Tree of Life Bundle

Guide to Presentation

August 2019 Update

Tree of Life Bundle

(recommended for children 6 to 12 years of age)

Contents of Tree of Life Bundle:

- Tree of Life Box *(lidded box with compartments and dividers to store all of the parts of your Tree of Life)*
- 69 wooden leaves *(with illustrations of species)*
- 20 wooden tree parts *(trunk and branches with the classifications)*
- 108 Fact File cards with wooden box *(Fact File cards are numbered on the back in order of presentation and the numbers on the front correspond to the number of the leaf as you build the Tree of Life. The Fact File wooden storage box has 5 slots, one for each presentation with Fact File cards outlined below, to help you keep the cards organized as you work through them. You can store the cards in these sections as you work through the deck - Second Presentation: Prokaryotes 1-5, Third Presentation: Protists 6-12, Fourth Presentation: Fungi 13-19, Fifth Presentation: Plants 20-37, Sixth Presentation: Animals 38-108.)*
- Tree of Life Mat *(4 x 3' vinyl mat printed with the control chart to build the Tree of Life)*
- Guide to Presentation
- Research Masters *(available for download from the A - Z PDF Library on our website: wasecabiomes.org)*

Guide to Presentation
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Introduction

The Tree of Life from Waseca Biomes is designed to provide a hands-on experience of building the classification of lifeforms. The branches reflect the evolution of life on Earth beginning with the single-celled prokaryotes without a nucleus and ending with the chordates possessing a brain. The leaves illustrate examples of the lifeforms these branches yield. The Fact File cards provide guidance and detail as you work your way through the levels of classification (they are numbered on the back for order of presentation and cards featuring a leaf have a number on the front that corresponds to that leaf's placement on the Tree of Life). As you build the Tree of Life, you will also be mapping the classifications with the Fact File cards and creating another visual demonstration of the relationships of living things. These cards can be easily stored by kingdom in the wooden box for reference and shelf work as you and your students progress through building the Tree of Life.

The scientific community is in the process of reorganizing the classification of life with the advent of DNA information. In light of their discoveries, scientists are turning away from the five kingdoms. Hence, we do not label Monera and Protista as kingdoms. Similarly, many groups that we have traditionally called phylums, such as Coelenterata, are no longer considered to be phylums. So, we identify Ctenophores and Cnidarians as separate phylums. In places where classifications are outdated, but still helpful, we refer to them as "groups." We appreciate the help of Priscilla Spears, PhD and science consultant, in making our way through the controversy and checking our facts. We will try to stay abreast of future developments and publish new versions of the cards when necessary. We want to be as accurate as possible, however, as this work is designed for a child's understanding, we do generalize to some extent in order to enhance understanding and avoid too much distracting detail.

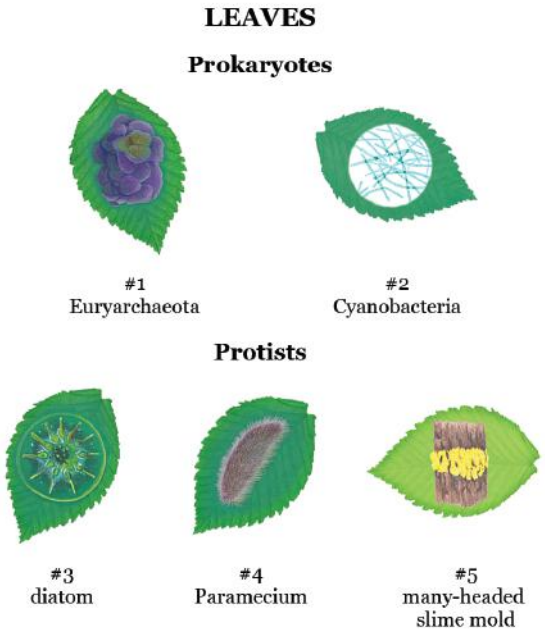
This guide outlines six presentations to help you and your students build the Tree of Life. As you progress through the presentations, they will cover increasingly complex lifeforms. Please keep in mind that these presentations are a general guideline and you should feel free to break the presentations down into as many lessons as you would like. There are suggestions for extensions of the presentations where relevant. Some of these extensions might work best for your group at a break point mid-presentation. For example, chordates is a phylum rich with information that works beautifully with integrating further curriculum (say, a whole section dedicated to research on fish or mammals). We greatly encourage you to build the Tree of Life to that point, then break to endeavor into further study and return as you move on to the next classification.

The opportunity to build this work on the floor many times will develop a mental map of the relationships of living things. We hope the children will also come to appreciate the incredible diversity of life on Earth and the myriad ways in which it has evolved over millions of years.

First Presentation: Overview

You will need: Tree of Life leaves, Fact File cards, large mat.
Purpose: To develop the concept of grouping lifeforms into classifications by recognizing similarities and differences. To familiarize the children with the kingdoms and the Tree of Life cards and leaves.

1. Take out the leaves and lay them out on a mat. Have the children identify the animals that they know.
2. Ask them to sort the leaves by plant and animal. Some may not seem to fit into these two groups.
3. Identify the leaves with lifeforms that do not fit into plant or animal classification.* You may need to take them from the plant or animal sorting to create new groups. Talk about why they don't fit those classifications as you do so.
4. Identify the Prokaryotes and discuss their characteristics (you can refer to the Fact File cards with the children for information). Discuss how they were the first life to evolve in the oceans. Talk about their role in the web of life today.
5. Identify the Protists. Discuss their characteristics and how they are different from the Prokaryotes.
6. Identify the Fungi. Discuss how they are different from Protists and how they differ from Plants.
7. Ask the children about the characteristics of plants and animals.



* There are 2 Prokaryote, 3 Protist, 3 Fungi, 11 plant, and 50 animal leaves in the Tree of Life. The leaves are not numbered on the back, but they can be referenced in the Fact File cards. Fact File cards: Prokaryote 1-5, Protist 6-12, Fungi 13-19, Plantae 20-37, Animalia 38-108.

