ancient sea life

teacher's guide

University of Nebraska State Museum

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University of Nebraska Lincoln

Dear Colleague,

The Ancient Life Encounter Kit is designed to bring hands-on materials from the University of Nebraska State Museum, as well as inquiry-based activities to the classroom. It is our goal to introduce some of the lesser-known aspects of the Paleozoic Era to students. For those groups able to visit our Morrill Hall Museum, the kit will complement and enrich a visit to the Gallery of Ancient Life.

The objectives of this Encounter Kit are for students to:

1. learn how to read time charts and time lines and discover the major events that have occurred throughout geologic time;

2. discover the types of invertebrate animals that lived during the Paleozoic Era;

3. learn how to use a key to identify fossils;

4. discover, through an activity focused on sharks' teeth, that shallow seas inhabited by sharks, once covered Nebraska;

5. compare fossil animals to the shells and skeletons of their present day relatives.

The activities range in **length from 30 to 60 minutes**. Any class size is possible, but **groups of fewer than 30 students** are recommended. Students should have a comfortable amount of space for viewing or working with materials.

Your input is greatly valued. Please assist us by completing the enclosed **Evaluation Form**.

We hope that you and your students enjoy learning about the rich diversity of Ancient Life. If you have any questions feel free to call (402) 472-6302.

The University of Nebraska State Museum Education Staff

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Encounter Kits

Encounter Kits are organized around a teaching-learning framework, which guides teaching and learning through four main stages.

STARTING OUT:

Usually a full group discussion. This provides an opportunity for you to stimulate curiosity, set challenges, and raise questions. Students share their knowledge and previous experience on the topic.

Teacher:

- Probes for current knowledge and understanding
- Motivates and stimulates activity
- Sets challenges and poses problems

Student:

- Shares thoughts and ideas
- Raises questions

ACTIONS:

Groups of students look closely at the phenomena or actively participate in actual scientific work. They work directly with materials. It is important to allow enough time for this inquiry stage, so that they can explore materials and concepts that are new and fully experience trial and error. This can be an investigation time as students discuss ideas together, try out activities and manipulate materials.

Teacher:

- Facilitates
- Observes

Student:

- Explores
- Observes
- Works as a team member
- Problem solves
- Records

TYING IT ALL TOGETHER:

Usually a full group experience, this stage provides students with the opportunity to share their discoveries and experiences. You guide them as they clarify and organize their thinking, compare their different solutions, analyze and interpret results, and attempt to explain the phenomena they have experienced.

Teacher:

- Questions
- Guides
- Assesses student understanding

Student:

- Interprets and analyzes
- Synthesizes
- Communicates
- Questions

BRANCHING OUT:

This optional stage allows the students to connect and relate learning from the kit activity into other projects and activities.

Teacher:

- Facilitates
- Assesses understanding

Student:

- Applies
- Questions
- Integrates

Contents of the Ancient Sea Life Kit

Activity 1: Time Travel

- Multicolored time line (25 feet long)
- 33 Event Cards (with popsicle sticks attached)
- Event Record Sheet - Template
- Quick Reference Card for teacher
- *How Much is a Million?*
- *Nature Scope: Digging into Dinosaurs*
- Roll of yellow twine (166 ft, oversized)
- 3 Posters: Each depicting a different era (oversized)
- Poster: Geologic Time Scale (oversized)

Activity 2: Meet the Sea Life

- Fossils of 6 ancient sea-dwelling animals:
  - 2 Horn corals
  - 2 Trilobites
  - 2 Ammonites
  - 1 Crinoid (stem fragment & crown)
  - 2 Belemnites
  - 3 Brachiopods
- 12 Pictures of ancient marine animals
- 12 Pictures of ancient marine animal life
- Paleozoic Story (template)
- Poster: *Geologic Time Scale* (oversized)
- Poster: *Life on a Coral Reef* (oversized)
- 3 Posters: *Ancient Marine Life Scenes* (oversized)

Activity 3: Let's Sort It Out

- 6 Horn Corals
- 6 Moss Animals
- 6 Cards with Protozoans
- 6 Brachiopods
- 6 Clams
- 6 Crinoids
- Key to Fossil Invertebrates (template)
- Fossil Background (template)
- AIMS activity
  - A Dichotomous Key for Creature Features (template)
  - A Key to Creatures (template)

Activity 4: Jaws

- Packet of 20 Shark teeth (piercing only)
- 1 Shark jaw (large blue box, oversized)
- 1 Clam
- Modern and ancient shark teeth (template)
- *Sea Searcher's Handbook*
- *Jaws: The Early Years* (Explorer article)
- *All About Sharks* (article from the Mini Page, Lincoln Star)
- *The Cellars of Time*
- Poster: *The World's Most Dangerous Sharks* (oversized)

Activity 5: Fossils and their Living Kin

- 5 Pairs of fossils and their living kin:
  - 1 Fossil snail and 1 modern snail shell
  - 1 Fossil bivalve and 1 modern bivalve shell
  - 1 Fossil nautiloid and 1 Nautilus shell
  - 1 Fossil sea urchin and 1 modern sea urchin skeleton
  - 1 Fossil coral and 1 modern coral
- 5 Pictures of modern snails, bivalves, *Nautilus*, sea urchins, and corals.
- 1-5 Observe and Discover Cards (templates) (3 sheets)
- *Fossils and Their Living Kin* Chart (template)
- 1-5 Sea Animal Life Styles (template) (2 sheets)

Additional Resources

The Macmillan Book of Dinosaurs and Other Prehistoric Creatures

Activity One – Time Travel

Learning Objective:

Students learn how to read time charts and time lines, and get an overview of the major events that have occurred through geologic time.

