Kansas 4-H Geology Leader Notebook

Chapter 2 — Geologic History

Peanut Butter Geology

Geologic Processes — Geology, Level I

What members will learn:

About the Project

- Much of the earth's history can be interpreted by studying the layers of sedimentary rock.
- The geologic law of Original Horizontality.
- The geologic law of Superposition.

About Themselves

- I can use examples I see in the present to learn about the past.
- Hands-on learning is more fun and helps me remember longer.
- Being neat helps.

Materials Needed:

- 2 kinds of bread
- Crunchy peanut butter and jelly (dark preferred)
- Table knives or plastic knives
- Two plastic spoons
- Napkins

Activity Time Needed: 20 Minutes

Activity

Demonstrate each step while you talk, and have the members follow along.

The dirt and rocks that make up the earth were laid down in layers of sedimentary rock. We are going to make peanut butter sandwiches to show how the earth's layers are made.

First we need to open a napkin and lay it down to protect the table and the sandwich. Then, put down a piece of whole wheat bread and spread peanut butter on it. Did everybody get theirs exactly the same? No? Some have lumps or are thicker or thinner than others. Well, sometimes the earth's layers are thicker in some places, too.

Now, let's add jelly and a top layer of white bread. Let's think about how we made the sandwich. When we were making the sandwich, was it easier to lay it flat or hold it on edge? *(Flat)*

That's also the way the earth is made. Layers start out flat like the horizon; that's called the "Law of Original Horizontality." Horizontal means flat, like the horizon. Layers sometimes get rearranged afterwards, but they

Leader's Note

You will need to demonstrate this yourself, and it would be even better if each person or team of two members could make their own sandwich. It is wise to have members wash their hands first, and then they can eat their sandwiches when you are done for refreshments; or, you could give the sandwiches away or put them out for the birds. NOTE: Some people are allergic to peanuts, so check with your group members before they eat the sandwiches.

Specially colored "rainbow" bread can add interest when used as some of the layers.

If you have done the experiment in the Rocks chapter where you shake up a jar of water and sediments and let it settle out in layers, remind members of the flat flayers it formed.

start out flat.

Now, which piece did we put down first? *(The bottom or whole wheat bread)* That's also the way the earth is made. The bottom layer is put down before the layer on top of it. Then, the next lowest layer until you get to the top. Geologists call this principle the "Law of Superposition."

Before we eat our sandwiches, let's think about it some more.

Dialogue for Critical Thinking:

Share:

1. Why did you make a peanut butter and jelly sandwich?
2. What happens if you hurry too fast?

Process:

3. How is the sandwich like the earth's layers? What geologic law says the layers are laid flat?
4. Which layer is the oldest or put down first? What do geologists call this?
5. What could the chunks in the peanut better represent in the earth? *(Rocks or conglomerates)*
6. What might eating or slicing off part of the sandwich be compared to on the earth? *(Erosion of various kinds)*

Generalize:

7. How does doing an illustration (like the bread) help you learn or remember better?
8. Why is it important to be neat and careful?

Apply:

9. Where else might you find layers of things? What is the same or different from the Geology layers?
10. What are some other ways to show the effect of erosion?

Going Further

1. Add raisins or M&Ms to the sandwich. What might those be compared to? Boulders in isolated pockets? For example, a small pond or pothole could leave an area that is different from the rest of the layer.
2. Make a sandwich a little differently. It could have two of one kind of bread, or honey instead of jelly. Is this sandwich the same as the others? Why not? *(Layers are not the same.)* That's also how you can match up layers from place to place. If they don't match up, they are usually from different ages. *(This is correlation of layers.)*
3. Look for layers on you next field trip, or when you are driving or walking near a road cut. Which layers are the oldest? Can you match them up on the other side?

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Reviewed by: Rex Buchanan, Geologist, Kansas Geological Survey
James P. Adams, Associate Professor, 4-H Youth Development

Era Dioramas

Geologic History — Geology, Level II

What members will learn:

About The Project:

- The earth has been around for a long time.
- The earth is changing.
- Some kinds of plants and animals are extinct.
- Geologic time is divided into four main eras.
- Each era has its own distinctive plants and animals.
- Plant and animal life has developed from simple to complex.
- Dinosaurs are only a small part of the earth's history.
- Vertebrates are animals with backbones.

About Themselves:

- To appreciate our world and its long and interesting history.
- We live in a logical world.
- We can learn through careful observation skills.
- Visual displays help us learn.
- Creative learning is fun.

Materials Needed:

- Four or more boxes — like shoe boxes or boxes from a store — for bases for the dioramas.
- Member Handout 3, Instructions for Dioramas
- Member Handout 4, *Archeozoic*
- Member Handout 5, *Paleozoic*
- Member Handouts 6 and 7, *Mesozoic* (2 pages)
- Member Handouts 8 and 9, *Cenozoic* (2 pages)
- Art materials: felt tip markers, highlighters and/or crayons and paints
- Scissors, glue, construction paper, etc.
- Blue plastic food wrap, or plastic bags (optional)
- Rocks, dirt and sand as desired
- Newspapers to protect tables

Activity Time Needed: 1 hour, or may be continued at the next meeting to complete the diorama.

Leader's Notes

It would be good to do the peanut butter geology lesson first, so members know a few basic geology concepts.

Divide into small groups of one to four. For large groups, make two or more series of dioramas. The Precambrian group should be small, or assign the first two eras to one group, as it is simpler than the rest. (Use a smaller box.) Hand each group member a handout of the appropriate era figures.

These answers may not come exactly in this form. Expand as you like. Reptiles also are cold-blooded. Expand on that if you would like.

If they ask, Jurassic is a period within the Mesozioc.

Go into more detail if members seem interested in what differentiates mammals, reptiles, etc. More information on both plants and animals can be found in the fossil

Hand out Member Handout 3, *Instructions for Dioramas*. Read or summarize the instructions before members start. They will likely need to take turns and share the supplies. Suggest appropriate backgrounds, etc., as needed. Praise their efforts and comment specifically and favorably on any creative or special efforts.

Activity

The earth started a very long time ago — way before I was born and even before your great grandparents were born. In fact, there were no people at all. There were no plants and no animals at all for a long time until a few things got started. First, there were little things like algae and bacteria, some too little to see. We call this time the Archeozoic or Precambrian and we don't know a lot about it because it was so long ago. Then, slowly, more things started to grow until now where we have lots of different plants and animals.

The earth's history can be divided into four large amounts of time called eras. In a little while, we are going to make dioramas—which are boxes with a model of the scene built into it — to show each era, or long amount of time. We'll need to divide into four groups, and each group will make one era diorama.

Who has the Precambrian or Archeozoic era? What is on it? You may want to use some of these rocks in your diorama to show what it was like. Most of the life forms shown started in this era.

Next was the time of ancient life called the Paleozoic. What figures do you have most of on your pages? Do they look like sea or land animals? *(Sea)*. That's because during some of that time, large areas were covered by seas. You can use this blue plastic wrap (or blue highlighters or paint) to make the sea. What else do you have? *(Sharks, bony fish, amphibians)* Some of these things were also on land. They are some of the earlier and simplest animals and plants. Some of the items in this diorama were earlier in the era, while the amphibians were in the later part of the era.

Who has the Mesozoic, the age of the reptiles? What are reptiles? *(A large group of scaly animals with backbones like lizards, alligators, etc.)* What animals do you have on your sheet? *(Dinosaurs)*. Yes, this era included the age of the dinosaurs.

There were also many other animals. What were some of them? *(Sharks, turtles, fish; a big variety)*. Are all these kinds of animals still around today? *(No, but some are)*. What do we call it when all types of an animal dies out? *(They are extinct)*. What were these plants like? *(Almost like a tropical forest; lots of large ferns and palm trees)*. What does that make you think the climate, or weather, must have been like? *(Warm and wet)*.

Now, we are ready to look at the last era: the one we are still in. It is called the Cenozoic, the Age of Mammals. What are mammals? *(Animals that feed their babies milk)*. They are also warm-blooded, have hair somewhere on their bodies and have backbones. People are mammals. Why? *(They have milk for their babies, hair, backbones, etc.)*. There were also many other animals. What were some of them? *(Fish, turtles, mammals that are a little like some we have today, a big variety, most of which are still around today)*. Quite a few animals are still alive from earlier eras, and these new ones were added to them, so now we have many kinds.

Now, we need each group to make a little museum-type display about your era, and then we'll see what we can learn from them. You can use these supplies to color your boxes and make them attractive. Don't put anything in your box that wasn't in your era. You can cut out the pieces on the sheet after you color them, and then fold the tab back and glue it down to the bottom of the box. Use your imagination to make your box look nice. If you have a partner, you will need to plan how to make the diorama together. Let's read the instructions before we start.

Now that we are pretty much done, let's take a look at your boxes and talk about the eras. They all look great, and I'm pleased with all the good work and ideas you put into them. You can look at the dioramas to answer these questions.

Dialogue for Critical Thinking:

Share:

1. How did you feel when you tried to say these new geology words?
2. What did you find most interesting about building your diorama? Why?

Process:

3. What eras might have had volcanoes? (*Any, but especially Precambrian and Mesozoic.*)
4. What kinds of animals do we still have today that used to live in earlier eras? (*Sharks, shellfish, etc.*)
   What kinds don't we have anymore because they all died? *(Trilobites, dinosaurs, etc.)*
   What kinds do we have now that we didn't have earlier? *(Elephants, tigers, etc.)*
5. What kind of plants do we have now that we didn't have in earlier eras? (*Plants with flowers*)

   What kinds of plants still live from earlier eras? *(We have palms, algae, bushes)*
6. Which era has the most complicated (fanciest) and the most kinds of animals and plants? *(Cenozoic)* Least? *(Precambrian)*

Generalize:

7. Do you think the dioramas helped you to understand how things have changed? Where else could you use models or dioramas?
8. Can we depend on a species being around if we don't protect its living space?

Apply:

9. Which era is exposed at the surface in the area where you live? How can you tell? *(Fossils you find.)* What might have happened to any layers that are missing? *(They might have eroded away or weathered until they were gone.)*
10. Where else might visual displays like dioramas help you learn?

Going Further

1. Display your dioramas at the fair, club meetings, school, nursing homes, etc. Make a fancier display. Use purchased animals or animals molded from clay. Add more plants and animals. You could make a poster about each era to go with it.
2. Read about the era you find the most interesting, and write a report or a small book to share with someone.
3. Study about plants and animals that are extinct and tell what you find out. What caused it? How does today's rate of extinction compare with those in the geologic past? How do we know?

References

Dinosaurs Alive! Teacher guide by Dinamation International Corporation

Many books available at your local library. Choose more factual books, like ones by Ailki, Osborne books, Eyewitness books, etc.

Murals at the Peabody Museum as printed in Time-Life books are a good source of ideas for dioramas.

National Geographic, June 1989 issue (extinctions)

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Era Dioramas

Member Handout 3, Instructions for Dioramas

Geologic History — Geology, Level II

Instructions for Dioramas

Each diorama is about a different era, so each should be different. You may add more items to the dioramas, but they should be appropriate to that era. Many animals continued into other eras, but you should first decide if the animal really did live then. Some are still living today, so it would be safe to add them to any dioramas between when they appeared and now.

Appropriate items to add to each era are these:

Archeozoic: Dirt, rocks and slimy things to look like molds or other simple life forms. Most life was in the water. No big plants, just algae.

Paleozoic: Some rocks, dirt, shell fish, fern type plants and large fern-looking trees. Much animal life still in water.

Mesozoic: Volcanoes molded from play dough or glue mixed with sand. Evergreen trees (conifers) and trees that looked like palm trees, but few flowering plants. Shallow seas in some areas.

Cenozoic: Trees and plants like today. Any animals still alive today. Dirt and mountains and/or glaciers in the background.