Fungi

#6 bread mold

#7 reindeer lichen

#8 fly amanita

Plants

#9 common liverwort

#10 hornwort

#11 thread-moss

#12 great horsetail

#13 rabbit's foot fern

#14 fir clubmoss

#15 ginkgo

#16 queen sago

#17 bristlecone pine

#18 feather grass

#19 ice-cream bean tree

Animals

#20 yellow tube sponge

#21 cigar comb jelly

#22 staghorn coral

#23 box jelly

#24 Susan's flatworm

#25 pinworm

#26 Class Bdelloid

#27 earthworm

#28 common octopus

#29 giant African snail

#30 red rock crab

#31 bay barnacles

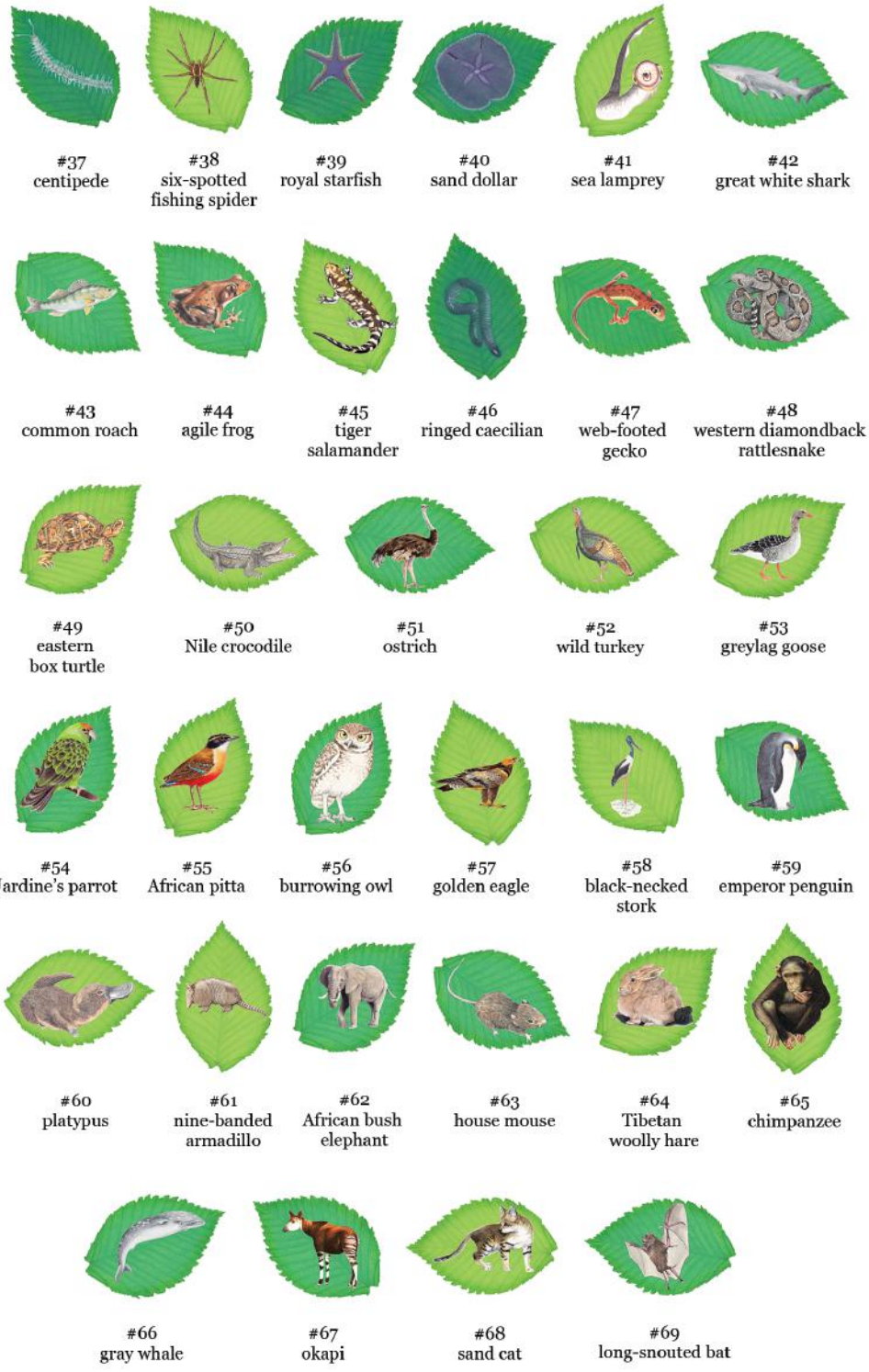
#32 Antarctic krill

#33 mosquito

#34 rhinoceros beetle

#35 luna moth

#36 carpenter bee



Second Presentation: Prokaryotes

You will need: Tree of Life leaves, Tree of Life tree parts, Fact File cards*, Tree of Life Mat, 3 large mats.
Purpose: To familiarize the children with the simplest forms of life and build a base of knowledge for the increasing cellular complexity that will appear with each branch in the Tree of Life. To begin to build the Tree of Life.

1. Lay the leaves out on the first mat.
2. Take out the Fact File cards and point out the numbers on the back of the cards that put them in order.
3. Take out the tree parts and announce to the children that they are going to build the Tree of Life. Place them on the second mat
4. Take out the Tree of Life Mat. Show how the cards with the leaf pictures have numbers on the front. The numbers correspond to the leaves on the Tree of Life Mat and show their place on the tree. Take a random card with a leaf, find the matching wooden leaf and find its place on the Tree of Life Mat.
5. Discuss how a tree grows from a seed. That first seed of life was the prokaryotes. The whole Tree of Life comes from that first seed. Find the trunk that is labeled *Prokaryotes*. Place it at the bottom and center of the mat. The Tree of Life has grown over billions of years and the trunk of the tree is the *Prokaryotes*.
6. Take the first card from the Fact File about *Prokaryotes*. Read it, or have the children read it, and place it at the top of the workspace on the third mat.
7. Take out the next card about *Archaea*. Note that the card has the name *Prokaryote* at the top and a new name under it. Explain that this means that it is a branch off of *Prokaryotes*. Read the card and place it under the *Prokaryote* card and to the left. Note how the trunk of the *Prokaryotes* tree piece has a branch with two branches at the end. One of them is *Archaea*.
8. Take out the next card about *Euryarchaeota*. Show the card and invite a child to find the matching leaf. Explain that the *Euryarchaeota* is a particular species of *Archaea*. There might be as many as 300,000 different species. This is just one example. Look at the Tree of Life Mat to see where leaf #1 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Archaea* card.
9. The next card, *Bacteria*, is the second branch of *Prokaryotes*. Read the card and place it under the *Prokaryotes* card and to the right. Discuss how bacteria can be both helpful and harmful to humans, but we cannot not live without it.
10. The fifth card, *Cyanobacteria*, is read and placed under *Bacteria*. Find the leaf to match and place it at the end of the second branch. Discuss how *Cyanobacteria* is a large part of the plankton in the ocean and the basis of the food chain there.
11. The lesson can be concluded at this point and the cards put away in order. If you choose to go on to the next presentation, put the cards used in order and place them in a stack (or in the storage box). Explain again that the numbers on the back show the

* There are 108 Fact File cards that come with the Tree of Life and a wooden box for Fact File storage. The wooden box has 5 slots, one for each presentation with Fact File cards, to help you keep the cards organized as you work through them. You can store the cards in these sections as you work through the deck. This presentation will specifically use cards 1-5.

order of the cards. Note how many cards are in the Fact File and what a chore it could be to reorganize them if they got mixed up.

Prokaryotes

These are the smallest and most simple cells. They are the first type of cells that appeared on Earth. Most members of this group grow as a single cell. The cells are prokaryotic, meaning "before a nucleus." Some have a simple flagellum that turns like a propeller to help it move. They can take energy from sunlight, minerals, or other living things to make food. They live everywhere - in soil, in water, and on other living organisms.