Activity One - Time Travel

Group size:
30 to 35 students

Time:
60 minutes or two 30-minute sessions

Materials Provided Per Class:

- Multicolored time line (25 feet long)
- 33 Event Cards (with popsicle sticks attached)
- Event Record Sheet (template)
- Quick Reference Card for teacher
- *How Much is a Million?*
- *Nature Scope: Digging into Dinosaurs*
- Roll of yellow twine (166 ft, oversized)
- 3 Posters: Each depicting a different era (oversized)
- Poster: *Geologic Time Scale* (oversized)

Additional Supplies Needed Per Student:

- 1 Pencil
- Crayons or colored pencils
- Masking tape and/or scotch tape

Preparation:

- Make copies of the Event Record Sheet (one for each student).
- Hang the Geologic Time poster on the blackboard or wall.
- Near the Geologic Time poster, hang the multicolored time line. This is 25 feet long and may cover much of the perimeter of the room. Post this at about students' eye level.
- On the board, write the scale for the multicolored time line: 1 inch equals 2 million years.
- Underneath the time line, hang the 3 posters that depict the different eras. Beneath the Cenozoic put the poster of the Age of Mammals, beneath the Mesozoic put the Age of Dinosaurs, and beneath the Paleozoic put the poster of the ancient marine life scene.
- Gather pencils and crayons for all students or ask your students to have these ready at their tables or desks.
- Have your Event Cards ready to distribute. If you have more than 33 students, make up some more cards so that each student has one. Use Nature Scope's *Digging into Dinosaurs* for ideas.

Activity 1

Background:

Geologic time scales and time lines are charts or posters that show the sequence of events that have taken place in the history of the earth. Most time scales are divided into 4 long intervals of time. The first interval is called the **Precambrian**. This is the longest interval in the earth's history (6.6 times longer than the following three intervals combined). It started with the formation of the earth and lasted 4 billion (4,000 million) years. On most time charts, Precambrian (at the bottom of the Time Scale poster) is not shown to scale and is made to seem unimportant. This is because although life started in the Precambrian, it did not really expand until the beginning of the next interval: The Paleozoic Era.

The **Paleozoic Era**, or Age of Ancient Life, is very short in comparison to the Precambrian. It started 542 million years ago and ended 251 million years ago. During this era, many new and odd-looking life forms appeared in the seas, the first vertebrate developed, and life moved from water onto land.

Following the Paleozoic is the **Mesozoic Era**, or Age of Middle Life, from 251 million to 65 million years ago. This is also known as the Age of Dinosaurs, as dinosaurs dominated the landscape. During this time, the first mammals appeared but they were quite small, the seas continued to teem with life, and flying reptiles filled the skies.

The **Cenozoic Era**, or Age of Recent Life, spans from 65 million years ago to the present. It started with the extinction of the dinosaurs and is also known as the Age of Mammals because mammals become the predominant land vertebrates (vertebrates are animals with backbones).

In this activity, students deal with the very abstract concept of geologic time. Before beginning it is important to review some figures:

10 hundreds equal 1 thousand,
1,000 thousands equal 1 million, and
1,000 millions equal 1 billion.

ERA	PERIOD, SUBPERIOD	EPOCH	MILLIONS OF YEARS
Cenozoic	Quaternary	Holocene	11,477 ±85 yr
		Pleistocene	1.806±0.005
	Tertiary, Neogene	Pliocene	5.332±0.005
		Miocene	23.03±0.05
	Tertiary, Paleogene	Oligocene	33.9±0.1
		Eocene	55.8±0.2
		Paleocene	65.5±0.3
Mesozoic	Cretaceous	Upper / Late	99.6±0.9
		Lower / Early	145.5±4.0
	Jurassic	Upper / Late	161.2±4.0
		Middle	175.6±2.0
		Lower / Early	199.6±0.6
	Triassic	Upper / Late	228.0±2.0
		Middle	245.0±1.5
		Lower / Early	251.0±0.4
Paleozoic	Permian	Lopingian	260.4±0.7
		Guadalupian	270.6±0.7
		Cisuralian	299.0±0.8
	Carboniferous, Pennsylvanian	Upper / Late	306.5±1.0
		Middle	311.7 ±1.1
		Lower / Early	318.1±1.3
	Carboniferous, Mississippian	Upper / Late	326.4±1.6
		Middle	345.3±2.1
		Lower / Early	359.2±2.5
	Devonian	Upper / Late	385.3±2.6
		Middle	397.5±2.7
		Lower / Early	416.0±2.8
	Silurian	Pridoli	418.7±2.7
		Ludlow	422.9±2.5
		Wenlock	428.2±2.3
		Llandovery	443.7±1.5
	Ordovician	Upper / Late	460.9±1.6
		Middle	471.8±1.6
		Lower / Early	488.3±1.7
	Cambrian	Upper / Late	501.0±2.0
		Middle	513.0±2.0
		Lower / Early	542.0±1.0
PRECAMBRIAN			

U.S. Geological Survey Geologic Names Committee, 2007, Divisions of geologic time—Major chronostratigraphic and geochronologic units: U.S. Geological Survey Fact Sheet 2007-3015, 2 p.

This 2007 timeline has updated dates which have been incorporated into the text of the teacher's guide. The supplemental materials in the kit do not have the latest dates so there are some discrepancies. Geologic timelines are frequently revised as new discoveries are made.