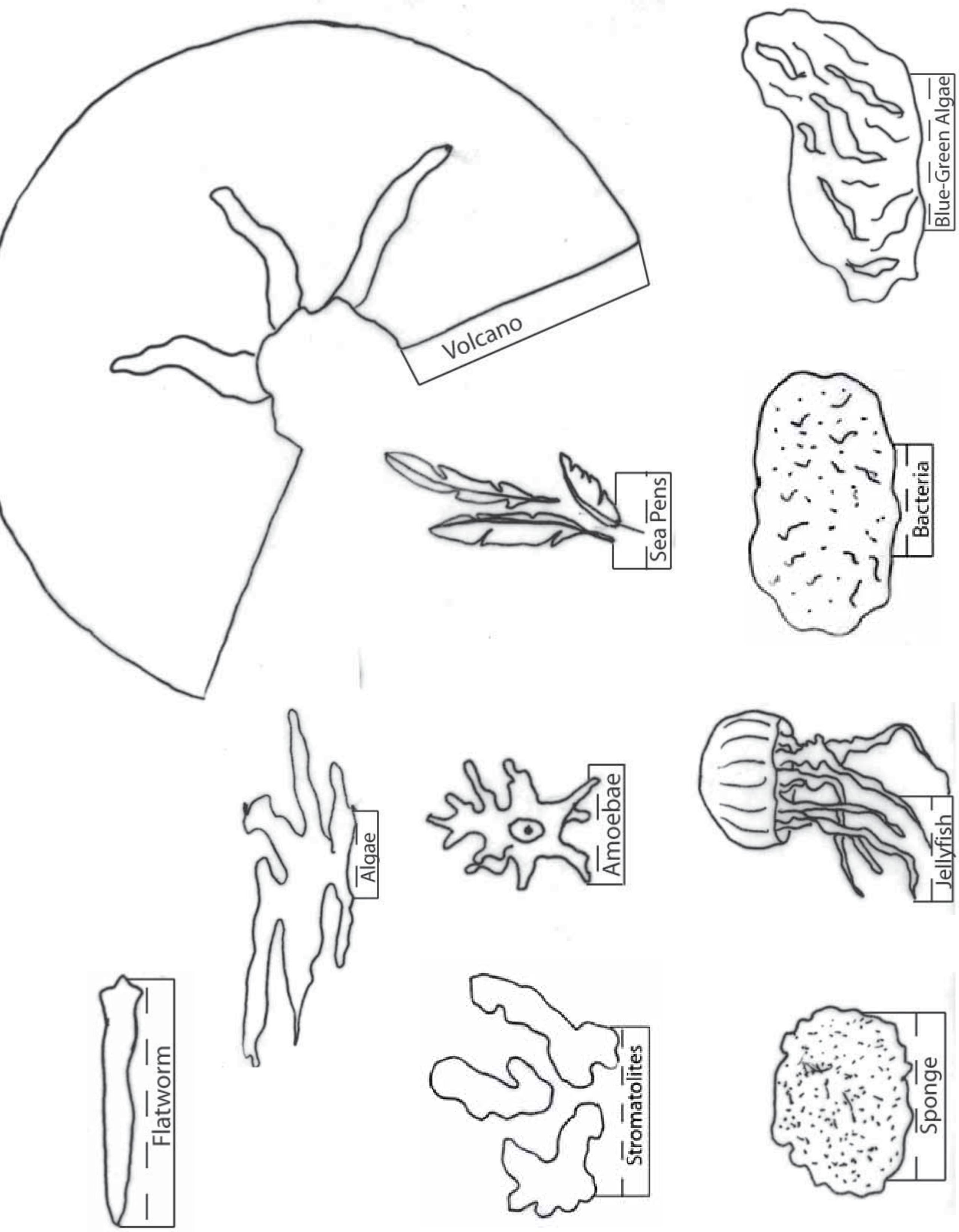
Steps To Make Dioramas:

1. Plan how you will work. If you have a partner, decide if one of you can work on the box and the other on the parts to go in it, etc.
2. Keep items for each diorama separate from the others.
3. Prepare the box. Place it on the side. Remove the top. Paint, or leave the bottom brown or tan, for dirt. Paint the sky. Paint the sides appropriately for each diorama. Should it be blue for sky or water? Should part of it be brown for dirt? Should it be green with trees? What kind of plants should you paint on it? Should part be for water, a lake or sea? Could you use plastic wrap to look like water?
4. Color the items to go in the box. Try to think of appropriate colors.
5. Cut out the items. Fold tabs on the dotted lines. Do you want all the tabs folded back so they don't show, or forward so people can read them?
6. Put them in the box and move them around until they look right. Is each in the right environment?
7. Glue the items in place, or lean them against something.
8. Find a good place to put the sign. You could also look up each era and write down some information so other people could learn about it .
9. Look at all the dioramas. What can you learn?
10. Find a good place to display your diorama? The fair? school?