Prokaryote
Archaea

These single-celled microorganisms are prokaryotes. They use many energy sources such as sugar, ammonia, or even hydrogen gas. Salt-tolerant archaea use sunlight as an energy source. Many archaea live in extreme conditions such as hot springs and salt lakes. They are very numerous in oceans as part of plankton. They may work within an organism to aid in digestion. They are some of the oldest lifeforms on Earth.

Prokaryote
Bacteria

These single-celled microorganisms are prokaryotes. While some bacteria form clusters or chains, each cell can live on its own. Bacteria are far more than just harmful germs. They help us digest our food, break down decaying matter, and even maintain our atmosphere. They provide us with medicine and foods, such as yogurt and cheese. They are in the air, soil, and water. They are also in and on plants and animals, including us. In a teaspoon of soil, there are about a billion bacteria. The human mouth is home to more than 500 different species of bacteria.

1

Prokaryote
Archaea
Euryarchaeota
Methanosarcina sp.

These microorganisms produce methane from carbon dioxide, hydrogen gas, and other elements. They are found in many different environments including marshes, garbage dumps, the gut of ruminants such as cows, and the intestinal tract of humans.

2

Prokaryote
Bacteria
Cyanobacteria
Tolypothrix sp.

This bacteria gets its energy from sunlight and gives off oxygen like plants do. The chloroplasts found in plants and algae evolved from cyanobacteria. It is one of the earliest lifeforms on Earth. Scientists think that it helped change the planet's atmosphere by creating oxygen and enabling more complex lifeforms to exist. It has mistakenly been called blue-green algae in the past.

Third Presentation: Protists

You will need: Tree of Life leaves, Tree of Life tree parts, Fact File cards*, Tree of Life Mat, 3 large mats.
Purpose: To review *Prokaryotes* and explore the diversity of *Protists*. To continue building the Tree of Life.

1. Lay out the leaves and tree pieces on separate mats.
2. Briefly review the Second Presentation: Prokaryotes by building the tree using the *Prokaryotes* trunk and the leaves that branch off of it. Review the names and turn the cards over in a stack or put them in the Fact File storage box (cards 1-5).
3. Consult the Tree of Life Mat to see what comes after *Prokaryotes*. Find the branch labeled *Protists* and place it on the tree above the trunk. Read the card about *Protists* and place it at the top of the third mat. Discuss the differences between *Protists* and *Prokaryotes*.
4. Note the three branches at the end of the *Protists* branch. Read the next card about *Algae*. Place it under the *Protists* card as shown.
5. Take out the next card about *Diatom*. Show the card and invite a child to find the matching leaf. Explain that the *Diatom* is a particular species of *Algae*. There are more species of *Diatoms* than of any other *Algae*. Look at the Tree of Life Mat to see where leaf #3 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Algae* card. *(Extension: Find algae growing in a pond or bring it into the classroom. Explain that you are looking at a colony of single-celled algae.)*
6. Read the card about *Protozoa* and place it as shown. Read the card about *paramecium* and place it under the *Protozoa* card. Find the matching leaf and its place on the Tree of Life Mat. Put it at the end of the correct branch. *(Extension: Research to find other pictures of Protozoa and their variations of flagellum. Get a microscope, if possible, and view live specimens.)*
7. Read the card about *slime molds* and place it as shown. Read the card about the *many-headed slime mold* and place it under the *slime mold card.* Find the matching leaf and put it at the end of the correct branch on the Tree of Life Mat. *(Extension: Research to find out about experiments that scientists did with slime molds in a maze: http://io9.com/5950984/why-slime-molds-can-solve-mazes-better-than-robots.)*
8. The lesson can be concluded at this point and the cards put away in order. It is always a good idea to stop a lesson before the children want you to. It leaves them wanting to learn more and to move on to the next branch. It is important to let them explore each kingdom and grasp the importance of the increasing complexity from branch to branch. If you choose to go on to the next presentation, put the cards used in order and turn them over in a stack on top of the previous stack of Prokaryotes (or in the storage box).

* This presentation will review cards 1-5 and focus on cards 6-12.

Protists

Some members of this group grow as a single cell, while others are multicellular organisms. The cells are eukaryotic, meaning they have a "true" nucleus enclosed in a membrane. Most have flagella or cilia that help the cell move. Some perform photosynthesis and give off oxygen. Others take food and energy from other living organisms. Some do both. They may reproduce by cell division, fragmenting, or by spores. They usually live in moist environments.

Protista
Algae

Algae are what we call simple organisms that produce their food using sunlight. There are several different branches of algae on the tree of life. In the process of photosynthesis, algae gives off oxygen. Algae can be a single eukaryotic cell or multicellular, such as giant kelp. They have a range of colors depending on their pigment. Chlorophylls are green. Carotenoids are red, orange, yellow, or brown. Phycobilins are red or blue. Algae live in a symbiotic relationship with coral and give coral its color. Along with cyanobacteria, marine algae forms the base of ocean food chains.

Protista
Protozoa

Many different kinds of single-celled eukaryotes are called protozoa. Most are able to move about. Some move with hair-like cilia and others use several long whip-like projections called flagella. Many species are predators of algae and bacteria. They may either absorb food through their cell membrane or surround food particles and engulf them. Others have mouth pores into which they sweep food. Most are too small to be seen with the naked eye. They are a major food source for larger animals and the basis of many food chains.

Protista
Slime Molds

Slime molds can exist as many single cells or congregate and move as a single body in search of food. They feed on organisms that live in dead plant material. They contribute to the process of decomposition and feed on bacteria, yeast, and fungi. They are found in soil and on decomposing logs. When conditions become unfavorable, slime molds congregate to form clusters of spores on the tips of stalks. The spores are released on the wind to find new habitats. Slime molds were once thought to belong to the Fungi Kingdom. However, they lack chitin in their cell walls and are more closely related to other amoebas.

3

Protista
Algae
diatom
Asterionella sp.

Diatoms are a major group of algae and one of the most common types of phytoplankton. They have an outer glassy shell that has beautiful patterns. They are microscopic, but they can sometimes be seen as a colony that produces a green film in the water. They are found where there is water. They are especially important in the ocean where they make up almost half of the food produced.

4

Protista
Protozoa
Paramecium
Paramaecium sp.

These single cell organisms are a type of protozoa called ciliates. They move by means of cilia that they beat back and forth. They live in water. Some can live in the bodies of animals or in moist soil. They eat algae, bacteria, and dead plant and animal matter. Some types of green algae can live inside of paramecium in a symbiotic relationship.

5

Protista
Slime Molds
many-headed slime mold
Physarum polycephalum

This example is called a plasmodial slime mold and is bright yellow. It is enclosed in a single membrane to become one very large cell with thousands of nuclei inside. It searches for food by moving very slowly and sending out a network of tendrils. It prefers shade to sunlight and thrives in temperate forests.

Fourth Presentation: Fungi

You will need: Tree of Life leaves, Tree of Life tree parts, Fact File cards*, Tree of Life Mat, 3 large mats.
Purpose: To review *Prokaryotes* and *Protists* and learn about *Fungi*. To continue building the Tree of Life.

