students insert the heavy gauge wire into the straws approximately ½ inch past the flexible part. Bend the straw/wire to approximately 23 degrees as shown on the right. Make sure all four straws have the same angle.

2. Have the students align the ring so that number one is at the 'top' of the ring (see figure, next page). The students then place the straws in the holes with the angles facing the same direction. *Keep in mind that the straws need to stay in these positions as they move the globe around the ring in the next step.* Place the sun sphere in the middle of the ring. It will help if you have them place it on a support (for example, an empty plastic bottle with the top cut off) to bring it up to the same height as the Earth model.



3. Have the students take a pin and insert it into Florida. Move the globe to each of the four points on the ring and rotate the globe on the straw so that Florida is facing the sun. Alternatively, each student in a team can simultaneously place their model on a straw (four Earth models on the ring at once).

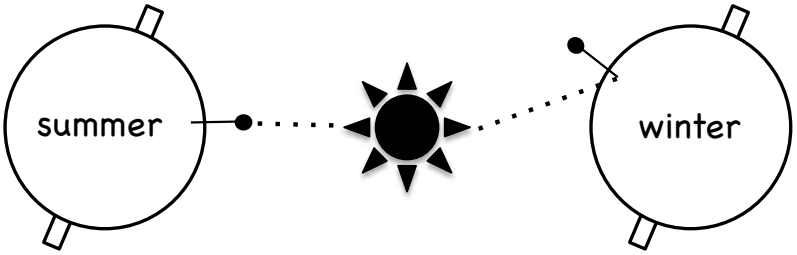


4. Have the students record whether Florida and the inserted pin are pointing directly at the sun at a downward angle or an upward angle.

4. Remind the students of your discussion about energy. At what position would the sun give the greatest energy to Florida? At what position would the sun give the least energy? Have the students write down what season they think occurs at each numbered position.

5. Now have them write down their ideas about why the seasons are formed.

6. Discuss as a class the ideas and review the correct answer: there is more sun energy per unit area hitting the earth when Florida is directly facing the sun in summer.



Results

After completing this activity your students should:

- Understand what causes the seasons.
- Make predictions about the amount of sun energy striking the earth at different times of the year.

V.B.2 Part Three—How Have Organisms Adapted to the Seasons?

During this exercise, students will think about how organisms have adapted to annual changes in temperature. The students will participate in class discussion of adaptations to seasonal change.

Materials:

- Powerpoint slide or handout of deciduous and evergreen trees, annual flowering plant, scrub jay with nestlings, black bear, and Florida scrub lizard

Instructions for the Teacher:

1. Use a powerpoint slide to start a discussion about how organisms have adapted to the seasons. Begin with a familiar example such as a black bear. *"What adaptations does the black bear have to seasonal changes?"* List the students' ideas on the board. *"What other adaptations do organisms have to handle the seasons?"* Add the following strategies to the list on the board if they are not discussed:
   Loses leaves
   Hibernates
   Reproduces in spring/summer
   Migrate

2. For each slide, have the students match an adaptation to the organism. Have the students make suggestions as to why these strategies are adaptations. For example, deciduous trees can't keep their leaves with so little energy from the sun. Similarly, black bears can't find enough food during the winter months.

4. After going through the slides, brainstorm as a class about how the following organisms have adapted to changes in the seasons.

Insects	many insects reproduce in the summer and the eggs or pupae overwinter
Alligators	build dens to stay in during cold weather
Birds	migrate to warmer regions of the world during cold weather

Results

After completing this activity your students should:

- Understand how organisms adapt to changing environment
- Provide examples of adaptations to different environments

QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students, and if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. Name two different types of habitats in Florida. What is a special characteristic of these habitats?
   There are many possibilities. For example:
   Swamp-wet, can have standing water
   Scrub-dry, sandy
   etc.

2. True or False (T or F):
   Bears live in scrub. *T*
   Scrub lizards live in swamps. *F*
   Crocodiles live in mangroves. *T*
   Gopher tortoises live in hammocks. *F*

3. Write a short essay about the habitat of gopher frogs. What special needs to gopher frogs have? How do they cope with fire?

4. List one way that an organism's habitat might be smaller than another's.
   An organism may have special requirements such as they can only live in areas that are frequently burned or that must have water at some times of the year. Organisms may also be dependent on other organisms which would limit their habitat size.

5. Give an example of a scrub microhabitat. Now name two organisms that live in that microhabitat.
   There are many possibilities. For example:
   Temporary pond- gopher frog, sundew
   Leaf litter- scrub lizard, wolf spider
   Open, sandy areas- prickly pear, gray fox
   Closed areas- deer mouse, scrub jay

6. List an adaptation of gopher frogs to their habitat.
   Live in burrows

7. True or False (T or F):
   Some animals eat plants. *T*
   Animals use sunlight to make food. *F*
   Plants use sunlight to make food. *T*
   Plants use their food to grow and produce offspring. *T*

8. Name two kinds of energy the Sun produces.
   Light, heat

9. Name three adaptations that help organisms deal with the seasons.
   Hibernation, migration, lose leaves, reproduces in spring/summer

10. Why do we have seasons? Put a check by the correct answers.
    ___ *Less energy hits the Earth in the winter.*
    ___ More energy hits the Earth in the winter.
    ___ *Earth is tilted at a 23° angle.*
    ___ Less energy hits the Earth in the summer.
    ___ *More energy hits the Earth in the summer.*
    ___ Plants use sunlight to make food.

C. CONDITIONS FOR ADAPTATION

Introduction

The snake-like body of the Eastern glass lizard, the defensive spines on the prickly pear cactus, and the hunting behavior of antlions are all **adaptations** which help organisms to better survive and reproduce in their environment. **Evolution by natural selection** produces organisms that survive or reproduce better in a particular environment by gradually shaping the traits that help them in that environment. These traits are called **adaptations**.

Adaptations are formed by changing pre-existing structures to serve new purposes. For example, the spines of the prickly pear cactus are actually the true leaves of the plant. Evolution has changed the form of the leaf into a protective spine that is now no longer able to collect sunlight or make food for the plant. Instead, the thick, green stems of the plant have taken over the role of the leaves. This may not be an ideal situation, but evolution is limited because it can only act on structures and traits that an organism already possesses. This is why humans will be unlikely to evolve wings on our backs or sprout antennae from our heads. Evolution doesn't always make perfect adaptations.