Starting Out

- Begin by telling students that today they will be talking about the length of time that has passed since the earth began.
- On the board, have students help you come up with a list of how many tens make 100, how many hundreds make 1,000, how many thousands make 1,000,000, and how many millions make 1,000,000,000.
- Have students look at both the **Geologic Time Scale** poster and the multicolored time line. Into how many intervals is the Time Scale poster divided? How about the multicolored time line?
- See if your class can identify the four intervals in earth's history by looking at the poster.
- Can students figure how long ago the Paleozoic stared? How about the Mesozoic? The Cenozoic?
- Can they guess how long ago the earth was formed? Was this millions of years ago or billions of years ago?
- Have the students find the Precambrian on the Time Scale poster. Can they tell when it began? Is it shown to scale?
- What are other names for the three eras shown on the multicolored time line?

Action:

1. Ask the students to get out one pencil and either crayons or colored pencils.
2. Pass out a different **Event Card** to each student. It is fun to read out the events as you give out the cards.
3. Pass out a copy of the **Event Record Sheet** to each student.
4. Have the students fill out their Event Record Sheets using the information on their Event Cards. They must record what their event was and how long ago it happened. Also, they should draw a colorful and creative picture of their event in the box provided on the sheet. Tell the students to leave the last two questions on the record sheet blank, as they will answer those later in the activity.
5. After students are finished drawing their pictures and taking down the information they need from their Event Cards have them go up to the multicolored time line and stick their Event Cards at the appropriate distance on the multicolored line. For this they should use a piece of masking tape; the popsicle stick on the card should point towards the number on the multicolored line (millions of years are marked on this line and are also written on each event card; all the students must do is match their event card with a point on the multicolored time line).
6. Have the students leave their Event Cards stuck to the multicolored time line. (If you are using two periods to do this activity this would be a good place to stop.)
7. When all Event Cards are posted on the time line students can answer the last two questions on their Event Record Sheet (this part of the activity is not recommended for children under the third grade). To answer these questions each must go back to his or her own event on the time line and count the number of millions of years backwards to the event that precedes it and forwards to the event that follows it. In some cases, students will have to do subtraction, as counting will not be possible (for example for those events in the late Cenozoic). Remind students, that one-inch on the time line is equal to 2 million years.
8. Ask students to look at the time scale poster on the board. Can they tell which time interval present on the poster is missing from the multicolored line? What is this time interval called? Did this interval happen before the Paleozoic or after the Cenozoic? Before going on make sure all students understand that the missing interval is called the Precambrian, which lasted 4 billion (4,000 million) years and occurred before the Paleozoic.
9. Bring out the twine and tell students that its length represents the amount of time the Precambrian lasted. Ask students to guess how long it is. Do they expect it to be longer, shorter or the same length as the multicolored time line?
10. Have several students help unroll the twine. By unrolling the twine they will discover the length of the Precambrian.
11. Once the twine is unrolled have students compare its length to the length of the multicolored line (the twine is 166 feet long, which is about 6.6 times longer than the 25 foot long time line.)

Tying It All Together:

- On the blackboard make a list of five different events from earth's history and have the class put them in the right order.
- Ask the students to compare the time line and the Time Scale poster. How are these different and how are they similar? (Scale, direction in which they are read, number of intervals included in each, etc.)
- Why do students think that the Time Scale poster does not show the Precambrian to scale?
- In which direction on the time line do numbers decrease in size?
- Do numbers increase in size on the time line as we get closer to the present day or do they decrease? What is going on?
- In which direction (bottom to top or top to bottom) do numbers increase on the Time Scale poster?

Branching Out:

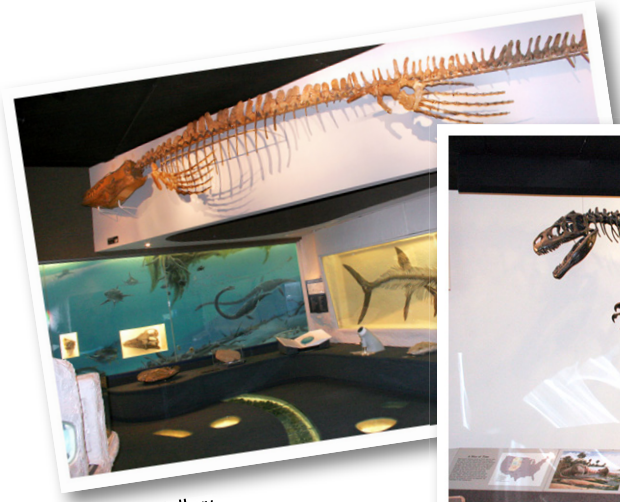
Directions

- If you have more than one 60 minute time period for this activity read the book *How Much is a Million* aloud and show students the pictures. Or read the book during a reading lesson one or two days before doing the activity. (This book is particularly appropriate for children between first and third grade).
- Make a time wheel of the history of life on earth by using pages 31-33 of Nature Scope: *Digging into Dinosaurs* and following the instructions on page 29.
- Arrange a field trip to Morrill Hall! Have students visit the Gallery of Ancient Life (Paleozoic Era), the Mesozoic Gallery, the Jurassic Gallery and the main hall on the second floor (Elephant Hall, Cenozoic Era).