1. Lay out the leaves and tree pieces on separate mats.
2. Build the tree using the *Prokaryotes* trunk and the leaves that branch off of it. Build the *Protists* branch with the leaves. Review the names and turn the cards over in a stack or put them in the Fact File storage box (cards 1-12).
3. Consult the Tree of Life Mat to see what comes after *Protists*. Find the branch labeled *Fungi* and place it on the tree connected to the *Protists* branch. Read the card about Fungi and place it at the top of the third mat. Discuss the similarities and differences between *Fungi* and *Protists*.
4. Note the three branches at the end of the *Fungi* branch. Read the next card about *Zygomycota*. Place it under the *Fungi* card and to the left.
5. Take out the next card for bread mold. Show the card and invite a child to find the matching leaf. Explain that the *bread mold* is a particular species of *Zygomycota*. Look at the Tree of Life Mat to see where leaf #6 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Zygomycota* card. *(Extension: Put out a piece of bread out and see what grows over the next several days; www.wikihow.com/Make-Mold-Grow-on-Bread provides helpful instructions.)*
6. Read the card about *Ascomycota* and place it as shown to the right. Read the card about *reindeer lichen* and place it under the *Ascomycota* card. Find the matching leaf and its place on the Tree of Life Mat. Put it at the end of the correct branch. *(Extension: Find lichen specimens and bring them into the classroom. Look at them with a magnifying glass.)*
7. Read the card about *Basidiomycota* and place it as shown. Read the card about *fly amanita* and place it as shown. Find the matching leaf and its place on the Tree of Life Mat. Put it at the end of the correct branch. *(Extension: Get a field guide about mushrooms and look at the diversity of fungi growing in your area. Go into the field looking for mushrooms.)*
8. The lesson can be concluded at this point and the cards put away in order. If you choose to go on to the next presentation, put the cards used in order and turn them over in a stack on top of the previous stack of *Protists* (or in the storage box).
9. You may wish to put the Tree of Life out on the shelf for the children to practice building. You may want to limit it to the *Fungi*, *Protists*, and *Prokaryotes*.

* This presentation will review cards 1-12 and focus on cards 13-19.

Kingdom Fungi

Members of this kingdom are important to many ecosystems where they recycle nutrients and work in symbiosis with plants. They use the food the plant produces and, in return, act like extra roots that bring the plant water and minerals it could not reach on its own. The network formed is called mycorrhizae. Some fungi feed on and help decompose dead organisms. Some are parasites on living things. All fungi use food made by other living things. Most live on land. Some live inside other organisms. They have a cell wall made of chitin.

Kingdom Fungi
Phylum Zygomycota

This phylum of fungi lives mostly in soil and decaying plant or animal material. It is most familiar as the mold that grows on fruits and vegetables in rapidly spreading colonies. It might be found on dung. Some members of this phylum are parasites of plants, insects, and small animals. Others form a symbiotic relationship with plants.

Kingdom Fungi
Phylum Ascomycota

About 75% of all known species of fungi are in the phylum Ascomycota (or "sac fungi"). Examples include the yeast used in baking and brewing, penicillin used to treat infections, and the edible morel. Many species play a big role in recycling dead plant material. Some join with algae to form lichens or with plant roots to form mycorrhizae. Some species form a symbiotic association with beetles that cultivate it, weeding out other species. The cup fungi found in forests are part of this phylum.

Kingdom Fungi
Phylum Basidiomycota

This phylum of Fungi includes the true mushrooms as well as rusts, jelly fungi, stinkhorn, puffballs, bracket fungi, smut, and some species of yeast. Like most members of the Fungi Kingdom, they grow filaments, or hyphae, that are like roots. The hyphae find and absorb food, minerals, and water. Some members of this phylum form symbiotic relationships with the roots of trees in a forest to form mycorrhizae. In return for the food source from the tree, the fungi provide an extended root system to deliver water and minerals to the tree. These networks can spread for miles.

6

Kingdom Fungi
Phylum Zygomycota
bread mold
Rhizopus nigricans

Colonies of the genus Rhizopus grow rapidly and quickly cover the surface of their food source. It is white at first and becomes grayish-brown over time.

7

Kingdom Fungi
Phylum Ascomycota
reindeer lichen
Cladonia rangiferina

Lichens grow in spots of the world that are too harsh or limited for most other organisms. They are able to shut down their life processes during periods of unfavorable conditions and can survive extremes of heat, cold, and drought. They form a symbiotic relationship with algae where the fungi provide water, minerals, and protection and the algae is the food source.

8

Kingdom Fungi
Phylum Basidiomycota
fly amanita
Amanita muscaria

This mushroom is a member of the order Agaricales which includes species that have a stem and a cap with gills on the underside. The gills produce spores. The spore-forming body is the visible part of the mushroom. It is produced by a threadlike network of filaments that deliver water and minerals as well as nutrients from decaying matter. This particular mushroom is poisonous.

Fifth Presentation: Plants

You will need: Tree of Life leaves, Tree of Life tree parts, Fact File cards*, Tree of Life Mat, 3 large mats, a fern, a collection of seeds (including a pine cone), monocots and dicots to sort (either actual plants or pictures).
Purpose: To review *Prokaryotes*, *Protists*, and *Fungi* to continue to build a knowledge base about the classifications of living things. To learn about the diverse kingdom of *Plantae* and continue building the Tree of Life.

1. Lay out the leaves and tree pieces on separate mats.
2. Build the tree using the *Prokaryotes* trunk and the leaves that branch off of it. Build the *Protists* branch with the leaves. Next, build the *Fungi* branch with its leaves. Review the names and turn the cards over in a stack or put them in the Fact File storage box (cards 1-19).
3. Ask the children what kingdom they think would come next: plants or animals? What looks more like Fungi: plants or animals? What would come first in evolution? Can animals survive without plants? Why not?
4. Find the branch labeled *Plants* and place it on the tree connected to the *Protists* branch. Read the card about *Plantae* and place it at the top of the third mat. Discuss the similarities and differences between *Fungi* and *Plants*.
5. Look at the Tree of Life Mat and find the first branch off of the *Plants* branch. Talk about how plants first evolved on land seeking more sunlight. They first adapted to moist environments. They did not have roots and tiny tubes inside to carry water to the leaves. They had to get their moisture from the air. They are called *Bryophytes* (or non-vascular plants). Read the *Bryophyte* card and place it under the *Plants* card to the left. Attach the *Bryophyte* branch to the *Plants* branch. Notice the three branches at the end.
6. Take out the next card for *common liverwort*. Show the card and invite a child to find the matching leaf. Explain that *common liverwort* is a particular species of *Bryophyte*. Look at the Tree of Life Mat to see where leaf #9 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Bryophyte* card. Repeat the same steps for leaves #10 and #11, placing the cards under *common liverwort*. *(Extension: Try to find Bryophyte specimens to bring into the classroom. Note that although they may have surfaces that look like leaves and roots, they can only absorb water through their surfaces.)*
7. Look at the Tree of Life Mat to see where *Tracheophyte* branches off of the Plants branch. Discuss the fact that as plants evolved away from water they needed to be able to absorb water from the ground where it was moist and transport that water to their leaves through their stems. Read the card about *Tracheophyte* and place it under the *Plants* card to the far right. Find the tree piece for the *Tracheophyte* and attach it to the *Plants* branch.
8. Look at the Tree of Life Mat and see where the *Tracheophyte* branch divides into two branches. Discuss how some vascular plants produce seeds and some produce spores. The first to evolve were the *Pterophytes*. Show the fern and the spores on its underside. They produce spores, but they still need a moist environment to reproduce. Read the card for *Pterophyte* and place it to the left under the *Tracheophyte* card. Find

* *This presentation will review cards 1-19 and focus on cards 20-37.*

the *Pterophyte* branch and attach it to the *Tracheophyte* branch on the Tree of Life Mat. Notice the three branches at the end of the limb.