Requirements of Evolution—Variation

There are a few simple conditions that are needed in order for evolution by natural selection to occur. First, a population of organisms must have **variation**. It is easy for us to identify variation in human populations. People come in many different shapes and sizes. We have different colors of hair, skin and eyes. Some people are very quiet and others are very loud. There is also variation among human populations that is not so easy to see. Different people have varying metabolisms and resistance to specific diseases.

We are very good at finding variation in human populations. It takes a little bit more practice and good observational skills to find variation in other organisms, but it is there too! Populations of organisms living in the Florida scrub can have just as much, and sometimes, even more variation than human populations. We just have to train ourselves to see it. The ultimate source of variation in a population is **mutation**, random changes in DNA during the formation of egg and sperm cells. However, a population can also have new variation (and new genes) introduced when individuals migrate between populations.

Requirements of Evolution—Heritability

Second, the variation in a population needs to be **heritable**. That means the variation has to be caused by genes in our DNA, not just by the environment. We inherit our parents' genes, but we do not inherit our parents' environment. Therefore, adaptive change can only happen in traits that are at least partly determined by genes. Eye color

is a characteristic that is completely determined by genes. Some traits are not determined by genes at all. For instance, the language we speak is a trait we acquire from our environment. Also, gender in alligators is determined by the incubation temperature of the eggs. If an egg is really warm, it becomes a male and if it is cooler, female!

Many traits are determined by a combination of genes and environment. For example, we tend to have a similar height as our parents. However, our height is also influenced by our childhood diet and some childhood diseases can stunt growth. Similarly, the height of plants is influenced by a combination of genes and the environment (for example, whether plants grow in full sunlight or in shade), and the color of green anoles is also influenced by both genes and the color of the background on which they are resting. The key thing to remember is that as long as the variation in a trait is partially determined by genes, that trait can potentially adapt to its environment through natural selection.

Requirements of Evolution—Natural Selection

Third, some heritable forms of a trait need to be better at surviving and reproducing in the environment than other forms. This differential survival and reproduction is called **natural selection**. The environment acts as a filter, allowing some traits through to the next generation, and removing other traits from the population. For example, prickly pear cacti with many stiff spines survive better than prickly pear cacti with few soft spines because the ones with many stiff spines are better protected from being eaten. We would expect the prickly pear population to gradually change over time so that each successive generation has more individuals with stiff spines... an adaptation!

It is important to remember that traits that help an organism survive in one environment might not help them to survive in another environment. Returning to the prickly pear example, consider an environment where there are no animals that eat prickly pear cacti. Both cacti with many stiff spines and cacti with few soft spines will survive equally well. In this case, we would not expect to see a change in the spines of this population from one generation to the next. Now imagine that this environment has very few resources or nutrients. The cacti that use their limited resources to produce many stiff spines might not have resources left to produce seeds. In this case, we'd expect more individuals with soft-spines to survive with each generation that passes.

The activities in this section will introduce students to the following concepts: 1) Populations of organisms have variation, 2) some variation is due to inheritance and some variation is due to the environment, and 3) the environment can filter variation to change a population over generations.

V.C.1 Discovering Variation

Concepts: Most populations of organisms contain a lot of variation in traits.
Skills: Measurement, graphing, identification, scientific method, description, observation, discussion, cooperative learning, interpretation of data.
Time needed: Approximately 45-60 minutes.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.1, LACC.3.SL.1.3, LACC.3.W.1.1, LACC.3.W.3.8, LACC.4.SL.1.1, LACC.4.W.1.1, MA.3.A.4.1, MA.3.A.6.2, MA.3.G.5.2, MA.3.S.7.1, MA.5.A.4.2, MA.5.G.5.3, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.3, SC.3.N.1.6, SC.3.N.1.7, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.5, SC.4.N.1.6, SC.4.P.8.1, SC.5.L.15.1, SC.5.L.17.1

Students will be very good at finding variation among humans. This exercise will help students to understand that there is a lot of variation in other types of organisms as well. Students will measure leaves of a common plant, graph their results, and discuss the variation observed.

Materials needed:

For each group:

- A ruler
- A student datasheet
- A clipboard or hard surface to write on
- A pencil
- A picture/photo of local tree with leaves in easy reach

For the whole class:

- Large graph paper
- Markers

Instructions for the Teacher:

1. Prior to class time, you need to select the site where students will be measuring leaves and the plant species they will measure. You need to find a large number of plants (~15 plants per group of students) of the same species for your students to measure. We recommend looking for a site with a large number of small oaks or herbs (such as gopher apple).

2. Divide the class into groups of three or four students, and give each group their materials.

3. Take the students outside, and instruct them on how to identify the plant. Find 15 individuals of the same plant species. We recommend using a very common plant such as sand live oak. If you choose to use grass, make sure that it has not been mown.

4. Instruct the students to measure the leaf length to the *nearest centimeter*, from where the leaf starts to the tip (see worksheet), following along the middle line on the leaf. They should record the length on their datasheet. You can use the image on the worksheet to explain this measurement.

5. Students measure the length of **one** leaf on each of 15 plants. They should have 15 different measurements from 15 plants of the same species when they are finished.

6. After each group has measured 15 leaves, return to the classroom.

7. On a new sheet of the large graph paper, make a frequency chart of all the leaf lengths, explaining how the frequency chart works. See example class data chart.

8. Have each group record their data on the large graph paper, by placing an X in the correct column for each of their measurements.

9. Ask the students to write down why they think there might be different lengths of the leaves of the plant even though they were all the same species. Then ask them to share their answers. If they are struggling, ask them why they think the students in the class aren't all the same height.

10. Explain that the differences the students have observed in the plants are known as variation. Variation exists in all species of organisms. Variation is the first thing needed in order for a population to adapt to its environment.

11. You can ask the students under what conditions they think a small leaf might be better than a large one. When are small leaves beneficial? Large leaves? What conditions might favor small versus large leaves? How might seasonal changes affect leaf size?