Era Dioramas

Member Handout 4, Archezoic

Geologic History — Geology, Level II

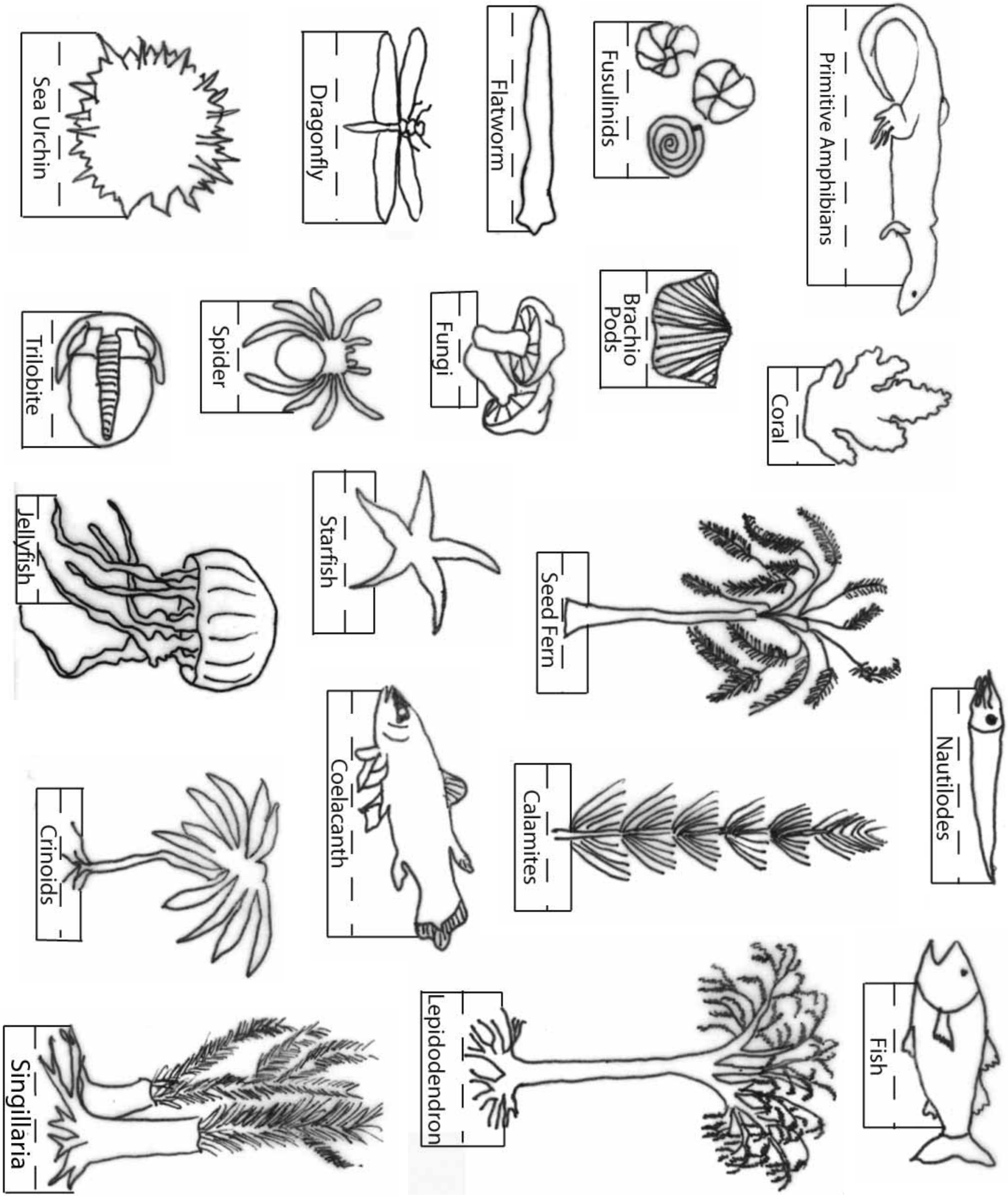


ARCHEOZOIC

Era Dioramas

Member Handout 5, Paleozoic

Geologic History — Geology, Level II

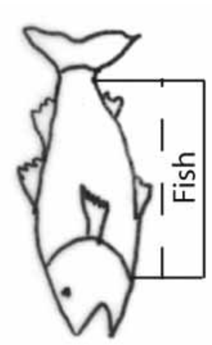


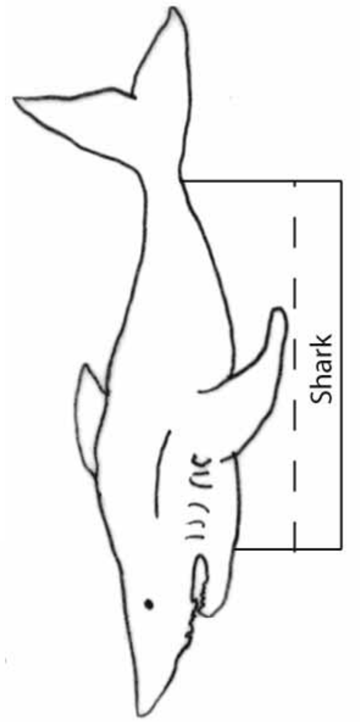
PALEOZOIC

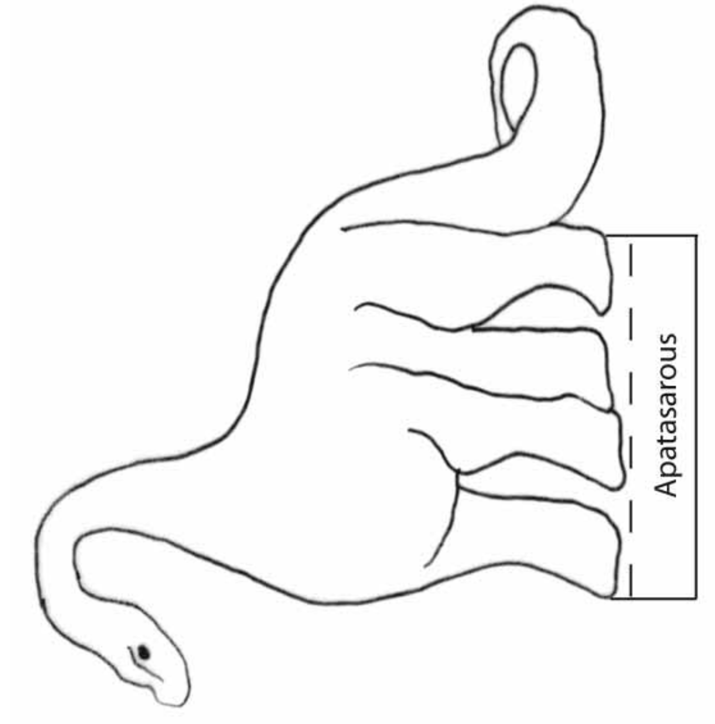
Era Dioramas

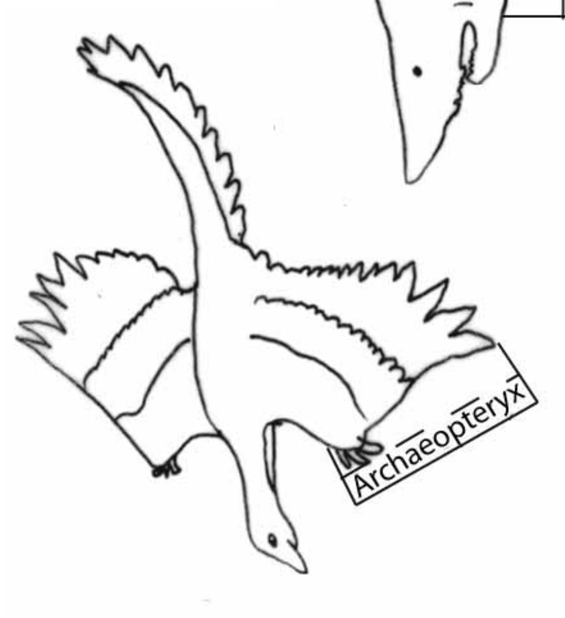
Member Handout 6, Mesozoic 1

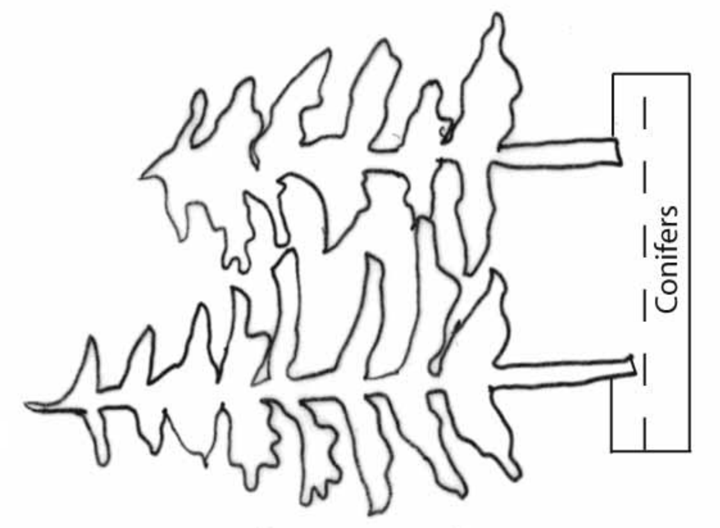
Geologic History — Geology, Level II



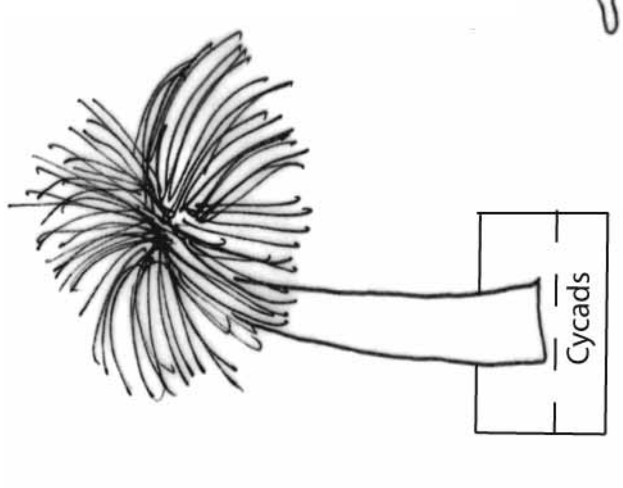


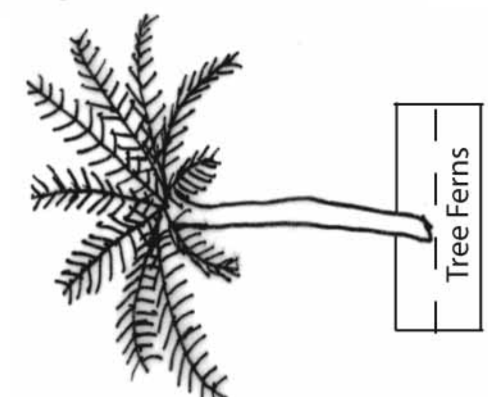






MESOZOIC



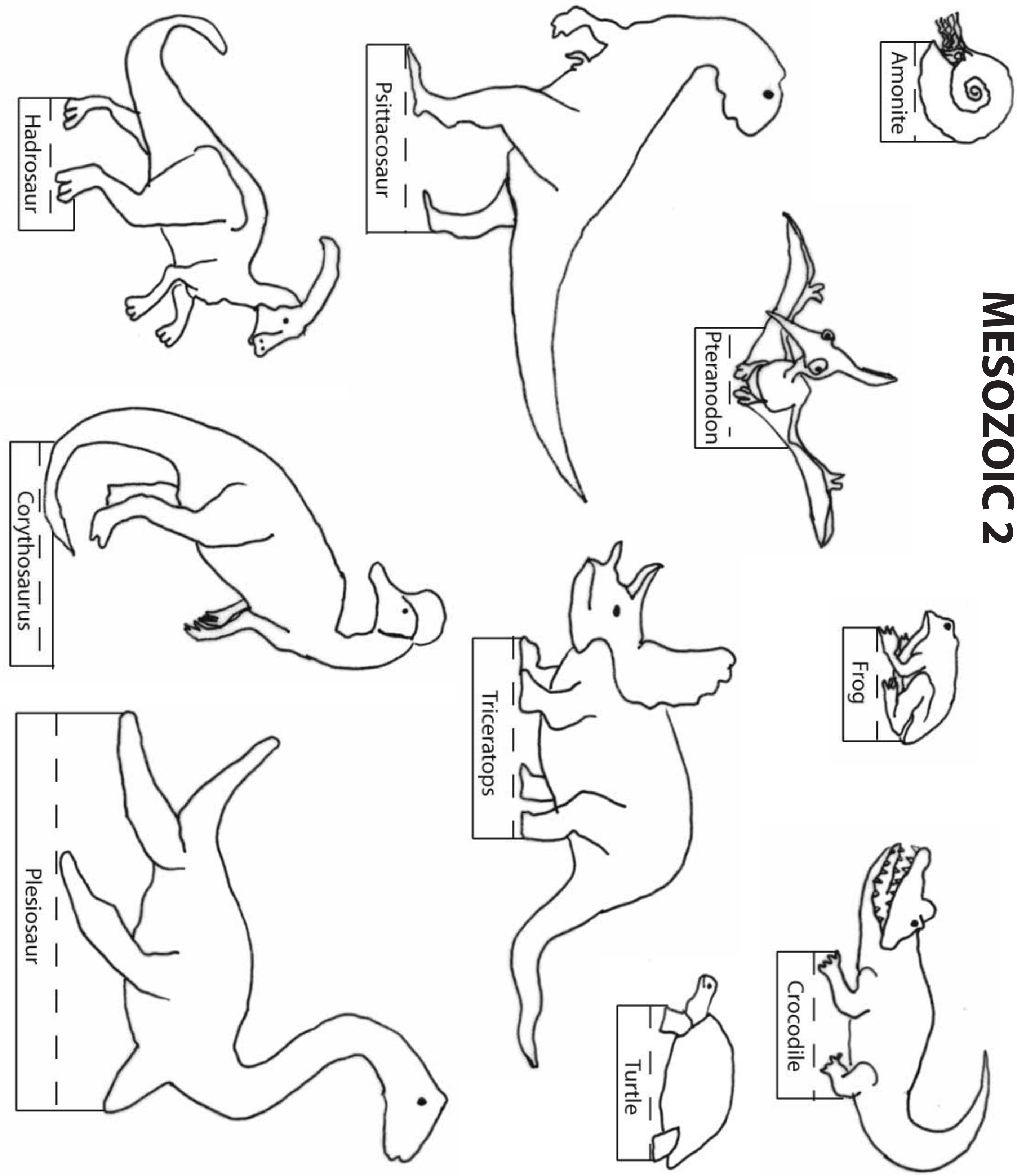


Era Dioramas

Member Handout 7, Mesozoic 2

Geologic History — Geology, Level II

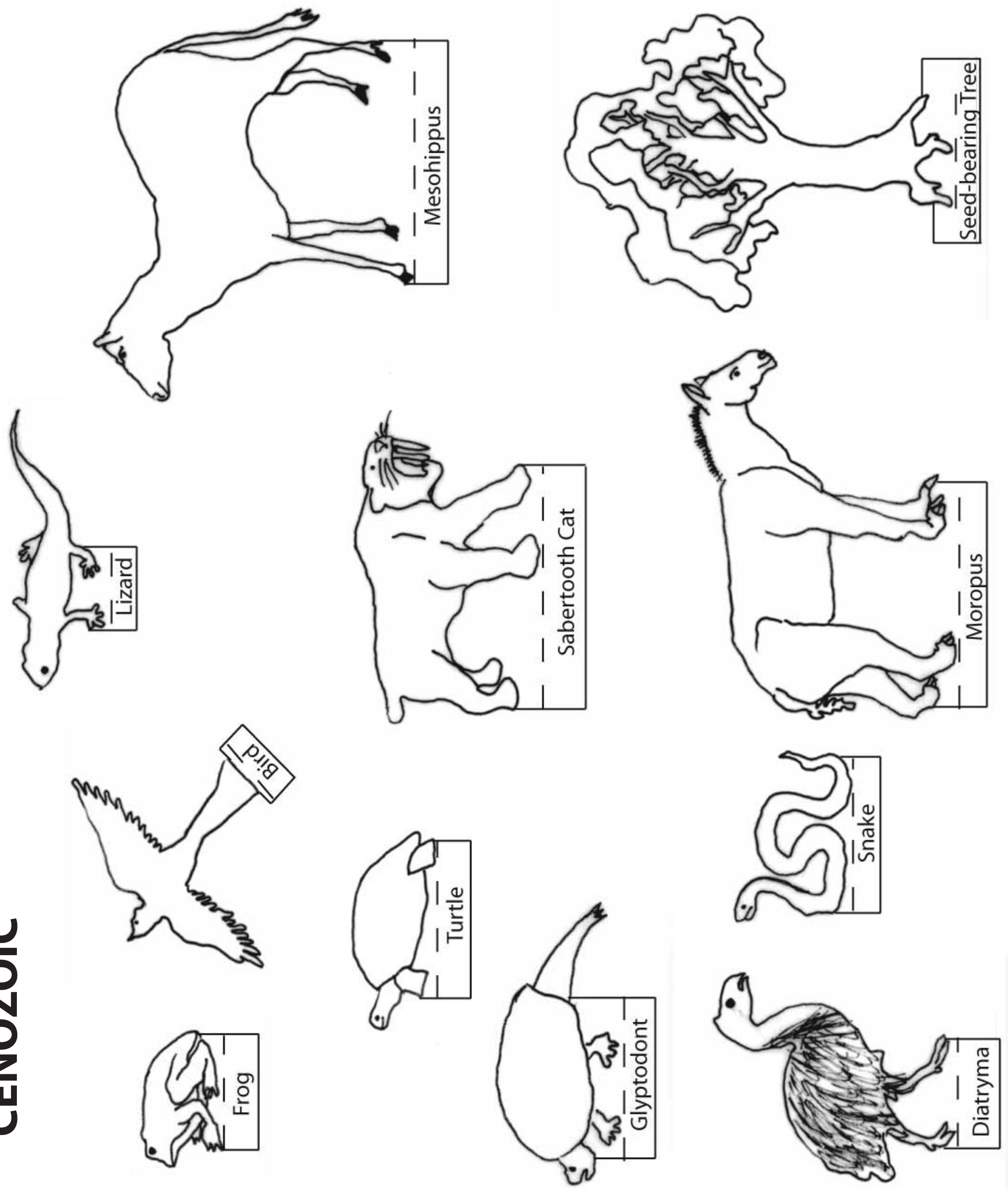
MESOZOIC 2



Era Dioramas

Member Handout 8, Cenozoic 1

Geologic History — Geology, Level II

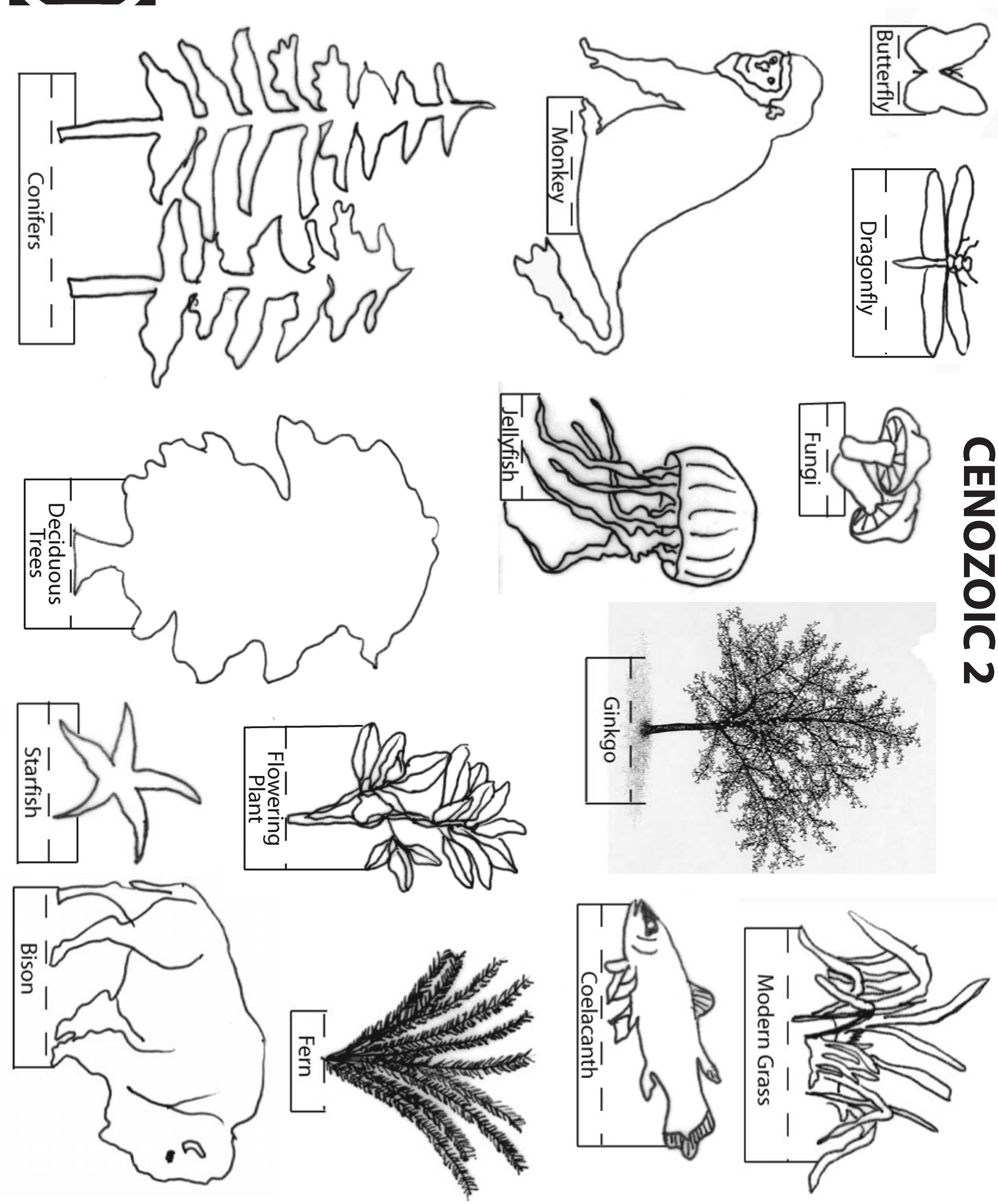


CENOZOIC

Era Dioramas

Member Handout 9, Cenozoic 2

Geologic History — Geology, Level II



Dinosaur Ancestors

Geologic History — Geology, Level II

What members will learn:

About The Project:

- A niche is the place where animals fit into nature.
- A theory is a guess about a principle that is based on fact.
- Extinction is when all animals of a species die.
- Geologists can tell things about how an animal lived by studying its bones.
- The inside of an animal is more important than the outside for deciding were it fits into families.

About Themselves:

- I can make a better guess if I first gather information.
- I can divide things into categories by looking at their common characteristics.
- I have my own niche where I fit in nature.
- What I am inside is more important than what I look like on the outside.