Vocabulary:

Precambrian	Trilobites
Paleozoic Era	Invertebrates
Mesozoic Era	Million
Cenozoic Era	Billion

Gallery of Ancient Life (Paleozoic Era)



Mesozoic Gallery

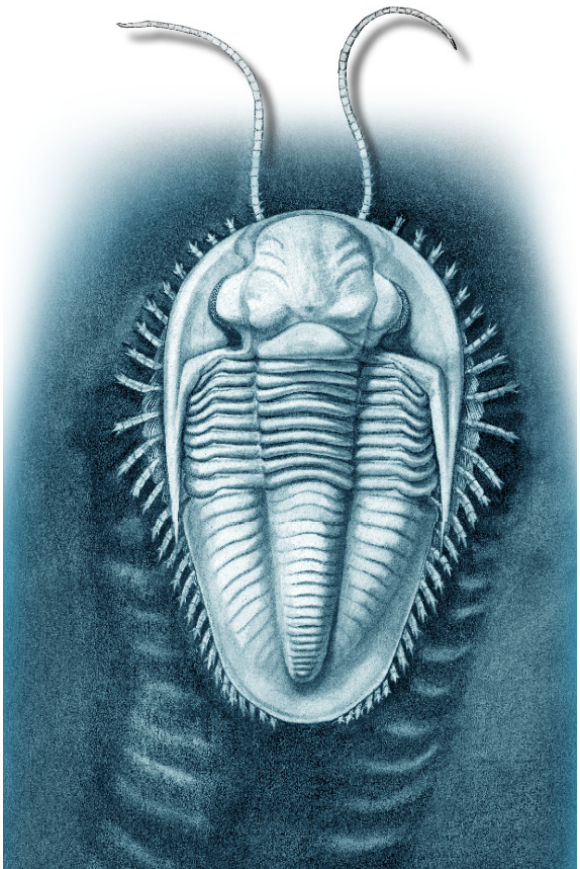
Jurassic Gallery

Elephant Hall (Cenozoic Era)

Activity Two – Meet the Sea Life

Learning Objective:

Students discover the types of animals that lived during the Paleozoic Era.



Trilobite
Mary Tanner
Courtesy Conservation and Survey Division,
UNL School of Natural Resources

Activity Two – Meet the Sea Life

Group size:
Have students work in groups of 2 or 3

Time:
30 minutes

Materials Provided Per Class:

- Geologic Time Scale poster
- Life on a Coral Reef poster
- 3 Cardboard-backed posters of marine life in the Paleozoic Era (early, middle, and late)
- 12 Fossils of ancient sea-dwelling animals:
  - 2 Horn corals
  - 2 Trilobites
  - 1 Crinoid (stem fragments and crown)
  - 2 Ammonites
  - 3 Brachiopods
  - 2 Belemnites
- 12 Pictures of ancient marine animals, one to match each fossil
- 12 Pictures of ancient marine life
- Paleozoic Story (template)

Additional Supplies Needed Per Student:

- A handful of oil based clay
- 1 Pencil
- Crayons or markers
- Scissors
- (Optional: supplies to make a diorama. May want to include blue cellophane paper, sand paper, small rocks or pebbles.)

Preparation:

- Hang the Geologic Time Scale poster and the Life on a Coral Reef poster.
- Set up the cardboard-backed posters of Paleozoic marine life. (Note, these posters represent three different times: early, middle and late Paleozoic life.)

Starting Out

- Talk about animals that you would expect to find living today in shallow seas and on coral reefs.
- Using the **Geologic Time Scale** poster explain that the top represents the present time and that towards the bottom is the time of Ancient Life or the Paleozoic Era. They will be studying life in the Paleozoic Era in this activity.
- Make sure each group of students has a picture of Life during the Paleozoic. Point out the time scale on the back of each picture. It is a brief version of the Geologic Time Scale. (Note: periods are subdivisions of eras.)
- Read the **Paleozoic Story** (p. 9) to the students and encourage them to look for the organisms in their pictures as you describe them.

Use the following for discussion

- By looking at the time scale on the back of your picture, identify what period of time your picture represents. Is it early, middle, or late Paleozoic?
- Look closely at the pictures of life in the Paleozoic. Describe the kinds of life you see. Trade pictures with another group whose picture represents a different period of time. What is different and what is the same?
- Compare life in the early Paleozoic with life in the late Paleozoic.
- Many of the animals that lived in the Paleozoic Era were invertebrates. What does that mean?
- What are some examples of vertebrates? How many of you see vertebrates in your pictures? What time periods are they in? Is it early, middle, or late Paleozoic?
- Name some vertebrates that live today. Are people vertebrates or invertebrates?
- What is the role of plants in ancient life?

Action:

1. Pass out one fossil and the matching picture to each group. Remind students that fossils are often just the skeletons of the animal and that they should look at their pictures to get a good idea of what the living animal looked like.
2. Have students make their own clay models of sea-dwelling Paleozoic animals. Each student should make a model of what they think their fossil would have looked like when it was alive.

Optional: Each group of students can create a three-dimensional miniature scene, or diorama, of ancient life.

Tying It All Together:

- Discuss the different types of animals that lived in the Paleozoic seas. What did they look like? Where did they live?
- What did these ancient sea-dwelling animals eat?
- What is the difference between a vertebrate and an invertebrate?
- Compare and contrast life in the Paleozoic Era with life today.