Results

After completing this activity, your students should:

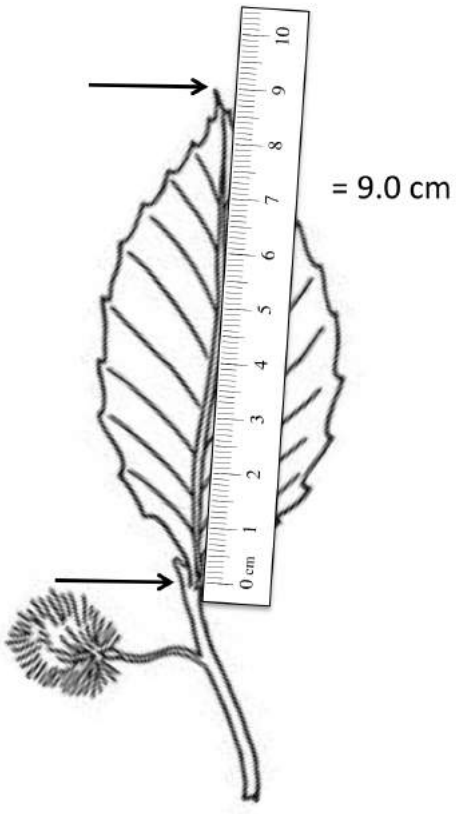
- Be able to identify the selected plant species
- Understand the concept of variation, that individuals in a population are not identical
- Describe variation in different organisms

V.C.1 Discovering variation

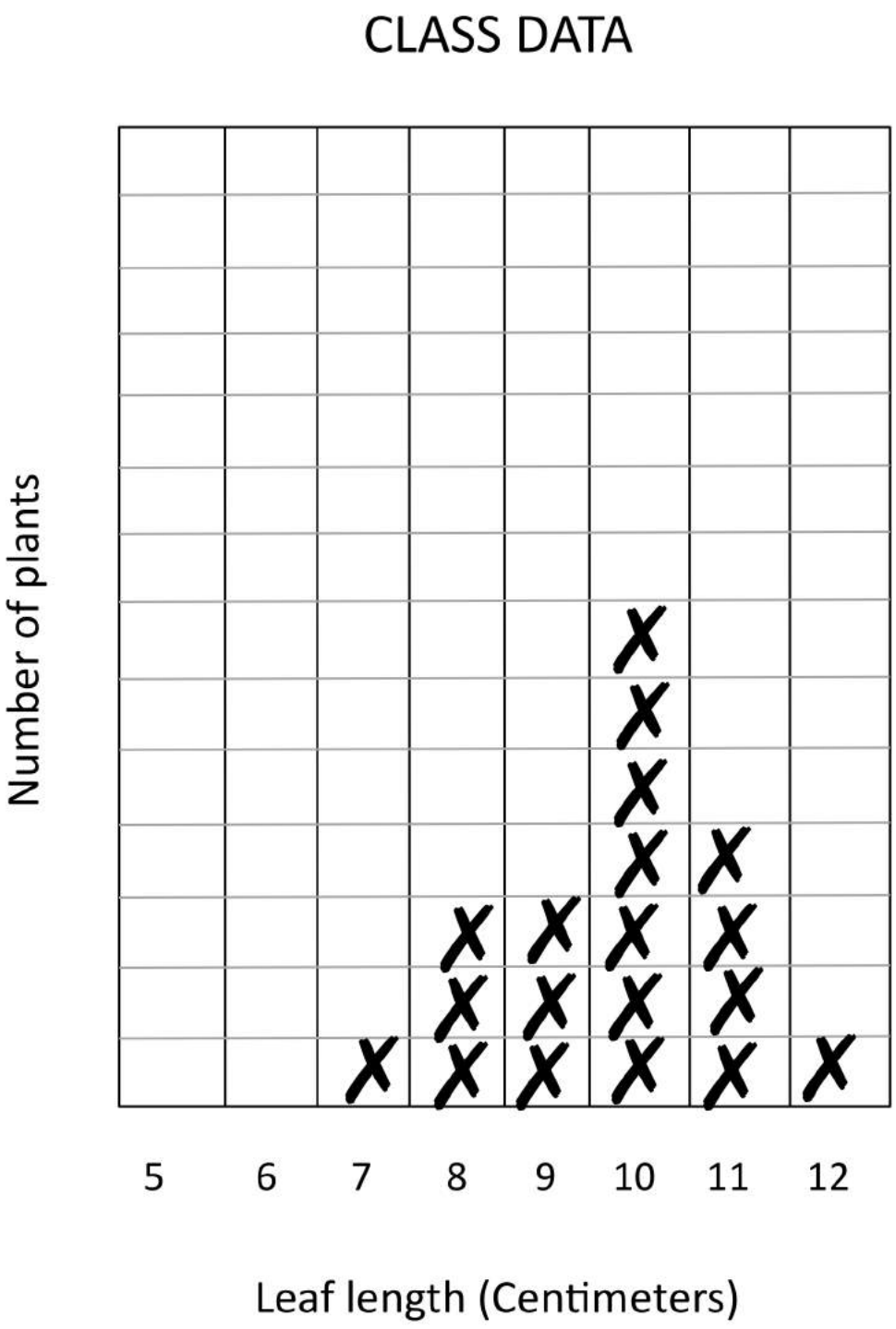
Student Data Sheet

Team members: _____

Plant number	Length of leaf (in centimeters)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	



Example Group Data Chart:



V.C.2 Variation: Genes or the Environment?

Concepts: Inheritance, environmental influence, instinct, learning in animals.
Skills: Observation, forming hypotheses, cooperation, critical thinking, discussion, scientific method, interpretation of data, data recording.
Time needed: Part One will take about 20 minutes, Part Two requires 1 week.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.1, LACC.3.SL.1.3, LACC.3.W.1.1, LACC.3.W.3.8, LACC.4.SL.1.1, LACC.4.W.1.1, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.3, SC.3.N.1.6, SC.3.N.1.7, SC.3.N.3.1, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.3, SC.4.N.1.5, SC.4.N.1.6, SC.4.N.1.7, SC.4.N.1.8, SC.4.N.2.1, SC.5.L.15.1, SC.5.L.17.1, SC.5.N.1.1, SC.5.N.1.2, SC.5.N.1.3, SC.5.N.1.4, SC.5.N.1.6, SC.5.N.2.1, SC.5.N.2.2

V.C.2 Part One—Anoles: Inheritance versus Environment

The variation observed among individuals may be caused by either their genes or by the environment that the individual was raised in. This exercise will help the students to recognize that traits can be shaped by one or both of these factors. In this exercise, green anoles will be used to demonstrate that they can change color based on their background. Although their ability to change color is an inherited trait, the color they become is caused by the environment.

Materials needed:

- Brown construction paper
- Green construction paper
- Several green anoles (*Anolis carolinensis*)
- Terrarium with a mesh cover on the top
- Piece of cardboard
- Student ballots
- Two boxes/bowls/hats for collecting ballots

Instructions for setting up the experiment – before students arrive

1. Cut the piece of cardboard so that it separates the terrarium into two sections. Make sure the cardboard reaches to the cover and sides of the terrarium, to keep the anoles separated.

2. In the left-hand section, line the exterior of the terrarium with green construction paper, leaving one side of the glass uncovered so the students can look inside. Line the right-hand section similarly, using brown construction paper. During the exercise, you are going to switch the construction paper, so make this easy to remove.