9. Take out the next card for *great horsetail*. Show the card and invite a child to find the matching leaf. Explain that the *great horsetail* is a particular species of *Pterophyte*, a vascular plant that produces spores. Look at the Tree of Life Mat to see where leaf #12 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Pterophyte* card. Repeat the same steps for leaves #13 and #14. *(Extension: Try to find specimens to bring into the classroom. Look for spores. If you keep these plants in the classroom, they will need to be misted with water.)*
10. Look at the Tree of Life Mat and see where the *Tracheophyte* branch splits into two branches. The next plants to evolve were the ones that produce seeds, the *Spermatophytes*. They did not need moisture to reproduce. Read the card for *Spermatophyte* and place it to the right under the *Tracheophyte* card. Find the *Spermatophyte* branch and attach it to the *Tracheophyte* branch. Notice the two branches on the *Spermatophyte* limb. One is labeled *Gymnosperm* and the other *Angiosperm*. Show the students the collection of seeds (including a pine cone). Pass the seeds around.
11. Read the *Gymnosperm* card and place it under the *Spermatophyte* card to the left. Discuss that this group has seeds that are in a cone. At the end of this branch are three branches. Read the cards for leaves #15, #16, and #17 and place the leaves at the end of the branches.
12. Read the *Angiosperm* card and place it under the *Spermatophyte* card to the right. Discuss that this group has seeds that are protected by a seed coat. At the end of the branch are two branches. Read the cards for leaves #18 and #19 and place the leaves at the end of the branches. Discuss the difference between monocots and dicots. Sort the monocots and dicot plant samples (or pictures thereof).
13. The lesson can be concluded at this point and the cards put away in order. If you choose to go on to the next presentation, put the cards used in order and turn them over in a stack on top of the previous stack of *Fungi* (or in the storage box).
14. You may wish to put the Tree of Life out on the shelf for the children to practice building. You may want to limit it to the *Plants*, *Fungi*, *Protists*, and *Prokaryotes*.

Extension:

- Have the children make pressings of plants that they can find (or pictures of those that they can't) to arrange on a chart with labels as shown in the illustration for the Fact File card layout.

Kingdom Plantae

Most members of this kingdom are are adapted to living on the land in many different climates. They take energy from the Sun to make food and they provide food for life on land. Some plants returned to living in water. They have groups of cells that have special functions called tissues. They have organs and organ systems that carry out tasks for the whole organism. The cell walls are made of cellulose. They use spores or seeds for reproduction.

Kingdom Plantae
Bryophyte
(non-vascular)

Bryophytes do not have specialised internal tissues to transport water and nutrients. They absorb water from their surfaces. They must live in a moist environment to survive. They do not possess true roots, stems, or leaves, although the plant body has leaflike and stemlike parts. In some species, there are rootlike structures called rhizoids.

Kingdom Plantae
Tracheophyte
(vascular)

Tracheophytes are the vascular plants. Vascular plants have tiny tubes that transport water and food throughout their parts. The xylem conducts water and minerals from the roots up to the leaves of the plant. The phloem transports the products of photosynthesis to all parts of the plant. Almost all vascular plants have roots, stems, and leaves. The evolution of a vascular system meant that plants could grow taller.

9

Kingdom Plantae
Bryophyte (non-vascular)
common liverwort
Marchantia polymorpha

This plant is found worldwide from polar to tropical biomes. It grows on moist soil and rocks in damp habitats. It is usually the first plant life to emerge after a fire. Its body is simple and flat. Rather than leaves, it has vegetative tissue called a thallus. It has rhizoids, which are rootlike filaments, that anchor it to the soil. It makes spores in a capsule at the end of a stalk.

Kingdom Plantae
Tracheophyte (vascular)
Pterophytes (seedless)

Pterophytes are vascular plants that do not make flowers or seeds. While these plants are not as dependent on a moist environment as non-vascular plants, they still require a moist environment for reproduction. The life cycle includes two stages. In the gametophyte stage, structures containing egg cells must be fertilized by swimming sperm cells. In the sporophyte stage, spores are carried by the wind and must find moisture in order to germinate.

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)

Life on land, as we know it, is largely shaped by the lives of seed plants. They provide oxygen and make up the forests that clean our air. They are also the plants we, and other animals, eat. Gymnosperms and Angiosperms are the two major groups of seeded plants.

12

Kingdom Plantae
Tracheophyte (vascular)
Pterophyte (seedless)
great horsetail
Equisetum telmateia

Ancient relatives of this plant dominated the forest floor in the late Paleozoic era. At that time, some grew like trees over 30 metres tall. Present-day horsetails have rhizomes which spread deep in the ground. The stems perform photosynthesis. The leaves are very tiny and form a collar around the node.

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)
Gymnosperm (non-flowering)

Gymnosperms are a group of vascular plants that make seeds. The term means "naked seeds." Gymnosperm seeds are not enclosed within an ovary like the seeds of flowering plants. They develop either on the surface of scales, in cones, or at the end of short stalks (as in the case of the ginkgo). Coniferae by far the largest branch of living gymnosperms, followed by cycads and ginkgo (the only living species of its branch).

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)
Angiosperm (flowering)

Angiosperms differ from other seed plants because they produce flowers and fruits. The ovary of the flower becomes the fruit once it has been pollinated. Pollen is spread in many ways. Angiosperms have become the most diverse group of land plants.

10

Kingdom Plantae
Bryophyte (non-vascular)
hornwort
Phaeoceros laevis

Hornworts make spores inside of a green, hornlike stalk. The leathery thallus forms a rosette close to the ground. They can be found worldwide, but only in places that are damp and humid. Some hornworts develop openings where colonies of cyanobacteria colonize the plant. The cyanobacteria give the hornwort nitrogen and a blue-green color.

13

Kingdom Plantae
Tracheophyte (vascular)
Pterophyte (seedless)
rabbit's foot fern
Davallia fejeensis

This fern grows in moist tropical and subtropical biomes. It can grow from the ground or as an epiphyte in a tree. It has true leaves, stems, and roots. It reproduces with spores instead of seeds. It may depend on a symbiotic relationship with mycorrhizal fungi.