Vocabulary:

Paleozoic Era
Trilobites
Nautiloids
Ammonites
Belemnites
Horn Corals
Crinoids
Cartilage
Fossils

Paleozoic Story

The Age of Ancient Life (Paleozoic Era) started about 600 million years ago and ended about 225 million years ago. This period occurred before dinosaurs lived on the earth. During the Paleozoic, life flourished and the seas teemed with unusual looking creatures. From the geologic record, we know that there were a lot of oceans and seas at this time. From the fossil record we know that most of life during this time lived in the sea. The majority of animal life was invertebrates with hard shells or skeletons (invertebrates are animals with no backbone). Plants (green algae in particular) were also abundant and formed the base of the food chain.

Two of the many different kinds of invertebrates that lived during the Paleozoic Era were trilobites and nautiloids. The trilobites crawled or swam and had an outer skeleton divided into three lobes. Nautiloids and ammonites had two kinds of shells, either long and straight, or coiled. These external shells were divided into chambers or sections that were filled with gases and water. By controlling the amount of gases inside these chambers, a nautiloid could sink or float, like a modern submarine. Most nautiloids and ammonites were predators and hunted other animals for food. A close relative of nautiloids and ammonites were belemnites. Belemnites had long cigar shaped shells that were internal, not external.

Horn corals were also abundant in the seas. These were corals that did not form colonies or coral reefs. Each individual animal lived in a horn-shaped skeleton, which it secreted around itself. The horn-shaped skeleton had a pointed end, attached to the sea floor, and a large end, from which the animals' tentacles projected. Horn corals are extinct.

Crinoids also lived at this time. They are among the ancient invertebrates that have survived to the present day. Although they are animals, they are often confused with plants because they are attached by a stem to the sea floor and have feathery radiating arms.

Vertebrates, or animals with backbones, appeared in the seas late during the Paleozoic Era. Examples of early vertebrates are armored fishes (fishes whose bodies were covered with an armor of bone), bony fishes and ancient sharks. Ancient sharks, like modern ones, had a skeleton made of a soft material called cartilage.

Primitive plants appeared on land in the middle Paleozoic. They began to flourish as the climate became warmer. By the late Paleozoic lush forests and swamps covered much of the land in the northern hemisphere.

Shortly after plants became established on land in the middle Paleozoic, animals soon followed. Invertebrates, such as spiders, cockroaches and dragonflies were among the first animals on land. Amphibians and reptiles followed them, possibly in search of untapped food sources. Some of the animals that lived during the Paleozoic have relatives that live in the seas and oceans today.

Activity Three – Let's Sort It Out – Nebraska's Common Invertebrate Fossils

Learning Objective:

Students understand how to use a key to identify fossils.

Activity Three – Let's Sort It Out – Nebraska's Common Invertebrate Fossils

Group size:
Any; divide into six small groups

Time:
60 minutes

Materials Provided Per Class:

- 6 Horn Corals
- 6 Moss Animals
- 6 Crinoids
- 6 Cards with Protozoans
- 6 Clams
- 6 *Composita* Brachiopods
- Key to Fossil Invertebrates (template)
- Fossil Background (template)
- AIMS Activity

Additional Supplies Needed Per Student:

- Pencil and paper

Preparation:

- Make 6 copies of:
  Key to Fossil Invertebrates
  Fossil Background sheet
- Make 1 copy per student of the *AIMS* activity.
- Have paper and pencils available for students.
- Read the instructions for the *AIMS* Activity.

Background:

To identify the group to which an organism belongs a, shorthand guide to easily recognizable features is used. This is called a dichotomous key. Dichotomous means "two forks". Such a key divides a group of organisms into two groups on the basis of certain noticeable differences, and then divides each of those groups into two groups, and so on until the desired level of identification is reached. The *AIMS* activity – *A Dichotomous Key for Creature Features* – is designed to allow students to become familiar with a key before they begin to use one to identify fossils.

A dichotomous key can be used to identify common invertebrate fossils from Nebraska's ancient seas. Invertebrate refers to animals that don't have a backbone, such as clams, worms, starfish, and sponges. Fossils are the evidence or remains of once living things. Invertebrate fossils can be found throughout Nebraska. The fossils included with this activity are from a limestone quarry near Weeping Water in rocks approximately 230 million years old.

Starting Out

Ask the students the following questions:

- What is a fossil?
- What is an invertebrate?
- How would you begin to identify a fossil?

Action:

1. Divide the students into six groups.
2. Hand out the **AIMS Activity** to each student.
3. Lead the AIMS Activity, and assist the students in following instructions at the beginning of the activity. Have them work in their groups.
4. At the end, ask a representative from each group to explain how they keyed out the items.
5. Pass out one each of the six different fossils to each group.
6. Give each group a copy of the **Key to Fossil Invertebrates** and **Fossil Background** sheets.
7. Ask the students to identify each fossil with the key.

Tying It All Together:

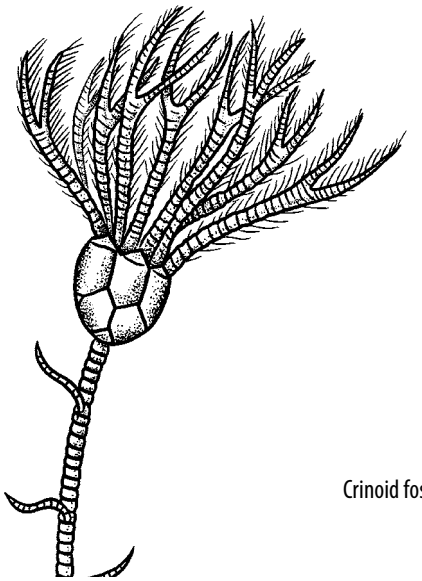
- What is the purpose of a "key"?
- What do you think are the basic characteristics scientists must use to key out a specimen?