3. Add an equal number of anoles to each side, and give them time to change their color to the background.

4. Place the two boxes/bowls/hats beside the terrarium, one next to each section.

Instructions for the Teacher:

1. Discuss heritability with the students. *"Have you ever been told that you look like one of your parents in some way? Have you ever noticed a resemblance to a brother or sister, such as having the same color eyes or same color hair? The reason for this is because people, as well as all living things, inherit traits from their parents. A trait is a characteristic of an individual. Traits include eye color, height, skin color, and the overall appearance of any living thing. Inheriting a trait means that the parents pass on how they look to their children through their* ***genes****."*

2. Show the students the terrarium with the anoles in it, and ask them, based on the information they just discussed, what color do they think the parents of the anoles on the left were, and what color they think the parents of the anoles on the right were. They should write down their 'hypotheses' on their student ballots. Most students will probably write down that the green colored anoles had green parents and that the brown colored anoles had brown parents.

3. Have the students tear their ballots in half and put their guesses for the left-hand side in the left hand box/bowl/hat and guesses for the right hand side in the right box/bowl/hat.

4. After the students have cast their ballots, cover the front of the terrarium to hide the anoles from the students' view. Switch the color of the construction paper on the outsides of the terrarium. Now the right hand side should be green and the left side brown.

5. Read, or explain in your own words, the next section to your class.

   "Although many traits of a living thing are inherited from their parents, the traits of all living things are also determined by their surroundings. One such example is proper nutrition in young animals. If an animal is given the right amount of food and the right kind of food, they usually grow to be much bigger than one that was not given enough food or given food that is not nutritious when they were growing up. Another example is the hydrangea plant. Hydrangeas with blue flowers can grow pink flowers in the following year if limestone is added to their soil."

   (the following website shows the color changes in hydrangea and could be used to illustrate the point: http://www.hydrangeashydrangeas.com/colorchange.html).

6. Read aloud ten of the hypotheses from the left hand side. Ask students if they agree with the hypotheses. Then uncover the left hand side of the terrarium.

Pause to let students look at the anole. The anole in the green environment should have switched to green whereas the one in the brown environment should have switched to brown.

7. Read aloud ten of the hypotheses from the right hand side of the terrarium. Ask the class if they agree with the hypotheses. Then uncover the right side of the terrarium. Pause to let students look at the anole.

8. Read/Discuss the following with the class:

   "Although the environment can cause changes in appearance that can take years to actually show up, it can also take minutes or even seconds for surroundings to change the characteristics of certain animals. Some animals have the ability to change their skin color to blend in with the surface they are on, such as anoles, chameleons and some octopi. Although the ability to change color is inherited from their parents, the surrounding environment is what causes their skin to be a certain color. Why do you think anoles change color to match the background?"

Questions for the class

How did a change in the environment (from one color background to another) affect the anoles?

How do **you** change when your environment changes (e.g., from a sunny day to a rainy day; from a warm to a cold day)? The changes could be ones that they change with their behavior (putting on sunscreen or a raincoat) or things that change because of the environment (getting a tan/sunburn or goosebumps).

What traits do you think these anoles inherited from their parents? The anoles inherited the ability to change color to match their background. This adaptation may help them to avoid predation or to make them better able to catch prey.

Think of a friend you know and then think of one of his or her parents. What traits do you think your friend inherited from his or her parents?

Results

After participating in this activity, your students should be able to:

- Give an example of a trait
- Distinguish between traits inherited from parents and traits determined by the environment

I think the anoles on the **LEFT** had parents that were colored: ____________________ My hypothesis	I think the anoles on the **RIGHT** had parents that were colored: ____________________ My hypothesis
I think the anoles on the **LEFT** had parents that were colored: ____________________ My hypothesis	I think the anoles on the **RIGHT** had parents that were colored: ____________________ My hypothesis
I think the anoles on the **LEFT** had parents that were colored: ____________________ My hypothesis	I think the anoles on the **RIGHT** had parents that were colored: ____________________ My hypothesis
I think the anoles on the **LEFT** had parents that were colored: ____________________ My hypothesis	I think the anoles on the **RIGHT** had parents that were colored: ____________________ My hypothesis
I think the anoles on the **LEFT** had parents that were colored: ____________________ My hypothesis	I think the anoles on the **RIGHT** had parents that were colored: ____________________ My hypothesis

V.C.2 Part Two—Antlions: Instinct versus Learning

The goals of this exercise are to have your students learn about experimental design, and to distinguish learned behaviors from those that are innate (instinctive). Students will set up a behavior experiment with antlion larvae. They will train one group of larvae to recognize when their traps are being poked by a skewer (false alarm) and then will compare this behavior to antlions that have not experienced this false alarm.

The antlions used for this experiment are actually the larvae of an adult insect that resembles a dragonfly. Many insects go through changes from one form to another during their lifetime (e.g., butterflies go from eggs to caterpillars to adults). Larvae are the forms of young insects. The antlion larva lives by tunneling through the sand and setting up a pitfall trap where it waits for another insect, such as an ant, to stumble into the pit trap. It then flings sand at the ant and at the sides of its trap to keep the ant from escaping until the antlion can grab it with pincers and eat the ant.

This way of living was not taught to the antlion. Antlion larvae just know to act this way to catch their food. This is known as instinct. An instinct is any behavior that an animal shows without needing to be taught how to do that behavior. Not all behavior is instinctive, however. Some behaviors are learned. For example, dogs can be taught how to follow commands from their owner, gazelles can learn what is a possible threat to them, such as a lion, and that they need to run away if they sense one. Even insects, such as antlions, can learn.

Materials needed for antlion collection

- Cups
- Garden trowels
- Fine mesh strainers, (ones for cooking work well)

Materials needed for experiment

- Fine, sandy soil
- Antlions
- Blue and red plastic cups (or any two colors)
- Permanent markers (Sharpies work well)
- Ants
- Small skewers

Instructions for gathering antlions:

1. Have the students form small groups

2. Give each group: 2 blue cups, 2 red cups, a garden trowel, and a mesh strainer

3. Show the students trails left by antlions so that they know how to find them. Antlions are often found in loose sand under cover (for example, near a house, under a carport with a sand floor).

4. Once students find the pit of an antlion, instruct them to dig up the sand around the pit, taking up sand from an inch below the bottom of the pit.

5. Place the sand in one of the strainers, and gently shake it so the sand falls through. Be careful not to hurt the antlion larva!

6. Once an antlion larva has been caught in the strainer, dump it into a cup, and pour a little sand inside the cup, about an inch from the bottom.