Materials Needed:

- Activity Sheets: 8 *Niche*; 9 *Niche, Leader's Key*; 10 *Dinosaur Dig*; 11 *Dinosaur Hips*; and 12 *Dinosaur Family Tree*
- Pencils and markers or crayons (optional)
- Scissors, paper, stapler and glue
- Library reference materials as desired (e.g. dinosaur pictures, models, books).
- Dinosaur bones, gastroliths, etc. as available.

Activity Time Needed: 50 Minutes (longer if doing additional activities)

Activity:

How many of you like dinosaurs? What are your favorite kinds of dinosaurs? Today, we are going to learn some things that apply to dinosaurs and also other prehistoric animals. All dinosaurs and many other prehistoric animals are extinct. What does that mean? Yes, they all died, and there are no more of that kind of animal left. What are some more recent animals that have become extinct? (*Auks, mammoths, passenger pigeons, etc.*)

Leader's Notes:

Allow a little discussion, and then move into the lesson.

When an animal becomes extinct, another animal usually replaces it to fill the place it held in the animal and plant community. The place that it has is called a niche. For example, if all of a species of an animal that ate grass died out, some other animal that could digest grass would come along to fill its niche. If you don't know what some of those animals are, you can ask or look it up before you match them up.

Hand out the Activity Sheet 8, *Niche*.

People have long wondered about dinosaurs. Long ago, when people found dinosaur bones, they thought they were maybe monsters or dragons. Even though we know more about them, we still are not sure why they all died. How many theories for dinosaur extinction do you think there are? (*Over the years, more than 80 theories or guesses have been suggested for why they died.*) A theory is a reasonable explanation for why something happened. People who think of theories first study what is known. Then, they think about how it could have happened. If their theory still makes sense, they tell people about and publish articles about it. It usually takes a long time before a major theory is accepted as fact. Dinosaur extinction theories are still in the early stages. In fact, there are still several theories that could explain what happened. Which ones have you heard? (*e.g. comet stirred up dust blocking sunshine, environment changed, etc.*) Maybe there is more than one reason for it. If you are especially interested, you can study and report back to us the next time we meet, or do an educational project on it.

Expect them to know almost as much about these theories as you do.

Geologists can tell a lot by studying the fossils they find. By studying the leg bones and the places where the muscles were attached, geologists can tell how the animal stood and ran. They can tell what an animal ate by studying its teeth. If a dinosaur had sharp, steak knife-type teeth, what did they probably eat? (*meat, other animals*) If they had flat grinding teeth, what did they probably eat? (*Plants that needed grinding up.*) Grass is so hard to digest that many animals store it in a separate compartment called a gizzard to allow a longer time to digest. Round stones — that geologists think were inside the gizzards of dinosaurs to help grind up the grass — have been found. These stones are called gastroliths.

Dinosaurs can be divided into two main kinds depending on the way their hips are shaped. One is called "Lizard-hipped" or Saurischian, because its hip bone is shaped like a lizard's hip. This makes sense because dinosaurs are closely related to reptiles like lizards, and some people think they are a kind of reptile. Reptiles have their legs sticking out of the sides of their body. Dinosaurs, however, were thought to walk more upright than reptiles, and had their legs straighter under their bodies.

Hand out:

Activity Sheet 10, *Dinosaur Dig*

Activity Sheet 11, *Dinosaur Hips*

Activity Sheet 12, *Dinosaur Family Tree*

The other main type of dinosaur is "Bird-hipped" or Ornithiscian. This also makes sense because birds are thought to be descendants or near relatives of dinosaurs. By using the hipbone type to separate the two categories, you can tell which dinosaurs are more closely related to each other. Using the *Dinosaur Dig* worksheet, you may first color the outside of the dinosaur if you wish. Then, cut out the pieces and use the *Dinosaur Hips* worksheet to match the hip bones to the outside of the dinosaur by the shape. Staple matching pieces together at the top. Now, sort them into lizard-hipped and bird-hipped categories. Can you always tell from the outside what kind of hip it will have?

Glue your pictures to the *Dinosaur Family Tree* worksheet. The trunk of the tree shows that they all started from animals called Thecodonts. Pterosaurs and crocodiles also came from them. Many geologists now think birds descended from dinosaurs, or that they branched off about the same place dinosaurs did. They think birds might have come from the lizard-hipped dinosaurs, with feathers being the distinguishing feature for birds. Some geologists also think some dinosaurs might have had feathers. It is very interesting. Glue the back layer of the animal picture to the *Dinosaur Family Tree* worksheet to show how they were related.

Dialogue For Critical Thinking

Share:

1. What part of this activity did you enjoy the most? Why?
2. What was the most difficult thing to do?

Process:

3. How many dinosaurs could you match up without looking at their hip type?
4. What would have happened if dinosaurs hadn't become extinct?
5. Which dinosaur extinction theory do you like and why?
6. Which is more important in deciding what an animal is related to; its inside structure or its outside appearance? *(Inside)*

Generalize:

7. Do you think your inside (your thoughts and feelings) or your outside (your appearance) is more important? Why?
8. What is your niche in biological terms? *(Both meat and plant eater)* What is your niche in social terms? *(You have an important place in your family and community — e.g. son or daughter, student, helper, team member)*

Apply:

9. How does dividing items into categories help you learn?
10. Why are so many reptiles confused for dinosaurs? (*Because they are closely related, have many of the same characteristics and look alike.*)
11. How would you check out a theory explaining something new?

Going Further:

1. Look up length and height for the biggest and smallest dinosaurs. Then, measure out in a long room or hall how long they were. Compare the largest one to a blue whale, the largest living thing.
2. Investigate teeth types in detail. There are many more kinds. How did they relate to the dinosaur's diet? Draw pictures of the types of teeth, tell what diet they probably ate and which dinosaurs had that type of teeth.
3. Birds may be descended from dinosaurs. Find out what the early birds looked like, and what the justification is for calling them either birds or reptiles. Compare the skeleton of a modern bird, a flying reptile, and Archaeopteryx. How are they alike? Different? Make a chart.
4. Make a mobile of ancient flying reptiles and early birds. Separate them by putting the reptiles and the birds in different areas of the mobile to make it easier to compare. Make a sign telling the differences.

The activity sheets can be added to their geology notebooks when finished. You may want to do one of the hands-on activities from the "Going Further" section to complete this lesson. Measuring the length of the longest and shortest dinosaurs is easy to do. The references with worksheets also have good activities.

5. Make a diorama of the dinosaurs in the different periods. Make sure the plants are also right for each period. How do dinosaurs differ in the periods, and can you see a connection between the plants available and the dinosaur's adaptations?

References

Braden, Evelyn M., *Prehistoric Life*, 1987, Milliken Publishing Company, St. Louis, Missouri. (Reproducible pages and good info on Dinosaurs and prehistoric life.)

"Digging into Dinosaurs" issue, *Naturescope*, National Wildlife Federation, 1400 Sixteenth St., N.W. Washington, D.C. 20036-2266. Reproducible worksheets and lots of good activities.)

Lucas, Spencer G., Dinosaurs, *The Textbook*, 1994, William C. Brown Publishers, Dubuque, Iowa. (Excellent in depth book.)

McLaughlin, John C., *Tree of Animal Life*, 1981, Dodd, Mead & Company, New York, NY. (Good book on evolution and pressure to fill niche. (Leaders and teenagers)

Gore, Rick. 1989. "Extinctions," *National Geographic*, June 1989, pp. 663-699. Good article on extinctions.

Unwin, Mike, *Where did Dinosaurs Go*, 1991, Usborne Publishing Ltd, Usborn House, 83-85 Saffron Hill, London EC 1n 8RT, England. (Children's book on dinosaur extinction)

West, Linda, *Dinosaurs and Dinosaur National Monument*, 1988, Dinosaur National Monument, Box 128, Jensen Utah 84035. (Leaders and older 4-Hers. Very good information and reproducible pages for a range of ages.)

"When Dinosaurs Shook the Earth," *Topeka Capital-Journal*, March 21, 1993, pgs. 1 & 2F. (Newspaper article on dinosaurs found in Kansas.)

Many good children's books are available. Look for ones that are readable and attractive. Also look for a depth of understanding of principles, not just a listing of facts about dinosaurs.

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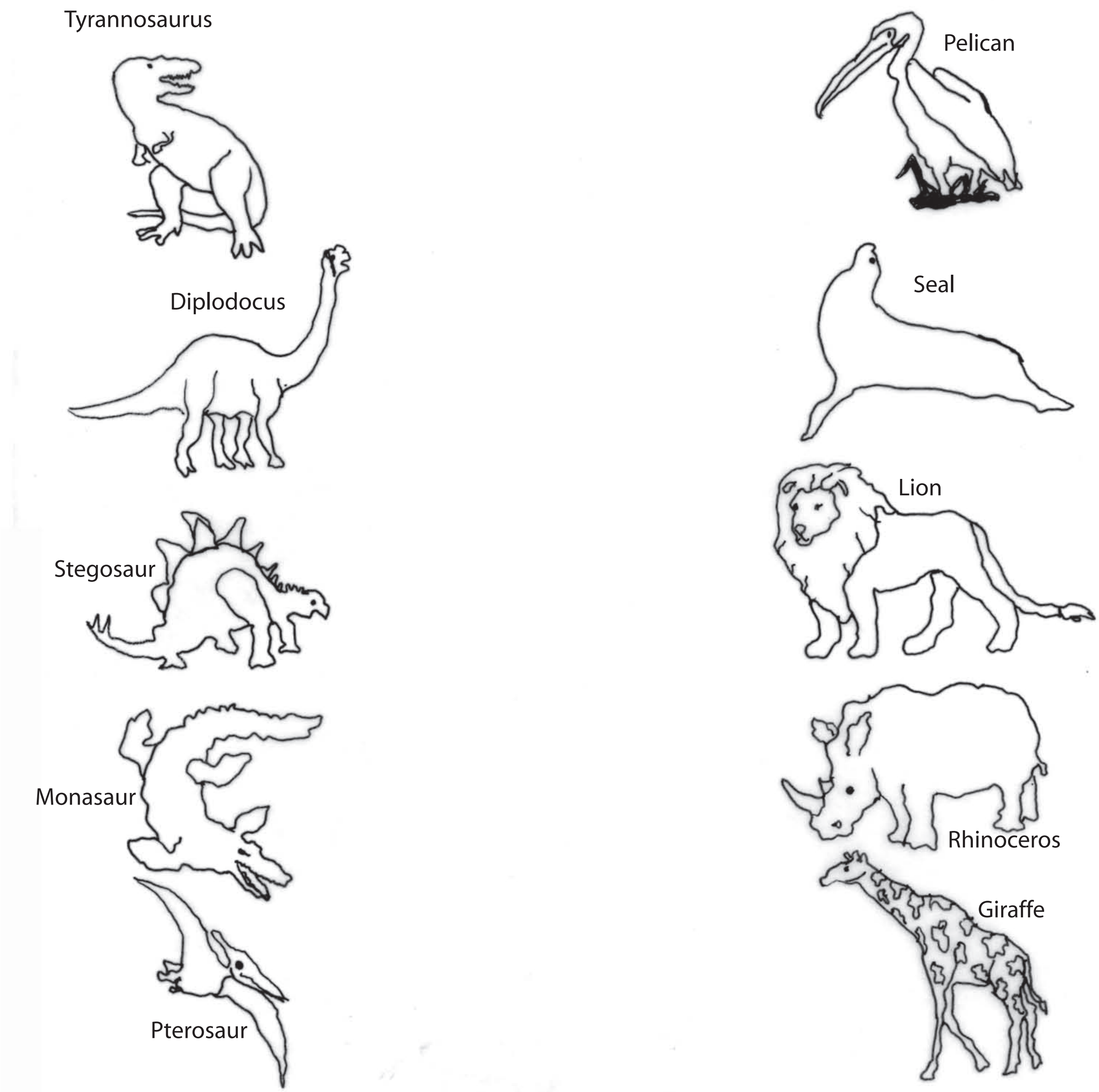
Dinosaur Ancestors