15

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)
Gymnosperm (non-flowering)
ginkgo *Ginkgo biloba*

Fossils show that ginkgo trees lived more than 200 million years ago. A ginkgo is deciduous with leaves that turn yellow in late fall. There are male and female trees. The male produces pollen cones. The female produces stalks with two ovules containing eggs at the end. The ovules may develop into seeds with a fleshy seed coat that smells very bad.

18

Kingdom Plantae
Tracheophytes (vascular)
Spermatophyte (seeded)
Angiosperm (flowering)
feather grass
Stipa sp.

This branch of flowering plants is called monocots. They have one seed leaf. Veins in the leaves of most monocots are parallel. Orchids, grasses, palms, and bananas are monocots. Almost all plants that form bulbs are monocots.

11

Kingdom Plantae
Bryophyte (non-vascular)
thread-moss
Bryum capillare

Mosses produce spores in a capsule at the end of a stalk. When the capsule dries out, the spores are released. Because mosses do not have a way to transport water, they depend on a moist environment. They grow close to the ground and have rhizoids that act as roots to anchor them. Moss can grow on bare rock.

14

Kingdom Plantae
Tracheophyte (vascular)
Pterophyte (seedless)
fir clubmoss
Huperzia selago

Members of the family Lycopodiaceae are small, creeping plants. They might be rooted in the ground or hang from trees. They are evergreen with thin, pointed leaves. They are native to tropical mountains, but they are also common in northern forests of both hemispheres.

16

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)
Gymnosperm (non-flowering)
queen sago *Cycas revoluta*

This tree belongs to a branch of plants called cycads that date back to the Permian period. A single tree may live for as long as 1,000 years. They look like palm trees, but are very different. The seeds develop on the margins of special leaves that are short and leathery. The queen sago is found on islands in Southeast Asia.

19

Kingdom Plantae
Tracheophytes (vascular)
Spermatophyte (seeded)
Angiosperm (flowering)
ice-cream bean tree
Inga feuillei

This tree belongs to a group of flowering plants called eudicots that have two leaves emerging from the seed. The leaves have netted veins that form a branching network. The ice-cream bean tree is a legume tree native to Central and South America. Legumes take nitrogen from the air and fix it in their roots.

17

Kingdom Plantae
Tracheophyte (vascular)
Spermatophyte (seeded)
Gymnosperm (non-flowering)
bristlecone pine
Pinus aristata

This tree belongs to a group called conifers. Conifers are cone-bearing seed plants. Male cones produce pollen that is carried by the air to pollinate female cones. Most are evergreen trees and have adapted to extreme cold. The bristlecone pine grows at high altitudes on dry, rocky slopes.

Sixth Presentation: Animals

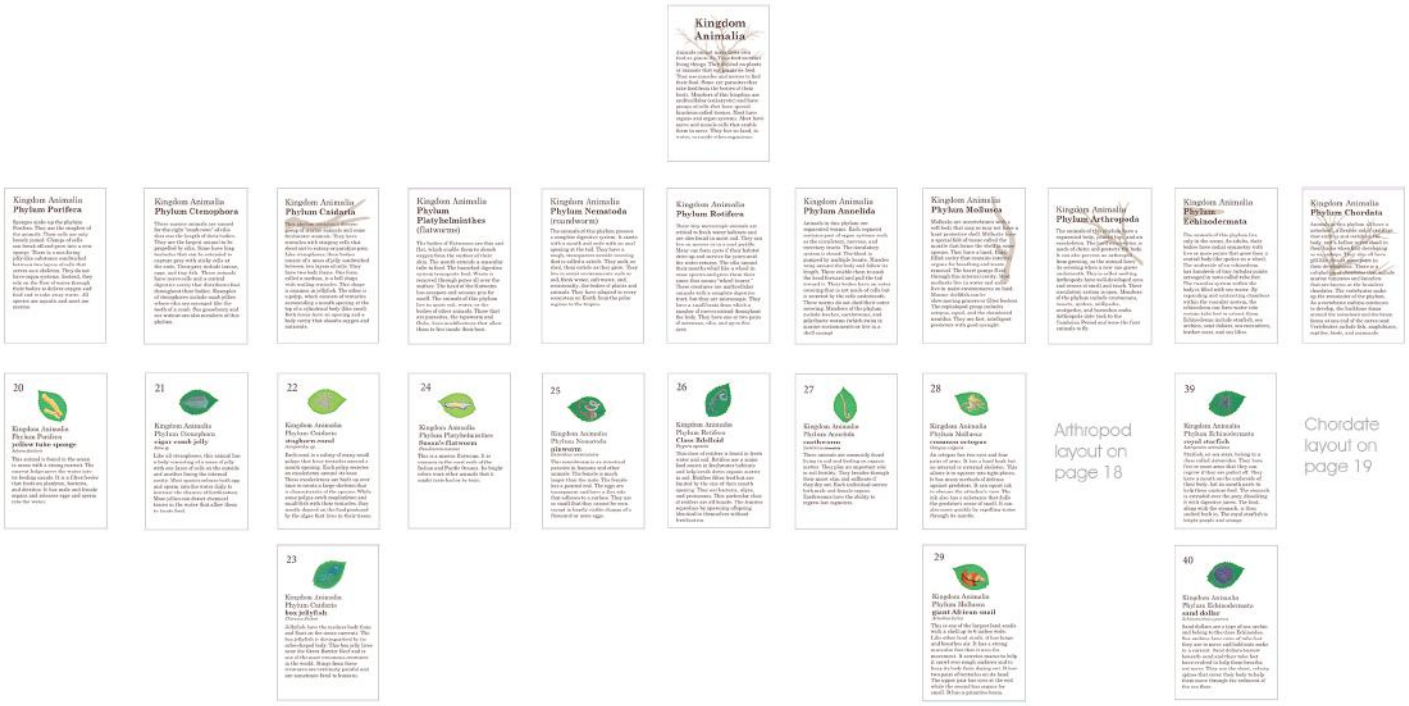
This presentation covers a lot of information and can be quite long (it covers cards 38 - 108 and 50 of the leaves). As mentioned previously, you may want to break the presentation into different sittings for time purposes and to incorporate related lessons from your curriculum at many of the steps. Suggestions for breaking points will be noted with dashes (- -).

You will need: Tree of Life leaves, Tree of Life tree parts, Fact File cards*, Tree of Life Mat, 3 large mats, natural sponge.
Purpose: To review the first four kingdoms in the Tree of Life. To learn about the diverse kingdom of *Animalia* and complete building the Tree of Life.