7. Return to the classroom after each team has gathered enough antlions to have 1 antlion in each cup.

Instructions for setting up the experiment:

1. Label the cups with the name of the team.
2. Label the red cups "1" and "2". Label the blue cups "3" and "4".
3. Add another inch of fine, dry sand to each cup.
4. Allow the antlions one day to create new pit traps.

Instructions for carrying out the experiment:

1. Using the small skewer, have students gently poke the side of each of the traps in the red cups ONCE. Have the students observe the behavior and record their observations on the data sheet.

2. For the antlions in the blue cups, drop one ant into or very close to the pit, allow the students to record their observations.

3. Do this twice each day, once in the morning and once near the end of the day, and have the students record their observations each time.

4. Be sure to feed the antlions in the red cups once every day so they don't starve. To feed them, drop an ant into the pits.

5. After the antlions in the red cups stop responding to the stick poking their trap, instruct the students to poke each of the traps in the blue cups ONCE, and have them write down their observations.

Questions for the class

What do you think the antlions in the red cups learned?

How can you tell they learned this? (Think about the antlions in the blue cups and how they acted.)

What do antlions know how to do, without being taught?

What do human babies know how to do without being taught (instincts)?

What are some things human children have to learn to do?

Notes

In this exercise your students will set up an experiment. After the initial setup, you may wish to discuss experimental design with your students. The following is a brief outline of a discussion you can have with your class.

What is an experiment? An experiment is a way that scientists can test ideas about how the world works. Some experiments involve making observations in natural populations. For example, the leaves we measured in V.C.1 Discovering Variation was this type of experiment.

Other types of experiments are **manipulative**, where scientists purposefully change the conditions. For instance, a scientist might take several plants and water some of them but not water the others and then measure how tall they grow in two weeks. In this example, the scientist has purposefully changed whether or not a plant is watered to test if water makes plants grow. Scientists would call the plants that get water the treatment and the plants that didn't get any water are the controls. Usually, **controls** don't receive any treatment and tell scientists what would happen without the treatment.

Once a scientist has set up an experiment by giving the experimental subjects the treatment (or not as in the case of the controls), what is the next step? Collect data! Scientific experiments always collect data and this can be in many forms. What are different types of data that can be collected? (measurements of leaf length, plant growth, how fast someone can run, etc.) Have the students brainstorm.

By collecting data, scientists can determine the result of the experiment. In our example of the scientist who watered some plants and didn't water the control plants, what do

you think the results looked like? Which plants grew the tallest? By purposefully changing the conditions, the scientist was able to tell that water helps plants grow taller.

Results

After participating in this activity, your students should be able to:

- Identify antlion pits
- Record observations
- Make a conclusion based on observations
- Distinguish between instinctual and learned behaviors and give examples

V.C.2 Antlions: Instinct vs. Learning

Name: _____

Day	What did you do? (Circle one)	Observations – What did the antlion do?				
		Red cup #1	Red cup #2	Blue cup #1	Blue cup #2	
1	Red: poke / fed					morning
	Blue: poke / fed					afternoon
2	Red: poke / fed					morning
	Blue: poke / fed					afternoon
3	Red: poke / fed					morning
	Blue: poke / fed					afternoon
4	Red: poke / fed					morning
	Blue: poke / fed					afternoon
5	Red: poke / fed					morning
	Blue: poke / fed					afternoon

V.C.3 The Environment and Natural Selection

Concepts: Variation, predation, natural selection, adaptation
Skills: Cooperative learning, observation, data recording, discussion, interpretation of data.
Time needed: Approximately 45-60 minutes for each part.
Best time of year: Anytime.
Sunshine State Standards: LACC.3.SL.1.1, LACC.3.SL.1.3, LACC.3.W.1.1, LACC.3.W.3.8, LACC.4.SL.1.1, LACC.4.W.1.1, MA.3.A.4.1, MA.3.A.6.2, MA.3.G.5.2, MA.3.S.7.1, MA.5.A.4.2, MA.5.G.5.3, SC.3.N.1.1, SC.3.N.1.2, SC.3.N.1.3, SC.3.N.1.6, SC.3.N.1.7, SC.3.N.3.1, SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.3, SC.4.N.1.5, SC.4.N.1.6, SC.4.N.1.7, SC.5.L.15.1, SC.5.L.17.1, VA.3.S.2.2, VA.3.S.3.1

In this exercise, students will observe the process of natural selection. The students will make a variable pupfish population that has a heritable trait: magnet/loop sides. Students will then use magnet or hook fishing poles to selectively remove one type of fish. By acting as predators, the students will change the number of each type of pupfish in the population and will observe natural selection in action.

V.C.3 Part One—Making a Pupfish Population

Materials:

- tagboard in at least two different colors
- magnets
- twist ties
- 4 one-gallon plastic bags
- scissors
- colored pens
- glue
- tape

Instructions for the Teacher:

1. Divide the class into two groups.

2. Provide students with fish templates (fish template below) and tagboard. One group will need to cut out 100 fish of one color and the other group will need to cut out 100 fish of a different color. Students can then decorate the fish.

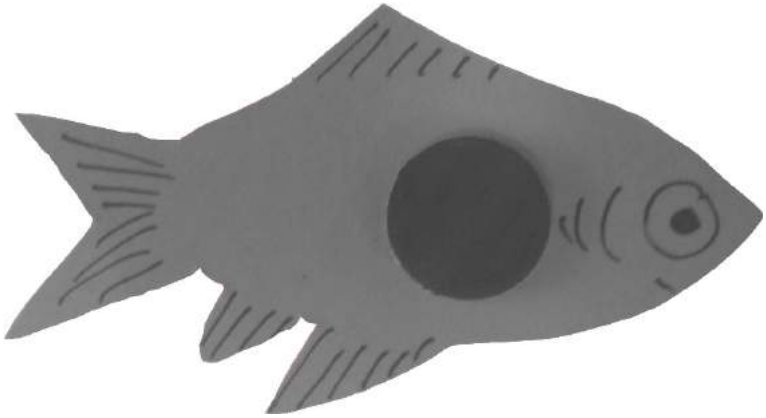
   Alternatively, you can give the students a mix of a number of tagboard colors to use. Later on, this will provide additional challenges for the student 'predators' as they try to catch the fish.

3. One group will glue a magnet on the side of all 100 of their fish. The other group will tape twist tie loops to all 100 of their fish.

4. When the glue is dry, divide the magnet fish into two bags of 50 and divide the loop fish into two bags of 50. Each should fit into a one gallon Ziploc baggie.