Activity Sheet 8, Niche

Geologic History — Geology, Level II

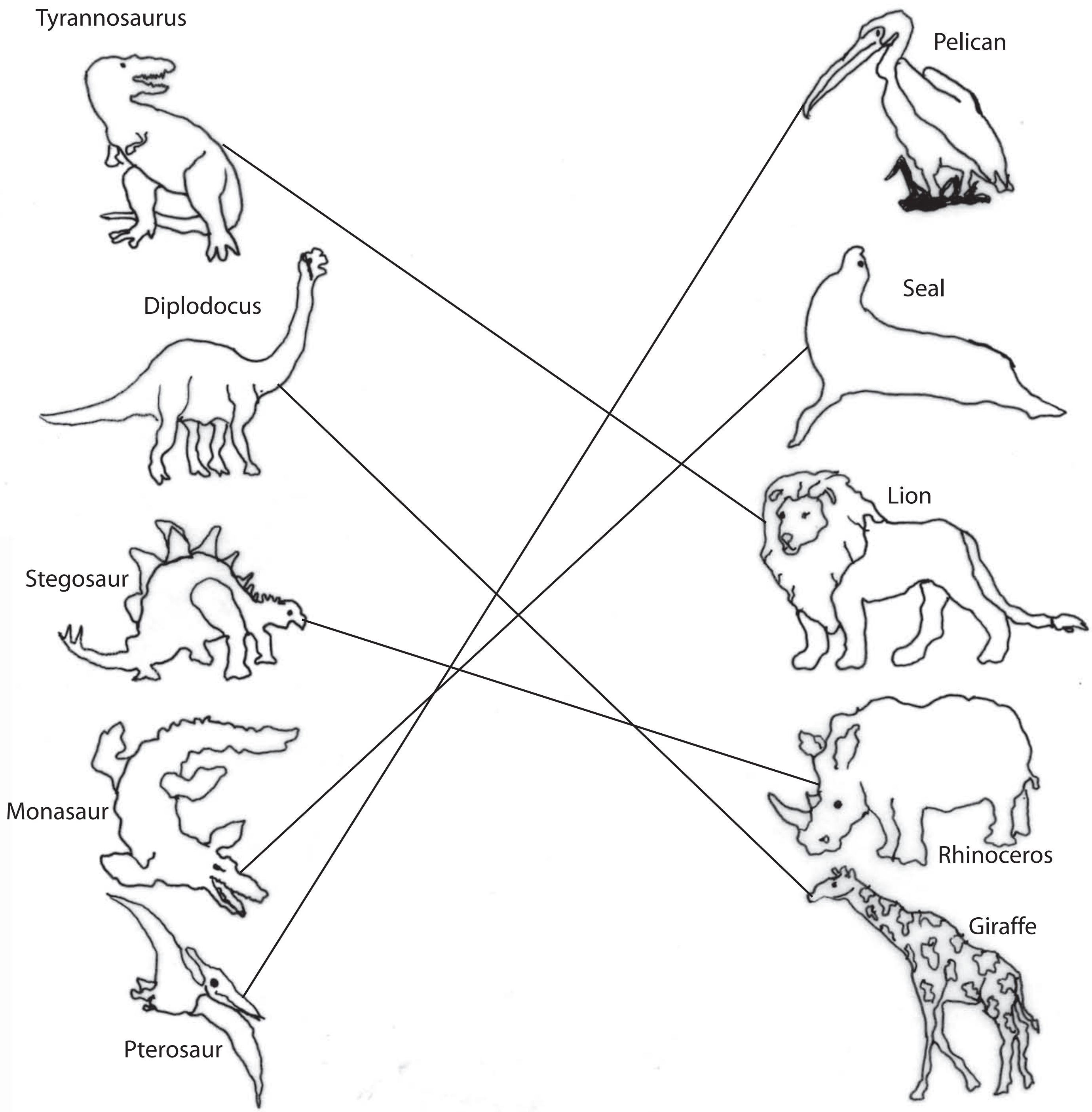
A living thing has a certain place where it belongs. A monkey's niche is in the tops of trees eating fruits and things like that. A fish has a far different niche, and it depends on what that fish eats. Each kind of animal that lived long ago also had its own niche. Think about what the animal eats, its size and where it lives. Draw a line from the prehistoric animal to the modern animal that fills the same niche.



Dinosaur Ancestors

Activity Sheet 9, Niche, Leader's Key

Geologic History — Geology, Level II

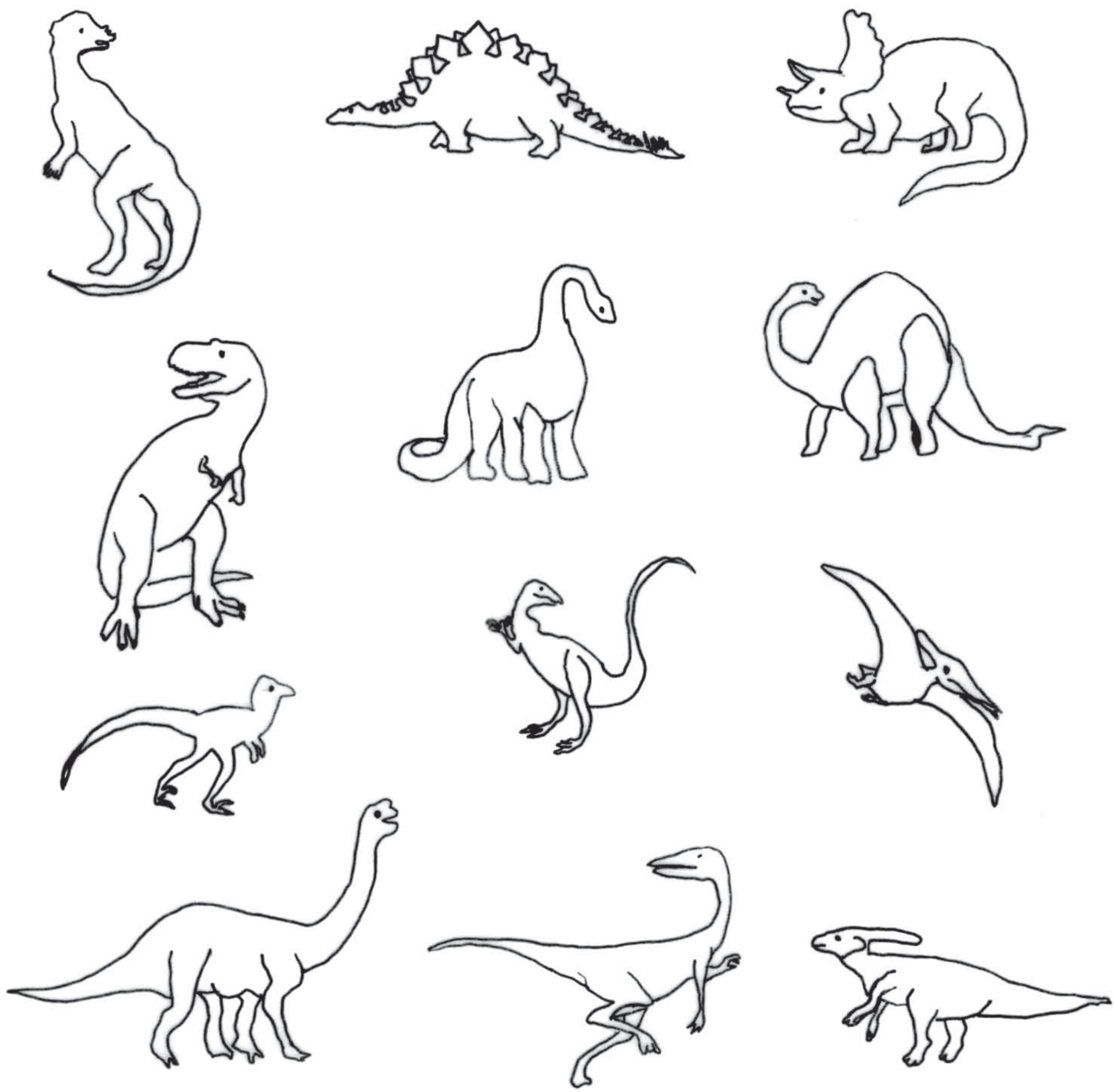


Dinosaur Ancestors

Activity Sheet 10, Dinosaur Dig

Geologic History — Geology, Level II

Color the dinosaurs and other animals on this page. Cut them out. Then, match the dinosaurs up with their match using the “Dinosaur Hips” activity sheet and staple them together near the top of each pair. Glue the back of each set to the “Dinosaur Family Tree” activity sheet.

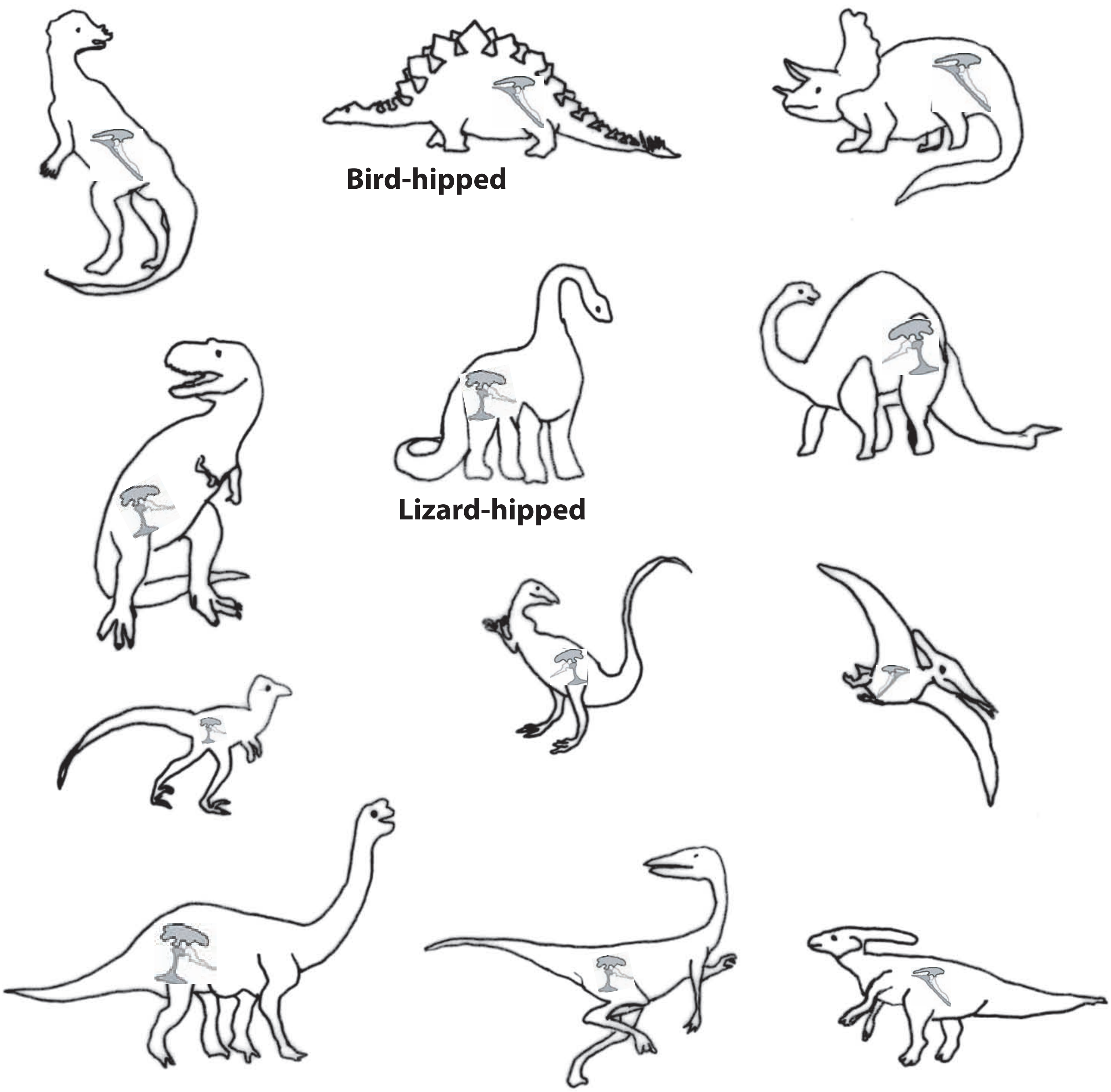


Dinosaur Ancestors

Geologic History — Geology, Level II

Activity Sheet 11, Dinosaur Hips

Dinosaurs have two kinds of hips. Color and cut the dinosaurs on this page and match them with the dinosaurs on the "Dinosaur Dig" page. Staple them together near the top of each pair. Sort the dinosaurs by hip bone type. Glue the back layer of each set to the "Dinosaur Family Tree" on the family tree page.

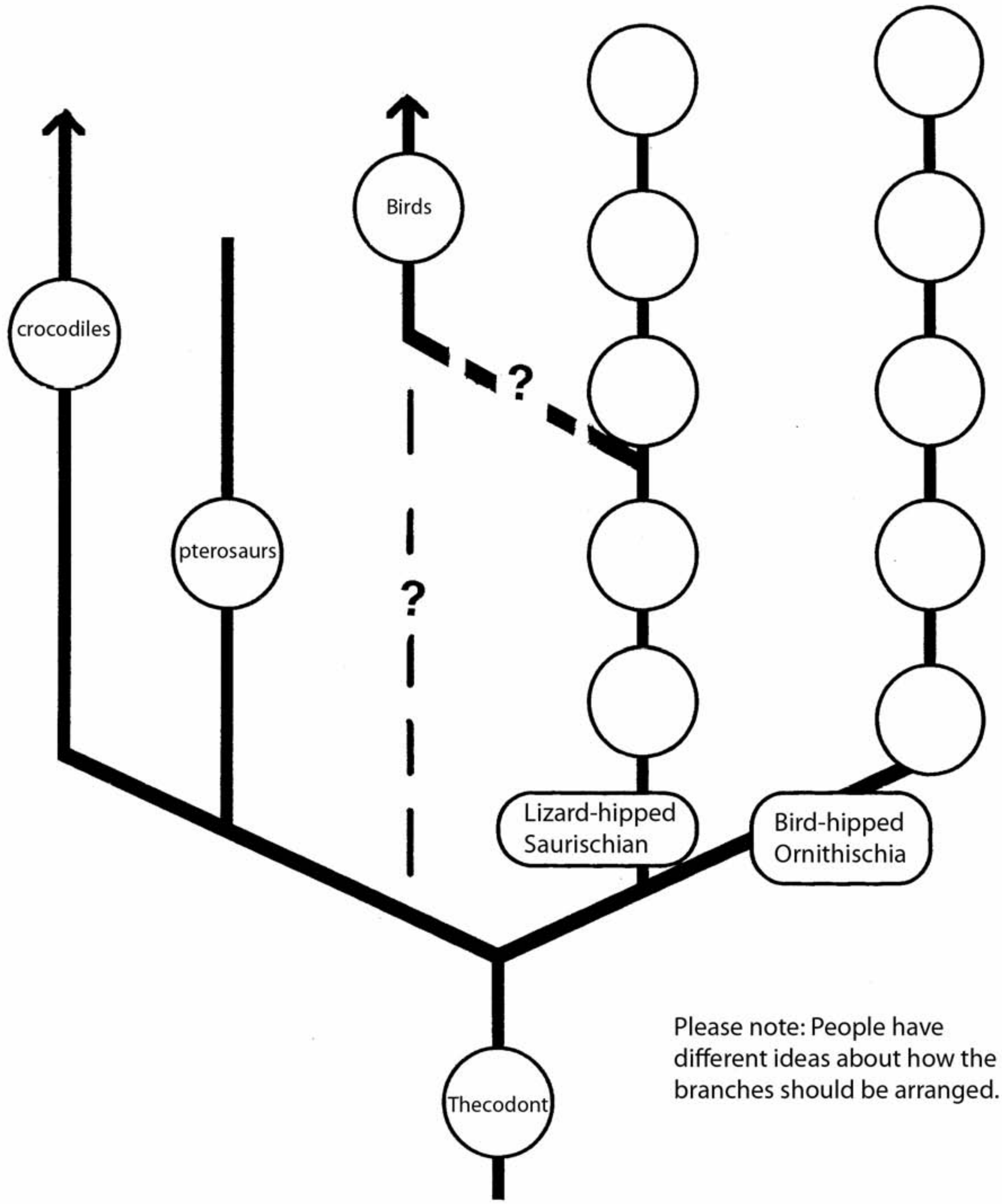


Dinosaur Ancestors

Activity Sheet 12, Dinosaur Family Tree

Geologic History — Geology, Level II

Glue the pictures of prehistoric animals on the family tree circles. The ones that are most alike should be on the same "branch."