Branching Out:

- Have students make a key to the plants and animals in the schoolyard.

Vocabulary:

Horn Coral
Moss Animals
Crinoids
Protozoan
Brachiopods
Dichotomous key
Invertebrate

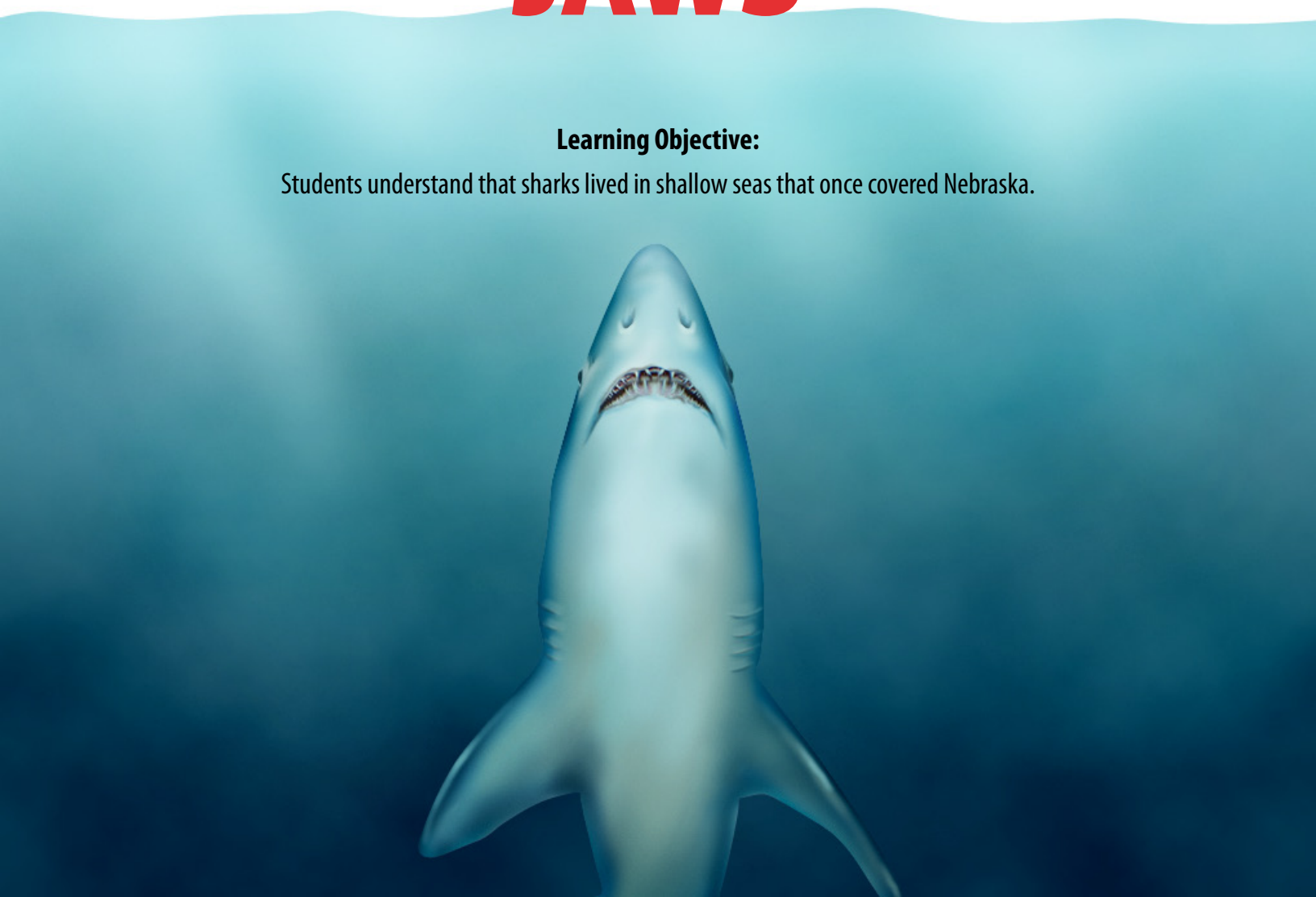


Crinoid fossil

Activity Four
JAWS

Learning Objective:

Students understand that sharks lived in shallow seas that once covered Nebraska.



Activity Four – Jaws

Group size: 20 to 30 students; divide into small groups of 4 to 6 students

Time: 50 minutes

Materials Provided Per Class:

- Packet of 20 shark teeth (piercing only)
- 1 Shark jaw (in large blue box) **(Cover hands before handling. Very sharp!)**
- 1 Clam
- Modern and ancient shark teeth (template)
- *Sea Searcher's Handbook*
- *Jaws: The Early Years* (article from the *Explorer*, Cleveland Museum of Natural History)
- *All about Sharks* (article from Mini Page, Lincoln Star)
- *The Cellars of Time*
- Poster: *The World's Most Dangerous Sharks*

Additional Supplies Needed Per Class:

- 40 sheets of 8 x 10 white paper
- 2 - 8 oz. containers of white glue
- Enough paper towels or newspapers to cover student work area
- 1 large bowl
- 1 metal can or medium sized, large mouthed container

Additional Supplies Needed Per Student:

- 1 Pencil
- 1 Sheet of tag board or soft cardboard

Preparation:

- Forty sheets of white paper need to be torn into small (dime-sized) pieces and soaked in a large bowl with two 8-oz. containers of white glue and 32 oz. of water (calculate 2 sheets of paper per student and 4 oz. of glue for every 10 sheets of paper.) Allow one hour of time to tear paper and prepare mix.
- Let paper mixture soak for 2 to 4 hours (or overnight) prior to student use. (This amount of pulp is adequate for 20 to 30 students.)
- Decide where the activity should take place and have enough newspaper or paper towels available to cover the work and drying area.
- Before class, squeeze and drain excess liquid from mixture. Put this in the can or large mouthed container and save in case the paper pulp (paper mache) becomes too dry.
- When ready to mold the sharks' teeth out of the paper pulp, cover the work area with paper towels or newspapers.
- Make enough copies of the shark teeth template to be able to have one at each workstation.
- On each work table set:
  - 3-5 shark teeth
  - 1 sheet of tag board or soft cardboard per student
  - Copy of the shark teeth template
  - Pencil for each student in the group.

Optional:

1. Briefly go over the Mini Page article *All About Sharks*
2. Review the *Shark, Skates, and Rays Field Guide* (Critter Cards) from the *Sea Searcher's Handbook* for a description of what different sharks eat.

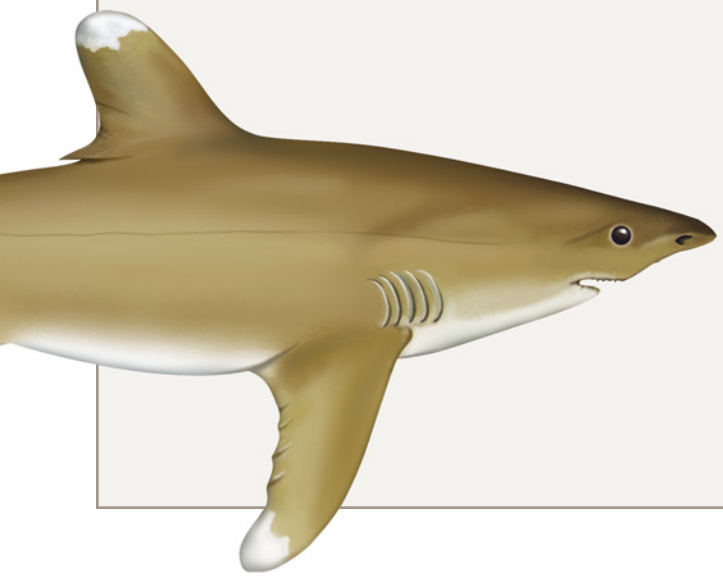
Activity 4

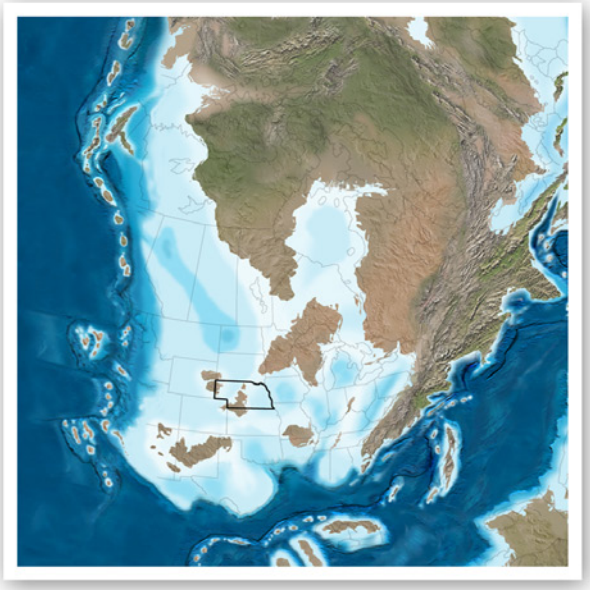
Background:

During the Paleozoic Era (Age of Ancient Life), much of North America was covered by shallow saltwater seas. Most of the Midwest, including Nebraska, was flooded at different times during this era. From the study of fossils, scientists know that the first sharks appeared in the sea about 400 to 450 million years ago in what is called the Devonian Period of the Paleozoic Era.

Nebraska's fossil record contains evidence of sharks, mostly in the form of teeth. Ancient shark skeletons are hard to find because their bones were made of cartilage, which is a soft material that does not usually fossilize. Teeth, on the other hand, were frequently lost by the sharks and were made of a hard material, which fossilized easily.

During the Paleozoic there were many different kinds of sharks swimming in the seas. They came in many shapes and sizes. Sharks that ate fish had sharp, piercing teeth and those that ate shelled animals had flattened, shell-crushing teeth. When looking at a shark's tooth, the side with the serrated edge is the chewing edge. Because of their greater availability, all of the teeth included in this kit are piercing teeth. For more information on the ancient seas in Nebraska see, *The Cellars of Time* p. 10-29.





Ron Blakey, Department of Geology, Northern Arizona University

Starting Out:

- What do you know about sharks? Make a list on the board of what students know.
- Draw on the board two different kinds of shark teeth: piercing and crushing. Ask the students which tooth goes with which kind of food (fish or invertebrates).
- Show the students the clam, an invertebrate animal that serves as food for sharks with crushing teeth. Ask the students if they can name other invertebrates that sharks might eat.
- Discuss with your class what various sharks eat.
- Carefully pick up the shark jaw with something covering your hands. Be real careful because these teeth are very sharp and may cut you. Show the students the shark jaw.
- Divide the class into groups of 5 or 6 students each.