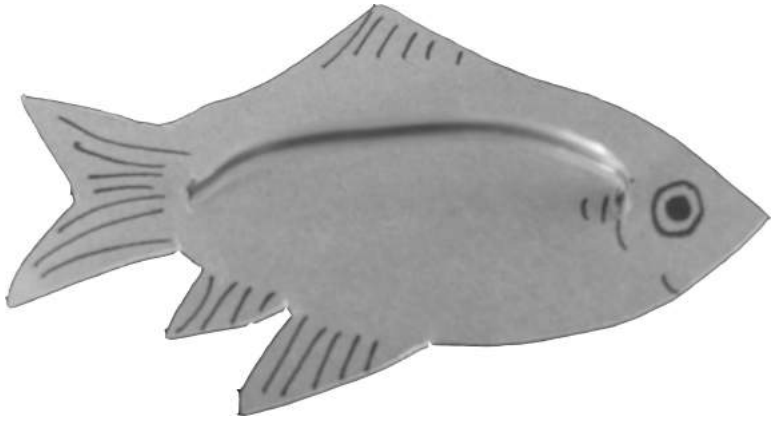
Use this as a template to make fish.

This is a magnet fish



Use this as a template to make fish.

This is a loop fish



V.C.3 Part Two—Evolving Pupfish Populations

Materials:

- 100 tagboard fish with weak magnets
- 100 tagboard fish with twist-tie loops
- 4 'fishing' poles: two with a large metal nut attached, two with paper clip hooks (these can be made out of any stick and thread combination)
- 2 three-meter lengths of rope to make the imaginary ponds
- A timer, stopwatch or clock
- 2 copies of the student worksheet
- 2 transparency copies of the class datasheet
-

Instructions for the Teacher:

1. Clear two open spaces in the classroom for this activity, or go to a gym.

2. Divide the class into two groups. Each group places their 3-meter rope in a circle in front of them on the floor. Tell them to pretend that this is a pond. Each group should name their pond.

3. Explain to the students that in this pond, there is one species of pupfish that has two different forms (variation!): magnet and loop forms. Have them think of other species that have different forms so they understand that individuals of the same species can look different (for example, dogs). You can remind them of the variation in plants that was observed in activity V.C.1 Discovering Variation.

4. Give each group a bag of loop fish and a bag of magnet fish. Instruct them to count out 25 of each, place them in the "pond", and mix them up a little. The other fish can remain in the bags. They should record the number of magnet and loop fish in the pond under the "Round 1" column in the data table (see example data table).

5. Now explain that each pond has a different environment, because the predators that catch fish have different fishing tools.

6. Give one group a fishing pole with the hook attached, and give the other group a fishing pole with the metal nut attached. Allow students to catch fish *using only their fishing poles* for 45 seconds.

7. Count the number of different forms that were caught after one round of fishing. Record these numbers in the second column.

8. Now explain that each pond can only hold 50 fish. This is the **carrying capacity** of the pond or its maximum population size. All populations have a maximum size before they eat all of their resources.

   The only way for more fish to get into the ponds is for the fish in the pond to have babies. The fish that were caught can't have babies because they were eaten by the predators. So we will replace the caught fish with fish of the opposite type. For example, if you caught 5 loop fish, add 5 magnet fish to the pond. If you caught 9 magnet fish, add 9 loop fish to the pond.

   Optional: You can alter the replacement of fish to be more biologically realistic. Have the students determine the number of each type of fish remaining and then have each fish pair with a mate of the same type (magnet with magnet; loop with loop), each pair can produce one offspring of the same type. Add this number of each fish type to the pond, up to the carrying capacity of 50.

9. Now record the number of magnet and loop fish in the pond under "Round 2".

10. Have the students fish again for 45 seconds.

11. Repeat #7 and #8 and then record the number of magnet and loop fish in the pond under “End”.

12. As a class, fill in a class data bar graph at the front of the room (on a transparency, the board or chart paper), one for each group.

13. For each pond, ask the students which form is likely to survive and which one is likely to disappear from the population. The surviving form is an **adaptation**, a trait that helps an organism survive in its environment. The process that changes the population from one form to another is called **natural selection**.

14. Ask students if the same form is an adaptation in both environments. Explain that this is what happens in nature. Natural selection works differently in different environments, producing different traits or adaptations. This is why closely related organisms in different environments can look very different (like the Florida scrub lizard and the Eastern glass lizard).

Notes

There are a number of variations of this experiment that can be conducted in class. For instance, if you want, you may wish to vary the fishing time. By lengthening the time the students have to fish, you will expect to see more predation and change during each generation, and vice versa if the time is shortened.

You can also provide them with additional charts to record more generations. Even adding just one or two generations may allow the students to observe extinction of one fish type.

Another possibility is to have the students repeat #7 and #8 again, but this time have the fisherpeople swap the fishing pole types. Ask the students what should happen now. Have the students fish with the new pole type and observe the results. This should reverse the results.

Questions for the class

What was different about the environment of the two ponds?

Why did one pond end up with different looking fish than the other pond?

What do you think would happen if the pond background were the same color as one of the fish forms? Which one would likely be able to hide from predators better and make more baby pupfish?

Results

After participating in this activity, your students should be able to:

- Make a bar graph
- Make a conclusion based on recorded data
- Explain how the environment influences the survival of organisms
- Predict that traits which help organisms to survive (adaptations) will increase in a population over time

V.C.3 Environment and Natural Selection

Example Data Sheet

Pond Name: Alligator Lake

Type of fish	Round 1				Round 2				End
	Start	Caught	Replace		Start	Caught	Replace		
	Number of fish in pond	Number of fish caught	Number to add to pond		Number of fish in pond	Number of fish caught	Number to add to pond		Number of fish in pond
Magnet Fish	25	15	5		15	8	7		14
Loop fish	25	5	15		35	7	8		36