Geologic Column

Geologic History — Geology, Level II

What members will learn:

About The Project:

- Major geologic time periods and eras.
- Typical plants and animals in each era.
- Progression of life from simple to complex.
- The order of time periods.
- Eras and periods are separated by geologic events.

About Themselves:

- How to use mnemonic devices and visual aides to help learning.
- Appreciation of living in a varied and interesting world.
- The relationship of people in geologic history compared to animals.

Materials:

- Activity Sheet 13, *Geologic Columns*
- Paste or glue, scissors
- Member Handout 10, *Geologic Column Figures*
- State geologic map, if possible (May be obtained from Kansas Geological Survey, or its Web site: www.kgs.ukans.edu/)
- Representative fossils of your area
- Four medium or large books

Activity Time Needed: 30-40 minutes

Activity

Geologists have divided time since the beginning of the earth into different periods. Geologists have found they can tell that different animals lived during different time periods of the earth's history. They seem to divide up naturally — by what fossils are found in them — into four big, long divisions. Some geologic event decides when they start and finish. For example, the Mesozoic ends with the dinosaurs dying out and then the next era, Cenozoic, begins with mammals becoming important. Here is an activity sheet on geologic eras. See how the big eras are shown here on the left side.

Leader's Notes

(It is recommended you complete the "Peanut Butter Geology" and "Era Dioramas" lessons before you begin this lesson)

If possible, complete an activity sheet yourself ahead of time to use as the answer sheet.

Hand out Activity Sheet 13, *Geologic Columns*. Hold up your own sheet and point to the eras.

This also serves as a review of earlier lessons. They may not remember all the names.

Let's pretend these four books are each an era. Remember peanut butter geology? Which layer was the oldest? *(The bottom one)*. We can pretend this lowest book is the oldest. Which era would that be? *(Precambrian)*. What is the next era? *(Paleozoic or Ancient Life)*. We'll pretend that the second book is the Paleozoic. What is the third one? *(Mesozoic, the age of the reptiles)*. Yes, let's pretend there are dinosaurs in this book. The last era — that we are still in — is what? *(Cenozoic)*

Each era is divided up into smaller pieces, like each of these books is divided into chapters. Look at your activity sheet, and show me where the time periods are located. What periods are in the Mesozoic era? *(Cretaceous, Jurassic, and Triassic)*. Which era and period are we in now? *(Quaternary)*.

If you don't have fossils in your area, ask them to remember what kinds of fossils they collect locally. Then proceed from memory.

Here are some fossils from this area. What era do you think these fossils are from? How can you determine their era? Is there a trilobite? They died out a long time ago, so they are not from the most recent eras.

You can take time to write some new mnemonics if you want to.

It will help you to know what fossils you might find if you memorize the geologic column. One way to make that easier is to use a mnemonic, a sentence that has the same first letter of each word as the list you are trying to memorize. Here is the mnemonic for the Periods of the Geologic Column starting at the bottom, "Can Old Senators Demand More Political Power Than Junior Congressmen? Tough Question." Do you see how each first letter of each word has the same first letter as that time period? What does the first word "Can" stand for? You can make up a different mnemonic saying if you like. Then, use it to memorize the time periods by the next meeting. Let's say it together a few times so we can remember it.

Distribute Member Handout 10, *Geologic Column Figures*.

Pass out copies of the geologic columns from the Geological Survey.

Cut out the pictures of the animals and plants from your member handout and glue them in the correct Eras. You can use these geologic columns to look at and find the right era in which to glue the pictures. When we are done, you can put it in your geology notebook.

Hold yours up.

Let's look at your completed sheets. Here is what it should look like. Now let's use it to think about some things.

Dialogue For Critical Thinking

Share:

1. What part of this exercise did you find easy or hard? Why?
2. Have you ever used a mnemonic to learn something before?

Process:

3. What era did dinosaurs live in? *(Mesozoic)*
4. What era did man live in? *(Cenozoic)*
5. At which age were animals the simplest? Most complex?
6. Figure out a nickname for each period. For example, the Mesozoic is known as the age of the reptiles. Which period within Mesozoic is most closely identified with dinosaurs? *(Jurassic)* Now figure out names for some of the other periods. Use the main life forms.

Generalize:

7. Is it easier or more difficult to memorize with a mnemonic?

Apply

8. What era and period is exposed in your county? *(Use a state geologic map if you don't know the answer).*
9. When else could you use a mnemonic?

Going Further:

1. Collect representative fossils on your field trips and compare them to the chart.
2. Periods are divided into even smaller segments of time called epochs. Find out what some of the periods are for this area and how to tell them apart.
3. Investigate one time period in detail. You could make a diorama or a poster about it and display it at the fair.
4. Use a mnemonic to memorize something else. You can make up your own if you don't know one.
5. Identify pictures used to the Phylum level or more.

References:

Geology, Geologic Time and Nebraska, by Marvin P. Carlson, Conservation and Survey Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln, 1993.

Kansas Geological Survey Web site: *www.kgs.ukans.edu* (used during 1999 and 2000).

Author: Pat Gilliland, Kansas 4-H Geology Curriculum Team

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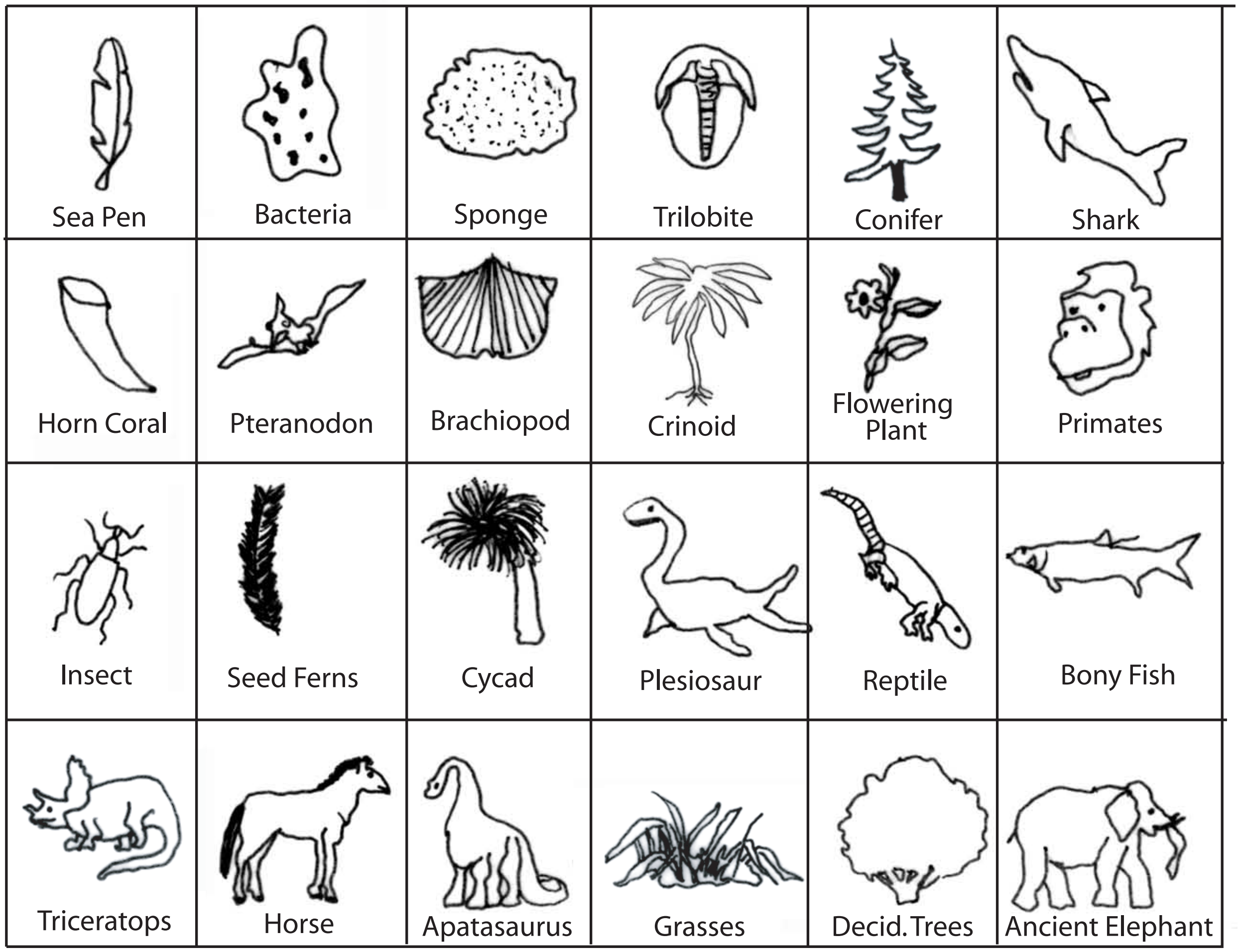
Geologic Column

Member Handout 10
Geologic Columns
Figures

Geologic History—Geology, Level II

Cut these pictures apart on the lines and glue them on the Geologic Columns Activity Sheet in the time period when they first became common. Please note that they are not to scale: for example, the bacteria are very small.



Answers:

Precambrian:

Bacteria
Sponges
Sea pens

Paleozoic:

Trilobite
Horn coral
Brachiopods
Crinoids
Insects
Seed ferns
Reptiles
Bony fish
Sharks

Mesozoic:

Triceratops
Apatasaurus
Plesiosaur
Pteranodon
Conifer
Cycads

Cenozoic:

Flowering plants
Ancient elephants
Grasses
Decidious trees
Primates
Horse

Geologic Column

Geologic History — Geology, Level II

Activity Sheet 13, Geologic Columns

Glue and draw pictures in the life forms section when they first became common. Approximate age in million years ago is given for each era.

Eons	Eras		Periods	Life Forms
PHANEROZOIC	**Cenozoic** 1-70 million		Quaternary	
			Tertiary	
	Mesozoic 70-225 million		Cretaceous	
			Jurasic	
			Triassic	
	Paleozoic 225-600 million		Permian	
			Pennsylvanian	
			Mississippian	
			Devonian	
			Silurian	
			Ordovician	
			Cambrian	
Proter-ozoic	**Pre-Cambrian**	600-4500 million		
Archean				

Geologic Timeline

Geologic History — Geology, Level III

What members will learn:

About The Project:

- The earth is very old.
- Eras are long lengths of time divided by the general types of life that lived during those times.
- Life forms progressed from simple to complex.
- Life forms had to build very slowly at first because of starting with basic elements and no oxygen.
- The major part of the earth's history was spent with very simple or no life forms.

About Themselves:

- Confidence when striving to be accurate.
- Appreciation for different learning styles.
- Metric measurements make it easy to multiply and divide.

Materials

- Meter sticks and rulers (most yardsticks have a meter stick side)
- Adding machine tape or shelf paper (five yards for the short form or 50 yards for the long form)
- Colored markers (washable)
- Activity Sheet 14, *Geologic Timeline*, and Activity Sheet 15, *Important Events*
- Member Reference Sheet "Kansas Geologic Timetable" for each member (also found on the KGS Internet site www.kgs.ukans.edu)
- Scissors and glue or glue sticks
- Pen or pencil
- Timescale showing geologic timeline for a reference

Activity Time Needed: Approximately 40 minutes

Activity

This exercise will show how long the earth has been around and how short a time humans and most animals have been around. It deals in large numbers and uses the adding machine paper to demonstrate this relationship. You may easily make it 10 times as long by simply moving the decimal over one place. The longer version does require a long hall,

Leader's Notes:

This lesson uses metric because it is easier to compute divisions of ten when using years.