1. Lay out the leaves and tree pieces on separate mats.
2. Have the children build the tree as they have learned from all of the previous presentations in preparation for this new lesson (reviewing cards 1- 37 as needed).
3. Find the branch labeled *Animals* and place it on the tree connected to the *Protists* branch. Read the card about *Kingdom Animalia* and place it at the top of a third mat. Discuss the similarities and differences between animals and plants.
4. Look at the Tree of Life Mat and find the first branch off of the *Animals* branch. Talk about how animals first evolved in the ocean. Read the *Porifera* card and place it under the *Animals* card to the far left (see the diagram for Animals on next page). Place the *Sponge* branch accordingly.
5. Take out the next card for the *yellow tube sponge*. Show the card and invite a child to find the matching leaf. Explain that the *yellow tube sponge* is a particular species of *Porifera*. Look at the Tree of Life Mat to see where leaf #20 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Porifera* card. Pass the natural sponge around and have the children examine its texture.
6. Look at the Tree of Life Mat and see where *Ctenophore* branches off of the *Animals* branch. Read the card about *Ctenophora* and place it under the *Animals* card just to the right of the last card. Note where the *Ctenophore* branch splits on the *Animals* branch. Take out the next card for *cigar comb jelly*. Show the card and invite a child to find the matching leaf. Explain that the *cigar comb jelly* is a particular species of *Ctenophora*. Look at the Tree of Life Mat to see where leaf #21 goes. Invite the child to place it at the end of the branch. Place the card directly under the *Ctenophora* card. *(Extension: Find different examples of Ctenophora on the web.)*
7. Look at the Tree of Life Mat and see where the *Cnidaria* branch off of the *Animals* branch. Read the card about *Cnidaria* and place it under the *Animals* card just to the right of the *Ctenophora* card. Find the tree piece for the *Cnidaria* and attach it to the *Animals* branch on the Tree of Life Mat.
8. Note that the *Cnidarian* branch has two branches at the end. Take out the next card for *staghorn coral*. Read the card and place it under the *Cnidaria* card. Find the leaf for *staghorn coral* and place it. Repeat the same steps for the next card, *box jelly*, placing the card under the *staghorn coral* card and leaf #23 at the end of the branch.
9. Look at the Tree of Life Mat and see across from *Cnidaria* where a major limb comes off the *Animals* branch. It is labeled *Flatworms* and *Rotifers*. Find the limb in the pieces

* This presentation will review cards 1-37 and focus on cards 38-108.

and place it. Begin with *Platyhelminthes (flatworm)* and read the card (or have one of the children read it). Place it just to the right of the previous card as shown in the illustration. Find the branch labeled *Flatworm*. Read the card for *Susan's flatworm* and place it under the *Platyhelminth* label. Find the leaf for *Susan's flatworm* and place it by the branch labeled *Flatworm*. Repeat this process for *Roundworm*, *Rotifera*, and *Annelida*, placing the cards according to the illustration and the leaves according to the labels on the limb.



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10. On the Tree of Life Mat, notice how the large flatworms limb branches in two. Read the card about *Mollusca* and place it to the right of the *Annelida* card. Find the tree piece for *Mollusk* and place it on the Tree of Life Mat. Notice how it divides into two branches.
11. Take out the card for the *common octopus*. Read the card and place it under the *Mollusk* card. Find the leaf for *common octopus* and place it on the branch as shown on the Tree of Life Mat. Repeat the same procedure for the *giant African snail*.
12. Go back to the Tree of Life Mat to look at the second branch labeled *Arthropod*. After reading the card, place it to the right of the *Mollusk* card. Find the *Arthropod* branch in the tree pieces and place it on the tree. Point out the many branches that it has. Start with *Crustacean*. Read the card and place it under the *Arthropod* card to the left. Read cards for leaves #30, #31, and #32 and place the leaves on the *Crustacean* branch. Place the cards under the *Crustacean* card.
13. Go to the next set of branches, *Insects*. Read the card for *Insecta* and place it to the right of the *Crustacean* card as shown in the illustration. Read the cards and place leaves #33-36. *(Extension: Use field guides to find other examples of each of the orders illustrated.)*

14. Read the card for *Chilopoda* and place it under *Arthropod* and to the right of *Insecta*. Read the card for *centipede* and place it under *Chilopoda*. Find leaf #37 and place it on the correct branch.
15. Read the card for *Arachnida* and place it under *Arthropod* and to the right of *Chilopoda*. Read the card for *six-spotted fishing spider* and place it under *Arachnida*. Find leaf #38 and place it on the branch labeled *Arachnid*. Discuss the difference between insects and arachnids. That completes the *Arthropod* branch (you can reference the card layout in the provided diagram on page 18).

- -

16. Go back to the main trunk on the Tree of Life Mat and find *Echinoderm*. Read the card and place it to the right of *Arthropod*. Find the tree piece for that branch and place it on the tree. Note that the branch splits into two. Read the card for *royal starfish*. Find its leaf and place it in the correct location on the Tree of Life Mat. Read the card for *sand dollar* before finding its leaf and placing it on the branch.
17. Look at the Tree of Life Mat above *Echinoderm*. Notice the label for *Chordate*. *Chordata* is the last phylum of animals. It includes all vertebrates. Read the card for *Chordata*. Place it under the A*nimal* card as shown in the layout on page 19.
18. Ask the children what they think were the first *Chordates* to evolve? Read the *fish* card and place it under *Chordata* to the left. Find the branch and attach it to the trunk on the Tree of Life Mat. Read the cards for leaves #41-43 and attach the leaves to the branch.
19. Talk about the first amphibians coming out onto land and how they still needed water to develop their eggs. Read the *amphibian* card and place it under *Chordata* to the left. Find the branch and attach it to the trunk on the Tree of Life Mat. Read the cards for leaves #44-46 and attach the leaves to the branch.
20. The next chordates to develop were the reptiles. They evolved to have eggs with a shell that held the water needed for the embryo to develop. Read the *reptile* card and place it under *Chordata* to the left. Find the branch and attach it to the trunk on the Tree of Life Mat. Read the cards for leaves #47-50 and attach the leaves to the branch.
21. Look at the chart and notice where the next group, *bird*, attaches to the tree. Do the children know of any dinosaurs that looked a bit like birds? There is modern day evidence that birds and reptiles are related. The crocodilians are the only reptiles that care for their young and communicate with them by making special sounds. That is one of the reasons why the bird branch is next to the crocodilians. Can the children think of ways that birds and reptiles are the same? How are they different? Read the *aves* card and place it under *Chordata* to the left. Find the branch and place it on the Tree of Life Mat. Read the cards for leaves #51-59 and attach the leaves to the branches.
22. Birds and reptiles have water in their shells for the embryo to develop. Mammals evolved to use the water inside of the female's body to develop the embryo. It is water that is very much like the ocean. Discuss ways in which birds and mammals are the same and ways that they are different. Read the *mammalia* card and place it under *Chordata* to the left. Find the branch and place it on the Tree of Life Mat. Read the cards for leaves #60-69 and attach the leaves to the branches.

23. After the presentations, leave the work on the shelf for the children to construct on their own. They may not always read the cards, but what they *are* doing is creating a mental map of the relationships of the lifeforms on the tree. As a guide, you can come by and ask questions that prompt them to go deeper.