V.C.3 Environment and Natural Selection

Student Data Sheet

Pond Name: _____

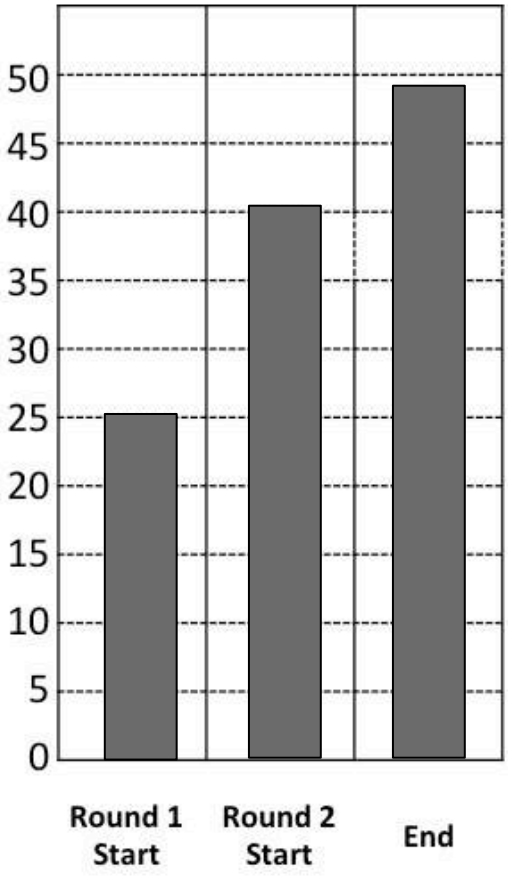
Type of fish	Round 1				Round 2				End
	Start	Caught	Replace		Start	Caught	Replace		
	Number of fish in pond	Number of fish caught	Number to add to pond		Number of fish in pond	Number of fish caught	Number to add to pond		Number of fish in pond
Magnet Fish									
Loop fish									

Class data chart

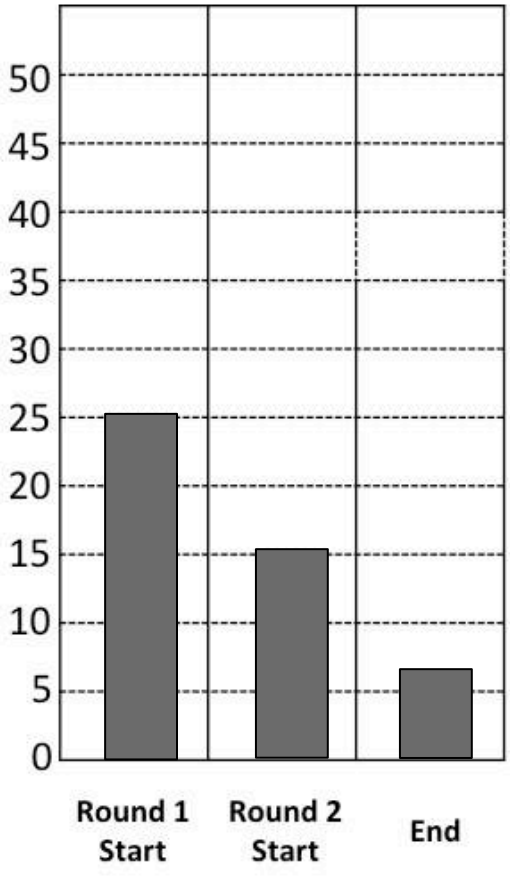
Name of Pond: Scrub oak pond

Type of fishing pole: hook

Plot the number of magnet fish in pond



Plot the number of loop fish in pond

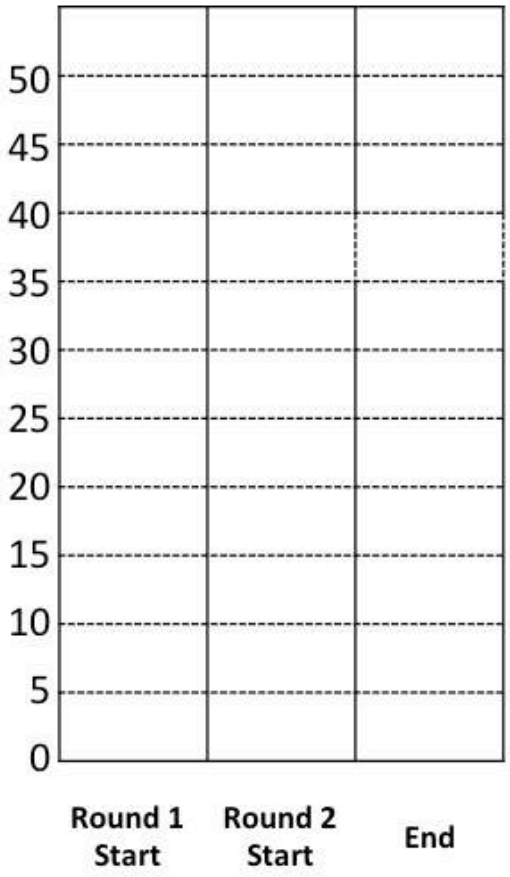


Class data chart

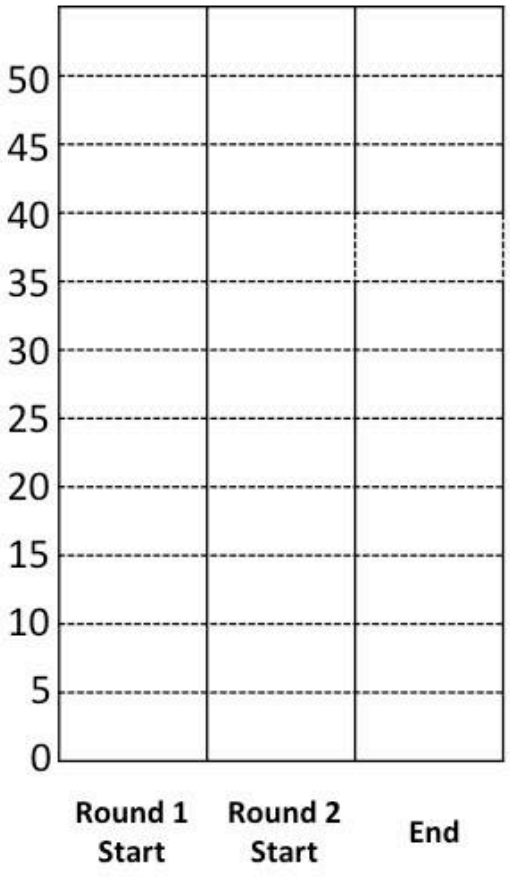
Name of Pond: _____

Type of fishing pole: _____

Plot the number of magnet fish in pond



Plot the number of loop fish in pond



QUESTIONS FOR STUDENT EVALUATION

The questions presented below range from easy to difficult. Select questions most appropriate for your students, and if necessary, modify the questions so they will be more useful in your situation. Answers are in italics.

1. Describe how we can tell if there is variation in a population.
   By observation. We can measure variation with a ruler (to determine size or shape), or by counting different categories of organisms (magnets vs. loops).

2. Why do you think children often look like their parents?
   Children resemble parents because they inherited their parents traits (genes).