The longer version is more difficult to manage but more impressive.

Accept any wrong answers graciously.

Show units as you talk. Make the units 10 times as long if doing long form (i.e. one meter is equal to 100 million years; a centimeter is a million years).

If time is short, the leader may want to measure the paper ahead of time. Hand out several copies of the *Geologic Timeline* and *Important Events* to participants. Have markers, scissors and glue readily available.

Show millimeters with the edges of your fingernails.

If you are using the long version, everything is multiplied by 10, and you should show a centimeter.

gym or other large room. You may enlarge the activity sheets on the copier or have the 4-Hers write larger letters if you are using wider paper.

Do you know how old the earth is? *(Approximately 4.5 to 4.6 billion years old)*

That is such a large number that it is difficult to even imagine. It is a lot longer than a million years. In fact, a billion years is 1,000 times longer than a million. The earth is very old. We are going to make a time line to show how old that is. We will make it on this paper and one meter on the paper will be equal to a billion years. One millimeter will be equal to a million years.

Then, we can glue information or events to it and note things on it to show when things happened. When we are done, we will have a nice way to show how old the earth is and when things happened.

First, we need to measure out the length of the paper and label the meter lengths. Let's use a pencil or pen to measure and mark off the total length of time the earth has been in existence. How long of a piece will we need? (4.5 meters for short version, or 45 meters for the long form). Measure out a piece a little longer than we will need.

Now, let's review the eras. What is the time we are in now? *(Cenozoic)*. How long has it lasted so far? *(About 66 million Years)*. Which era was next? *(Mesozoic)*. Third? *(Paleozoic, or Ancient Life)*. Fourth and oldest one? *(Precambrian or Archaic)*. It is also the longest. It lasted almost 4 billion years. We'll glue the square that says the beginning of the earth at the far end of the paper after we measure and mark it.

Now, let's measure in the eras, using different colored markers to draw the line for each. Draw a line about 1" from the edge of the adding machine paper (2" or 3" for the shelf paper) and 66 millimeters (or centimeters for long form) long for the Cenozoic. Draw a cross slash to mark the beginning and end of it. We'll cut out the era signs to glue below its line, on the narrow space of the paper. Here are all of the lengths:

	Short form	**Long form**
Precambrian	3.9 meters	39 meters
Paleozoic	.325 meters	3.25 meters
Mesozoic	.179 meters	1.79 meters
Cenozoic	.067 meters	.67 meters

That should bring us to a total of 4.5 meters. Glue the era squares beside their lines. (Eras could be written on with a marker.) Now, let's divide the eras into periods, each working on a section. Measure out the period you are working on, and mark it. The periods toward the middle of the eras will have to be done after the first ones have been established. Be sure to measure accurately. These time periods are smaller parts of the eras. It is as though the eras are different books and each period is a chapter of the book. You will also notice that different things lived at different times. When one kind of life dies out, that leaves room for something else to grow in its place. See if you can tell when that happened.

We can now start calling these numbers by millimeter instead of meters, as that will make the numbers easier to work with. A millimeter is one thousandth of a meter, so it is pretty small. It is this little mark on the ruler right here.

Now, let's glue on the pieces of paper from the next sheet showing the different events telling what kinds of life lived at different times. Cut them out of the sheet and glue them at the right place. The times given are in million of years ago, so you will need to start measuring from the present time marker, or from some period or era marker that gives a time close to the one you have. The times given on the event rectangle are approximate. It might vary just a little, but the order in which events happened will remain mostly the same.

Divide up the events, giving some to each. Supervise the measuring.

OK, doesn't that look great? Now, I would like each of you to stand next to the events you put on, and we'll go down through time as each of you tells us what happened.

We'll put it up somewhere so more people can see it when we are done studying it. Now, what can we learn from this time line?

Dialogue For Critical Thinking

Share:

1. What did you see when the timeline was completed?
2. Was it hard or easy for you to work with the metric measures? Why?

Process:

3. What was the most surprising thing you learned from this?
4. Have you ever seen a million of something? What?
5. What is the longest era? *(Precambrian)*
6. In which era would you find very few large animals? *(Precambrian)*
7. What animal forms were most common in each of the eras?
   Precambrian – Invertebrates, very simple forms
   Paleozoic – Invertebrates and other sea life
   Mesozoic – Reptiles and dinosaurs
   Cenozoic – Mammals
8. What plant forms wer common in each era?
   Precambrian – Simple, algae, etc.
   Paleozoic – Bushes, large fern-like trees
   Mesozoic – Lush tropical-like palms; conifers towards the end
   Cenozoic – Flowering plants and grasses
9. Compared to the rest of geologic time, how long has man been on earth? *(Very short period of time)*.

Generalize:

10. What seems to mark the end of each era and the beginning of the next? (Some animals die off and others begin).
11. Why is the Precambrian so long, and we don't have many events to put on it? (Conditions at first were not good for life — too much heat and metamorphism of rocks). So, fossil-wise not much was going on. Some fossils could have been destroyed by heat, erosion and time. Most organisms need oxygen for life as we think of it. Oxygen was driven off when the earth got too hot at first, so algae and bacteria had to build it up.
12. How did this activity help you identify ways which help you to learn?

Apply:

13. Coal forms from buried plant material. In which era would you expect to find the most coal? *(Paleozoic and Tertiary)* Why? *(The abundance of lush plants.)*
14. What era do we have exposed at the surface in this area where we live? How can you tell? *(Fossil evidence).*
15. In what other situations is the metric system more useful?

Going Further

1. Add more things to the timeline. Look them up to see you are getting it right. You could easily add the pictures from the lessons "Geologic Column" or "Era Dioramas" to your timeline.
2. Display your timeline at the fair, to a class, at your 4-H club, etc.
3. Investigate one period in depth. Make a diorama, a timeline, a poster, a written report or several of these things, and display it somewhere.
4. Find out what periods are represented in your state. Collect representative fossils from each and make a display. You might want to correlate them with a geologic map of the state.

References:

Geologic Time, U.S. Geological Survey, U.S. Department of the Interior

"Kansas Geological Timetable." Originally from the *Decade of North American Geology*, 1983 Geology Time Scale, Geological Society of America. Adapted by the Kansas Geological Survey, Lawrence, Kansas, 1996.

Dates estimated from various sources.

Author: Pat Gilliland, Kansas 4-H Geology Curriculum Team.

Reviewed By: Rex Buchanan, Geologist, Kansas Geological Survey

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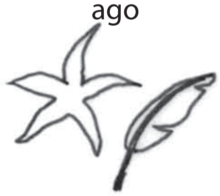
Geologic Timeline

Geologic History — Geology, Level III

Activity Sheet 14, Geologic Timeline

Measure out a piece of paper a little longer than 4.5 meters (or 45 meters for a longer model) and draw a line near the edge that long. Cut out the various rectangles and glue them to the geologic timeline at the places indicated. You may color them if you wish. Measure a millimeter for each of the million years given for the short timeline, and a centimeter for each million years if using the long form. Numbers are approximate, and show how long each was.

ERA SIGNS

Beginning of earth and beginning of Precambrian 4.5 billion years ago	**PRECAMBRIAN** 3.9 bllion years ago 	**PALEOZOIC** 325 million years long 	**MESOZOIC** 179 million years long 	**CENOZOIC** 66 million years long 

PERIOD SIGNS

CAMBRIAN 65 m. years 	**ORDOVICIAN** 67 m. years 	**SILURIAN** 30 m. years 	**DEVONIAN** 48 m. years 	**MISSISSIPIAN** 40 m. years 	**PENNSYLVANIAN** 34 m. years 
PERMIAN 41 m. years 	**TRIASSIC** 37 m. years 	**JURASSIC** 64 m. years 	**CRETACEOUS** 78 m. years 	**TERTIARY** 65 m. years 	**QUATERNARY** 2 m. years 

Geologic Timeline

Geologic History — Geology, Level III

Activity Sheet 15, Important Events

These signs show various thiings that have happened during Earth's history. The times listed represent the time from now in millions of years. The times listed are approximate.

Key: Mya = million years ago

Cut them apart, then place them where they happened on the timeline.

Oldest rocks found 3,800 mya	Oldest bacteria found 3,500 mya	Stromatolite-like mounds found — Algae? 3,500 mya	Mountain building 2,500 mya	Earliest cell with nucleus 2,500
Earliest plants: Blue-green algae 2,000 mya?	First invertebrates 590 mya	Abundant multi-cell plant life 570 mya	Earliest hard parts (shells); End of Precambrian 560 mya	Burgess Shale soft-body fossils 550 mya
First animal with vertebrae (jawless fish) 500 mya	First land life — plants 430 mya	Fungi, mosses 400 mya	First land animals — Amphibians 395 mya	First true ferns 355 mya
Seed plants Large trees 350 mya	First reptiles 320 mya	Early winged insects 300 mya	Coniferous trees 285 mya	Sharks 280 mya
First dinosaurs 230 mya	First birds 175 mya	Largest mass extinction 250 mya	Flowering plants 130 mya	Modern mammals 80 mya
Donosaurs and other species extinct 65 mya	First apes 35 mya	Human culture 2 mya	End of Ice Age .01 mya	Present time 0 mya

Stratigraphy

Geologic History — Geology, Level III

What members will learn:

About the Project:

- Breaks between rocks which represent missing time periods are called unconformities.
- Contacts are the areas where two types of rock meet with a visible division between the two.
- Formations are visually distinct bodies of rocks that have recognizable contacts with neighboring rock units.
- Formations are generally named for the location where they are first described and for the dominant type of rock they are composed of.
- Groups are rock units composed of two or more related formations.
- Members are smaller divisions within a formation.
- Formations, members and groups are rock type classifications and are only somewhat related to time periods.
- Formations can be diagramed in vertical columns called stratigraphic sections.
- The thickness of vertical sections of rocks can be measured or estimated to aid in identification of the formations and studying the formation.
- A small change carried on for a long time can accumulate to a large effect.

About Themselves:

- Using past reference points are helpful when estimating.
- Observation skills are important in making judgements and decisions.
- Confidence in classifying complex items.
- Adapting to change is a natural part of the life cycle.

Materials Needed

- Peanut butter sandwich (thick — several layers) and additional peanut butter or jelly and bread of a different kind.
- Two knifes — one sharp and one table knife
- Silly Putty; or another option using small chunk of ice and wire rack
- Small plate
- Handouts of stratigraphic sections of rock in your area, one for each member (You might be able to use one from a field trip guide or from KGS bulletins and maps.)

- Rulers and yardsticks
- Large field trip location with back slope (e.g. maybe a hillside road cut or dam spillway that is not overgrown with plants and clearly shows visible layers)
- Paper and pencils
- Clipboards or other writing surface for field trip

Activity Time Needed: 30 minutes plus field time

Activity

When we think of geologic time, we usually think about great changes like oceans coming and going and mountains being built and eroded away. But, these geologic changes take place so slowly that they may not look like much while they are changing. To see how that works, we are going to start an example now and look at it again later. Could I have a volunteer to roll this Silly Putty into a ball? Now, let's put it over here on this plate and check it periodically as we talk. (If using ice, place on plate and wire rack). Can you see anything moving or happening now? What do you think will happen?

While we are waiting for that, let's talk about **unconformities**. These are places where rock layers are missing. Remember when we made the peanut butter sandwich to show layers of the earth?

Leader's Notes:

If you have done that lesson, this part will be a review. If not, be sure to explain it carefully. It is a Level I lesson in this chapter, "Geologic History."

Here is a peanut butter sandwich. What geologic principles does it represent? Do you remember the Law of Original Horizontality? What does that mean? *(The layers were laid down flat)*. What does the Law of Supposition mean? *(The lower layers were laid down first)*.

What would happen if part of the layers were eroded away? First, I'll cut the sandwich in half so we can see what it looked like at first, and put it to the side. Now, could we have a volunteer to cut off a layer to show erosion? Cut off only one or two layers please. What kind of erosion could cause that to happen? *(Glacier scraped off, wind blew away, river washed away, etc)*. Now, let's pretend that another layer gets deposited on top of the eroded area. Please add a half piece of this bread and some jelly to half of the sandwich. What could be an example of this happening? *(Lake deposits, etc.)*. Now, let's compare it to the original half sandwich. Can you see where this layer is missing from one half? What was that called again? *(Unconformity)*. Thank you for helping demonstrate unconformity.

How many of you have heard about a formation? Common ones here are the ___________ and ____________.

Use local formations from a field trip guidebook or geological reports. Hand out copies to members now.

A **formation** is a layer of rock that looks different enough from the layers above and below it to easily tell them apart. It must also be a thick enough layer that it can show up on a map. Here is a handout showing some of the layers in this area. A drawing like this showing the formations is called a stratigraphic column. Even on the drawing you can tell the layers apart. The place where two formations meet is called the **contact**.

Formations have two part names. The first part is usually a place name where the layer was first identified, or that has a nice layer exposed. The second part of the name usually tells the main type of rock from which it is made. For example, Dakota Sandstone Formation is a common sandstone in the center of the United States. Look on your handout. Which names do you recognize?

Several formations are grouped together into Rock Groups. Look at the column to see what group or groups are on our stratigraphic section.

Pause to look it up.