Extensions:

- Children can choose a lifeform on the tree that they would like to research. You can feel free to use the research form provided or make your own. A pdf of this form is available on our website in the A - Z PDF Library.
- Once the children have become familiar with the Tree of Life, challenge them to find other examples to replace the leaves on the tree with ones that they make themselves. For example, they might find another monocot to place at the end of the Plant branch. Use the research master provided (available on our website in the A - Z PDF Library) to draw the plant in the leaf shape and the box to create a card. Cut out the new leaf and place it on the tree where it belongs.
- For further challenge, point out to the students that there are other phylums, classes, and orders that are not illustrated on the tree. It was designed to show the most common and familiar examples. Challenge them to find more phylums for each of the kingdoms. Then, challenge them to find more classes for the phylums. How many orders of mammals can they find?

Other ideas:

- Give a three period lesson on the animals of a branch to learn the names.
- Organize the leaves of some of the lifeforms in a food pyramid. Organize all of them into a food pyramid.
- Choose leaves of lifeforms that would be found in the same biome, such as the ocean. Place them in the order of a food chain.
- Take a leaf from the tree when it is completed and turn it over when the children have their eyes closed. See if they can deduce what life form is on the leaf. Give them clues until they guess.

Kingdom Animalia

Animals cannot make their own food as plants do. They feed on other living things. They depend on plants or animals that eat plants as food. They use muscles and nerves to find their food. Some are parasites that take food from the bodies of their hosts. Members of this kingdom are multicellular (eukaryotic) and have groups of cells that have special functions called tissues. Most have organs and organ systems. Most have nerve and muscle cells that enable them to move. They live on land, in water, or inside other organisms.

Kingdom Animalia
Phylum Arthropoda

The animals of this phylum have a segmented body, jointed legs, and an exoskeleton. The hard exoskeleton is made of chitin and protects the body. It can also prevent an arthropod from growing, so the animal loses its covering when a new one grows underneath. This is called molting. Arthropods have well-developed eyes and senses of smell and touch. Their circulatory system is open. Members of the phylum include crustaceans, insects, spiders, millipedes, centipedes, and horseshoe crabs. Arthropods date back to the Cambrian Period and were the first animals to fly.

Kingdom Animalia
Phylum Arthropoda
Crustacea

This group of arthropods lives in or near water. Marine species include shrimp, lobsters, and crabs. Freshwater species include crayfish and crabs. Some species have adapted to living on land, such as terrestrial crabs and woodlice. Most move about freely, but some parasitic crustaceans like fish lice, whale lice, and sea lice grow attached to their host. Barnacles attach to a surface like a rock or host animal.

Kingdom Animalia
Phylum Arthropoda
Class Insecta

While insects have an exoskeleton and jointed legs like other arthropods, they differ in that they have three body parts: a head, a thorax, and an abdomen. They also have compound eyes, three pairs of jointed legs, and a pair of antennae. There are more than a million insect species on the planet. Some insects, like bees and ants, are social and have developed large, well-organized colonies. The major insect orders include Coleoptera (beetles), Lepidoptera (butterflies and moths), Diptera (flies, mosquitoes, and gnats) and Hymenoptera (wasps, bees, and ants).

Kingdom Animalia
Phylum Arthropoda
Class Chilopoda

Centipedes are the only member of this class. There are over 8,000 species of centipedes. They have segmented bodies with one pair of jointed legs per segment. They always have an odd number of paired legs, so there is no centipede that has 100 legs. They lack a waxy cuticle common in other arthropods and require a moist environment. They are mostly carnivorous.

Kingdom Animalia
Phylum Arthropoda
Class Arachnida

Arthropods in the class Arachnida have eight legs. They also have other appendages that are adapted for feeding, defense, and sensory perception. Arachnids differ from insects because they do not have antennae or wings and they have two body parts instead of three (the head and thorax are fused together). Arachnids include spiders, scorpions, ticks, mites, and solifugae.

30

Kingdom Animalia
Phylum Arthropoda
red rock crab
Cancer productus

Crabs have a pair of pincers that they use for defense, communication, and grabbing food. They often walk sideways. The red rock crab eats smaller crabs, worms, dead fish, sea cucumbers, and other invertebrates that it finds in intertidal pools and bays. Males will guard females that are molting during the mating season.

33

Kingdom Animalia
Phylum Arthropoda
Class Insecta
mosquito
Mansonia sp.

Members of the order Diptera have two wings. Flies, mosquitoes, and gnats are found worldwide (except for Antarctica). They favor freshwater and moist environments. Most have mouthparts adapted for taking in liquid food. Some, like the mosquito, have a proboscis to pierce animal tissue. The female mosquito takes the blood of vertebrates. Some transmit diseases.

37

Kingdom Animalia
Phylum Arthropoda
Class Chilopoda
centipede
Scolopendra sp.

No arthropods except centipedes have forcipules. Forcipules are pincer-like appendages found just behind the head. They are used to capture prey and inject venom. Centipedes feed on earthworms for the most part, but will eat anything self of reasonable size. This genus includes large tropical centipedes that can grow 12 inches long.

38

Kingdom Animalia
Phylum Arthropoda
Class Arachnida
six-spotted fishing spider
Dolomedes tenax

This species of spider lives on the land but hunts in the water. It likes places with shallow, quiet water like the shores of ponds, lakes, or slow-moving streams. It can walk on water to catch prey. It can also dive up to 18 inches to capture the insects, tadpoles, and small fish it feeds on. Females can reach more than two inches in length.

31

Kingdom Animalia
Phylum Arthropoda
bay barnacles
Balanus improvisus

These marine animals attach themselves permanently to a surface. It can be a rock, dock, boat, or another animal. They extend their legs and beat the water to draw in plankton and organic matter to eat. They have many predators, but many will settle in the same place, allowing some to survive.

34

Kingdom Animalia
Phylum Arthropoda
Class Insecta
rhinoceros beetle
Dynastes tityus

The order Coleoptera consists of all beetles. Beetles have two pairs of wings. The first pair is hard and thick to form a protective shell. They have mouthparts that include a mandible with two pincers that grasp. The rhinoceros beetle is very common in East Asian countries. The horn of the male is used to fight other males and to dig in the soil.

32

Kingdom Animalia
Phylum Arthropoda
Antarctic krill
Euphausia superba

These marine crustaceans are near the base of the marine food chain and feed on phytoplankton. They swim in huge schools. There can be as many as 10,000 to 30,000 individual krill in a cubic meter. Whales, squid, penguins, seals, and fish depend on them for survival in the harsh Antarctic environment.

35

Kingdom Animalia
Phylum Arthropoda
Class Insecta
luna moth
Actias luna

Butterflies and moths belong to the order Lepidoptera. The adults have scales covering their bodies and wings. They also have a proboscis. Lepidoptera change from egg to caterpillar. The caterpillar goes into a cocoon, or chrysalis, to change into an adult. The luna moth is one of the largest moths in North America with a wing span of up to 7 inches. The adult lives for only 7 to 10 days.

36

Kingdom Animalia
Phylum Arthropoda
Class Insecta
carpenter bee
Xylocopa sp.

Insects belonging to the order Hymenoptera include wasps, bees, and ants. This is the only order of insects, aside from the order Blattodea which includes termites, to develop a complex social system with different jobs. Carpenter bees bore holes in wood for their separate nests near other carpenter bee nests. They bring pollen to their nests.