3. A scientist sets up an experiment. She takes four potted plants of the same size. Plants 1 & 2 are fertilized every week for a month, and plants 3 & 4 are not fertilized. Which plants are the treatment plants? Which plants are the controls?
   Treatment plants are 1 & 2; controls are 3 & 4.

4. Give an example of a behavior that is innate (instinctive).
   There are many possibilities. Pit building behavior of antlions, anoles change color to match the background, human babies cry when hungry, etc.

5. Name a behavior that is learned. What did the antlions learn in your experiment?
   There are many possibilities. Reading, writing, speaking a language, dog tricks, etc. The antlions learned to stop responding to having their pit poked.

6. Name an antlion behavior that is instinctive.
   Pit building, feeding, etc.

7. List an adaptation of anole lizards.
   Camouflage, long tail for balance, etc.

8. If natural selection favors a trait, would you expect the number of individuals with that trait to go up or down? Why?
   The number of individuals with a favored trait should increase in a population. Natural selection favors traits that help individuals survive and/or reproduce better, so individuals that bear these traits will tend to leave more offspring.

9. Give an example of variation in a trait.
   Variation in leaf length, color, size. There are many possibilities.

10. In the pupfish experiment, fishing changed the number of magnet and loop fish in your pond.

    If you were using a hook fishing pole, which type of fish would you expect to increase in your pond? Why?

    The magnet fish will increase because the loop fish are being eaten more often. Natural selection favors the magnet fish.

    If you kept fishing for many rounds, what do you think would eventually happen to the magnet and loop fish in your pond?

    The loop fish may become extinct and the pond would only have magnet fish.

11. Variation is important for evolution. Circle the correct answer.
    a. variation means that individuals have different traits
    b. variation can be caused by the environment
    c. variation can be inherited
    d. all of the above

12. Which of the following is true about antlions?
    ___ *antlions are insects*
    ___ *antlions are predators*
    ___ *antlion larvae build pits*
    ___ antlions eat sand

13. For adaptations to evolve, which of the following must be true?
    ___ *natural selection favors traits*
    ___ *individuals must vary in a trait*
    ___ *the trait needs to be heritable*

Sunshine State Standards (updated May 2012)

Activity	Language Arts	Mathematics	Science	Social Studies	Fine Arts
How and why do we put organisms into groups? Parts 1&2	LACC.3.SL.1.3 LACC.3.SL.2.4 LACC.3.SL.2.6 LACC.4.SL.1.1 LACC.4.SL.2.4 LACC.5.SL.1.1 LACC.5.SL.2.4	MACC.3.OA.1.3	SC.3.L.15.1 SC.3.L.15.2 SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.5 SC.3.N.1.6 SC.3.N.3.1 SC.3.P.8.3 SC.4.N.1.2 SC.4.N.1.5		VA.3.O.2.1 VA.3.S.2.2 VA.3.S.3.1
Organisms have relatives! Parts 1,2,&3	LACC.3.SL.1.1 LACC.3.SL.1.3 LACC.3.SL.2.4 LACC.3.SL.2.6 LACC.3.W.1.1 LACC.4.SL.1.1 LACC.4.SL.2.4 LACC.4.W.1.1 LACC.5.SL.1.1 LACC.5.W.1.1		SC.3.L.15.1 SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.5 SC.3.N.1.6 SC.3.N.3.1 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.3 SC.4.N.1.4 SC.4.N.1.5 SC.4.N.1.7 SC.5.L.17.1 SC.5.N.1.1		VA.3.S.1.1 VA.3.S.2.1 VA.3.S.3.1 VA.4.C.2.3 VA.4.S.1.3
Organisms adapt to their environment Parts 1&2	LACC.3.SL.1.3 LACC.4.SL.1.1		SC.3.N.1.1 SC.3.N.1.3 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.4 SC.5.L.15.1 SC.5.L.17.1		
Organisms adapt to deal with seasons Parts 1&2			SC.3.E.5.2 SC.3.E.6.1 SC.3.L.17.1 SC.3.L.17.2 SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.3 SC.3.N.1.6 SC.3.N.3.2 SC.3.P.11.1 SC.4.E.5.3 SC.4.L.17.1 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.4 SC.5.L.15.1 SC.5.L.17.1	SS.3.G.3.1 SS.4.G.1.1 SS.4.G.1.3	VA.3.S.2.2 VA.3.S.3.1

Activity	Language Arts	Mathematics	Science	Social Studies	Fine Arts
Discovering variation	LACC.3.SL.1.1 LACC.3.SL.1.3 LACC.3.W.1.1 LACC.3.W.3.8 LACC.4.SL.1.1 LACC.4.W.1.1	MA.3.A.4.1 MA.3.A.6.2 MA.3.G.5.2 MA.3.S.7.1 MA.5.A.4.2 MA.5.G.5.3	SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.3 SC.3.N.1.6 SC.3.N.1.7 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.5 SC.4.N.1.6 SC.4.P.8.1 SC.5.L.15.1 SC.5.L.17.1		
Variation: Genes or the environment? Parts 1&2	LACC.3.SL.1.1 LACC.3.SL.1.3 LACC.3.W.1.1 LACC.3.W.3.8 LACC.4.SL.1.1 LACC.4.W.1.1		SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.3 SC.3.N.1.6 SC.3.N.1.7 SC.3.N.3.1 SC.4.L.16.2 SC.4.L.16.3 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.3 SC.4.N.1.5 SC.4.N.1.6 SC.4.N.1.7 SC.4.N.1.8 SC.4.N.2.1 SC.5.L.15.1 SC.5.L.17.1 SC.5.N.1.1 SC.5.N.1.2 SC.5.N.1.3 SC.5.N.1.4 SC.5.N.1.6 SC.5.N.2.1 SC.5.N.2.2		
The environment and natural selection Parts 1&2	LACC.3.SL.1.1 LACC.3.SL.1.3 LACC.3.W.1.1 LACC.3.W.3.8 LACC.4.SL.1.1 LACC.4.W.1.1	MA.3.A.4.1 MA.3.A.6.2 MA.3.G.5.2 MA.3.S.7.1 MA.5.A.4.2 MA.5.G.5.3	SC.3.N.1.1 SC.3.N.1.2 SC.3.N.1.3 SC.3.N.1.6 SC.3.N.1.7 SC.3.N.3.1 SC.4.N.1.1 SC.4.N.1.2 SC.4.N.1.3 SC.4.N.1.5 SC.4.N.1.6 SC.4.N.1.7 SC.5.L.15.1 SC.5.L.17.1		VA.3.S.2.2 VA.3.S.3.1