If there are separate, smaller layers in the formation, they are called **members**. What members are listed on our section of the stratigraphic column?

The smallest division usually identified are beds. Are there **beds** listed on our section?

An example might be coal beds.

Now, let's see what happened to our Silly Putty (or ice cube). What did you observe? *(Flat or melted)*. Did you see it happen? *(No, change was too slow).*

All of a formation is not always laid down at the same time. Sandstone can be laid down as a beach at the edge of bodies of water. Slowly, over time, the area where sand is laid down may move to a different area; for instance, as a sea dries up and the shores move. Therefore, one continuous band of similar rock was not necessarily deposited at the same time. Formations are not time divisions.

Pretty soon (or on the next field trip) we'll see this section — or one like it — in real life. We'll go to a back slope and compare it with a section. It's going to look a little different, so we'll have to look carefully to see which layer is which. What can we use to identify individual layers? *(The order of rock types; section may show some layers lumpier than others, etc.).* We'll also want to have some idea of a layer's thickness. That can be quite a problem to measure because most cuts slant and are uneven. This time, we'll just estimate its thickness and compare it to the section to see if the layer is about the right thickness to be the layer we think it is. To estimate more accurately, we can compare it to something for which we know the length. For example, would you each estimate the length of this table (or height of chair). Now, I'm going to put this ruler (or yardstick) near it. Now, estimate it again. Now, let's measure and see which time you were closer.

To help us estimate taller things, we could use our own height. Do you each know about how tall you are? It doesn't have to be exact. If you look straight across at something that is even with your eyes, it would be just a little shorter than you. This will only work with things close by. Let's practice by estimating the height of this wall. Now, when we are in the field, you can estimate the thickness of each layer and compare it to the section.

Refer to diagram at the end of this lesson.

Dialogue for Critical Thinking

Share:

1. What is a stratigraphic column used for?
2. How can you tell if you have any unconformities on your col-umn? *(It would be hard to tell unless you had another column to compare to, or knew something about the region. Unconformities are indicated by a wavy line)*.
3. What was the most difficult thing we did? What was the easiest? Why?

Process:

4. What was the area that is represented on the section of the stratigraphic column you have like? *(Ocean? Seashore or river? — sandstone, Shallow sea — limestone, Plant-rich land — coal, Thin layers — frequent change, etc)*.
5. What similar experiences have you had?

Generalize:

6. Is estimating as accurate as measuring? *(No)*. Then why use it? *(It is faster and close enough for many uses)*.
5. Have any of you made small changes that have added up to big changes over a long time? *(Growing, improving skills like reading and identifying rocks, etc)*.

Apply:

6. If you were not sure which part of the section was at a location, how could you figure it out? How could you use this concept in the future to better understand something you were unsure of? *(Compare rock types and order of layers, measure thicknesses to compare with thicknesses on section, ask an expert, consult field trip guides, etc)*.
7. Where else could you use estimating heights?

Going Further

1. Estimate the thicknesses of the different layers in the road cut. Draw a diagram of the layers as you see them. Compare to the stratigraphic column. Label each formation, member, etc.
2. Research local formations. How were they named? Where do they outcrop?
3. Research one formation in depth. Follow it from location to location. What are its characteristics? (*This is a physical correlation of a formation.*)
4. Look for examples of unconformities in your area.
5. Imagine a seashore goes down an average of 10 inches a year. How far will it have moved in a thousand years? *(833 ft. or approximately one eighth of a mile)*.
6. The plates in the earth are moving about as fast as your fingernails grow. Compare their original positions to their present ones. How many years did that take?

References:

Written By: Pat Gilliland, Kansas 4-H Geology Curriculum Team

Reviewed By: Rex Buchanan, Geologist, Ks. Geological Survey

Steven D. Fisher, Professor and Extension Specialist, 4-H Youth Dev. (Retired)

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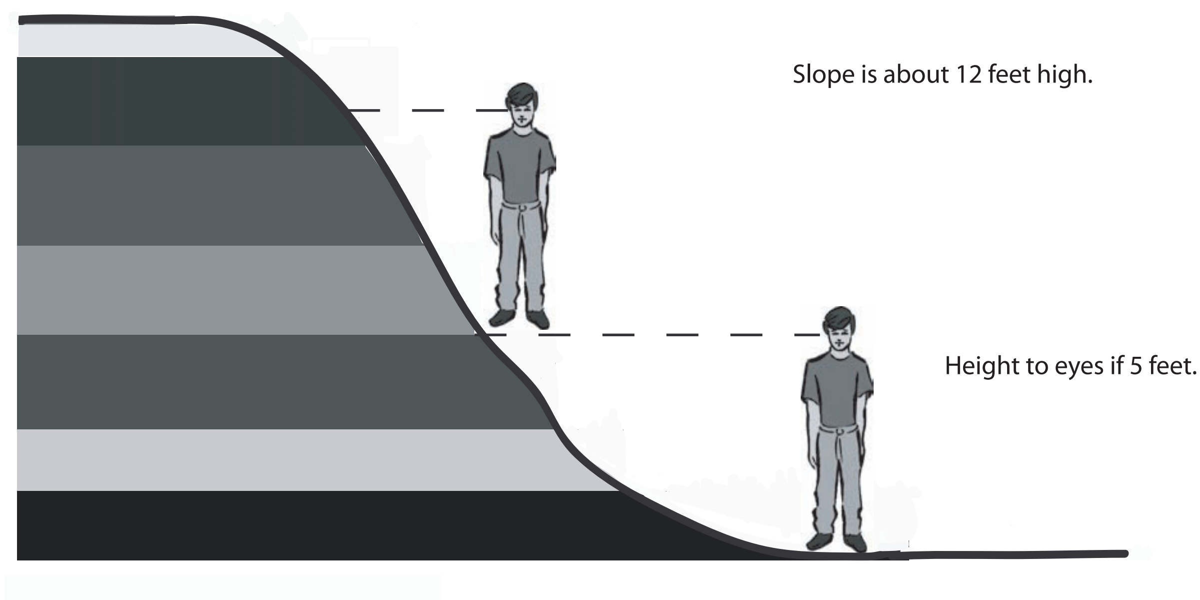
Estimating layers of formation by eyesight.



Measured Sections

Geologic History — Geology, Level IV

What members will learn:

About The Project:

- How to accurately measure the thickness of a formation.
- Which geologic terms describe time, which describe rock types, and which describe both.
- Fossils in a layer sometime help us identify the formation.
- How different naming systems relate to each other.

About Themselves:

- Accurate measurements are important.
- Appreciation and understanding of appropriate tools to get a job accomplished
- How to work together as a team.

Materials Needed

- Sturdy string
- Two poles at least five or six feet tall
- Yardstick or meter stick
- Line levels (obtainable at a lumberyard or home products store)
- Paper and pencils
- Stratigraphic sections of area formations
- Geologic map of the state
- Back slope free of vegetation clearly showing rock layers (spillway of a lake would be suitable)
- Member Handout 11, *Geologic Units and Measuring Sections*

Activity Time Needed: Two or more hours in the field, and about 30-40 minutes preparation with your group.

Activity

More than 200 years ago, people started drawing up stratigraphic columns of the layers in the earth. These columns are still considered fairly accurate today even though we have a much better understanding now about why the rock layers occur in the order we find them. The early geologists' observations of the earth support a modern view of geologic history. You have probably noticed stratigraphic columns are made of rock groups

Leader's Notes:

This lesson will be more effective if you have done several previous Level III activities. Refer back to the information in those exercises and include what you need for this activity. If you have a small group, you might want to make extra copies of this lesson so the members can follow along.

(formations, members, etc.). These rock groups have been described and named by geologists over many years. Usually, the names are related to some geographical location near where the rock unit was first described. You may have also noticed that the rock units are in a certain order in the column. What is that order? *(Oldest layer on the bottom).* The rock group name may also include the name of the main type of rock that comprises it. (e.g. Topeka Limestone Formation).

Different events could have been occurring at different places in the world in ancient times, just as still happens. Some places now have lakes and some don't. Some have blowing sand and some don't. Swampy areas sometimes dry up and some years they stay wet. Using the geologic principle "The present is the key to the past," we can look at the rock evidence and try to imagine what it was like millions of years ago. Imagine you are at the edge of a large shallow sea. What would it be like? Now imagine what would happen to sea levels when it was very wet. Would the same things grow there? What kind of rock would be deposited? Now, imagine that much of the water is frozen into glaciers, and sea levels go down. What is it like now? What kind of rock would be deposited? Would the shoreline be at a different place?

Write the Time-Stratigraphic chart out on big paper or a chalkboard, or give copies of the handout, *Geologic Units and Measuring Sections* to members.

Stratigraphic columns also often list the geographic time in which rock units were deposited. This blends together two different ways of working with the earth's past. The first is when things have occurred in the past (Era, Period, Epoch, Age) and the second is the kind of rock being deposited at that location (Group, Formation, Member, Bed). When we talk about the age of the rock layers, we usually refer to the period during which the rocks were deposited (See geologic time scale in this lesson). This blends together two different ways of working with the past in a time-stratigraphic system. This type of system helps us determine what rock we are working with and when in time they were deposited. The geologic units chart shows how time, stratigraphic-time and rock units compare to one another. The relationships are not always consistent.

Fossils often aid in the identification of these units. In fact, it is the main criteria determining some of the layers. You will want to remember what you learned in the units on fossils as you study correlation by fossils in rocks.

Now, we are going to learn how to measure the thickness of rock layers in the field. We'll use this method on our next field trip (or today).

Try to balance teams. Up to five or six people can be used on each team. If your group is small, use just one team. Possible duties: two pole persons, level reader, pole reader, recorder, manager (e.g. keep diagrams, instructions for moves, etc).

You will need to work carefully and accurately. We'll use string with a level on it to make sure we are sighting straight across from one measuring spot to another. You will need to work in teams, and you will need teams of at least three people, so let's form teams now. Each team will decide who will do what on their team. You need two people to hold and carry the poles, one person to observe the level, and a person to write down results and observations. Someone can double up on writing down descriptions if you only have three people on your team.

Practice this with them before going out in the field. Also practice later when you have it on the string. See diagram in the member handout, *Geologic Units and Measuring Sections* and demonstrate this section, if possible.

Then, we will mark your poles off in feet (meters if that is the unit of measurement used on your stratigraphic columns). Next, we'll tie 20 feet of string between your poles and slip the level onto the string before we wind the string up around the poles and carry them to the site. See how the bubble in the level moves around as you tilt it? Practice moving one pole to see how to make the bubble move to the middle section of the level.

At the site, you'll measure up the slope slowly, using the string and level to make sure your next measuring pole is placed at the height that your last measuring ended. To do that, two people have to be holding the poles and one has to observe the bubble in the level and tell the uphill pole holder to move his or her pole until the bubble is in the middle. When measuring the slope, start at the bottom. Hold one pole upright and set the second pole on the slope with the string at the bottom. Have one person move the string on the lower pole until the string is level and tight; or have the upper pole moved so that the string is level and tight. Record the difference in height from the foot markings on the lower pole. Then, someone has to write down how many feet up it is. Before or after a layer is measured, the person recording the height also needs to write down a good description of the rock layer being measured. Then, move the lower pole to the location where the upper pole had been, and move the upper pole to a higher location. Measure the next layer until you reach the top.

When you get done, draw a cross section of the slope. Use the same symbols that the stratigraphic section uses. Now, compare it to the section. Which part did you measure? Label each formation and smaller units as completely as you can.

You may want to help them out by giving them the starting formation.

Dialogue For Critical Thinking

Share:

1. What was the most difficult part of this exercise? Why?
2. Have any of you used a level before? Where?

Process:

3. Why is it important for the bubble to be in the middle of the level? *(So the string will be even and you will have an accurate measurement).*
4. Could one person have done a good job of measuring the slope by him or herself? *(No, not with two poles, a string and a level. A team is needed, with each member doing his or her part).*

Generalize:

5. What possibilities for errors existed? Where could similar errors occur in other projects? *(Accurate measuring is important in the building trade, sewing, crafts and many other pursuits Other answers also acceptable).*

Apply:

6. For what other purpose could you use this technique of measuring slopes? *(Telling others the best place on a slope to collect samples or to measure a slope for a building site).*

Going Further

1. Compare your measurements of the slope to others. Why could there be differences?
2. Measure another slope and practice your skills.

3. Use your new skills to map a good collecting slope you don't think has been mapped in detail before. Make your information available to others by doing a display at the fair and/or writing a paper. Samples from each layer would add to the display.
4. Correlate stratigraphic sections with geologic columns for your area. Then, compare them to some other area of the world. How do they differ? Make a chart or drawing.

REFERENCES:

Session presented at a Kaw Valley in-service for teachers by the Kansas Earth Science Teachers Association.

Authors: Pat and Will Gilliland, Kansas 4-H Geology Curriculum Team

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Measured Sections

Member Handout 11, Geologic Units and Measuring Sections

Geologic History — Geology, Level IV

Time Unit	Example	Time Stratigraphic Unit	Example	Rock Unit	Example
Era	Paleozoic	Erathem	Paleozoic		
Period	Pennsylvanian	System	Pennsylvanian		
Epoch	Late Pennsylvanian	Series	Upper Pennsylvanian		
Age		Stage	Virginian	One or more groups	
				Group	Shawnee
				Formation	Topeka L.S.
				Member	Hoyt Shale

Measuring Sections