Action:

1. Ask students to have their pencils ready.
2. Have each group look at the fossil shark teeth at their table. What different textures can they feel? (Rough, smooth, serrated, jagged, etc.). What side of the tooth do they think is the chewing side?
3. Have students look at the drawings of shark teeth (template) at their tables. Which teeth are modern and which fossils? Which look like piercing teeth and which like crushing teeth?
4. Have each student draw one tooth on their sheet of cardboard; this can be one of the fossil teeth, which they have at their table or one from the drawings. Students will be molding the tooth they will draw, so tell them to draw a tooth they feel they can make.
5. Pass out the newspaper and ask each group to cover their work area.
6. Give each student one handful of the previously made paper pulp (paper mache).
7. Ask students to use the pulp to make their shark tooth.
8. After the students finish molding their teeth, have them place the teeth on their sheets of cardboard next to their drawing. Next have students carry their teeth to the drying area. These should dry for at least 24 hours.

Tying It All Together:

Ask the students the following questions:

- If you found a piercing tooth, similar to the one you made, what would you say about what that shark ate?
- Shark teeth are found in varying sizes. What do you think this means in terms of shark sizes?
- Scientists have found fossil shark teeth in Nebraska. How could this be possible? What sort of environment must have been present in Nebraska at the time that shark was living?
- If you found a shark's tooth near your home, what would that mean?

Branching Out:

Activities in *Sea Searchers Handbook*:

- Who Likes Sharks
- Design a Shark
- Sidewalk Sharks
- Shark Trivia
- Shark Math
- A Shark's Story.

Vocabulary:

Paleozoic Era
Devonian
Texture
Invaded
Continent
Fossils

Activity Five – Fossils and Their Living Kin

Learning Objective:

By making observations, students learn about some of the differences between the fossils of ancient sea animals and the shells of their present day relatives.

Activity Five – Fossils and Their Living Kin

Group size:
20 to 30 students; divide into five small groups

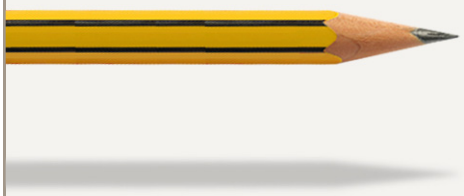
Time:
50 minutes

Materials Provided Per Class:

- 5 Pairs of fossils and their living kin:
  1 Fossil snail and 1 modern snail shell
  1 Fossil bivalve and 1 modern bivalve shell
  1 Fossil nautiloid and 1 *Nautilus* shell
  1 Fossil sea urchin and 1 modern sea urchin skeleton
  1 Fossil coral and 1 modern coral
- 5 Pictures of modern snails, bivalves, *Nautilus*, sea urchins, and corals.
- 5 Observe and Discover Cards (one per pair)
- *Fossils and Their Living Kin* Chart (template)
- 5 Sea Animal Life Styles templates (one per pair)
- Poster: *Geologic Time Scale* (Wards)
- Poster: *Life on a Coral Reef*

Additional Supplies Needed Per Student:

- 1 Pencil



Preparation:

- Make copies of:
  ~ Fossils and Their Living Kin chart (one per student)
  ~ 3 Copies of each Observe and Discover Card (one for every two students in a group)
  ~ 6 Copies of each Sea Animal Life Styles (one for every two students in a group)
- Post Geologic Time Scale poster on blackboard or wall.
- Post Life on a Coral Reef poster on blackboard or wall.
- On the blackboard list the five types of animals students will be examining (snails, bivalves, sea urchins, nautiloids, and corals).
- On the blackboard copy a large version of the Fossils and Their Living Kin Chart.

- On each work station or table (five stations, one for every type of animal) set:
  ~ 1 Fossil and the shell or skeleton of its living relative
  ~ The picture corresponding to that pair
  ~ 3 Copies of the Observe and Discover Card for that pair (one for every two students).
  ~ 6 Copies of the Sea Animal Life Styles template for that pair (one for each student)

Activity 5

Background:

Fossils are evidence of life in the past. They are often formed after an animal dies and its porous shell or skeleton becomes filled with minerals. Most of the fossils we commonly see have resulted from this process and are heavier and harder than the original shells or bones. Also, because of weathering, fossil shells are not as colorful or shiny as the shells of animals that have died recently. This kit contains five pairs of marine animals, including snails, bivalves, nautiloids, sea urchins, and corals. Each pair is made up of one fossil animal and the skeleton or shell of a modern day relative. These animals are all invertebrates – animals without backbones.

Snails belong to a large group of shelled animals called gastropods. They live inside coiled shells, which they secrete around themselves. Their shells are made of a mineral much like chalk, but harder. As snails grow, they add layers of mineral around their shell's opening. Snails are mostly crawlers but some can swim. For the most part, they feed on algae but some species prey on other animals.

Like snails, bivalves are also shelled animals. Unlike the snails, however, bivalve shells are divided into two parts, or valves, which completely surround and protect the soft body of the animal inside. Each valve has a set of teeth-like bumps on one side, which fit perfectly into the matching valve, forming a hinge. While the animal is alive, the two valves are held together by strong muscles and ligaments. Most bivalves live embedded in sand, hidden in rocks or attached to hard surfaces. They feed by filtering water through their gills and trapping the food particles that go through.

Nautiloids (NAW'-tih-loyds) are yet another shelled animal. Together with the squid and octopus, they belong to a group called the cephalopods. Like snails, nautiloids live inside a shell but they differ in that their shells are divided into chambers or compartments. Only the compartment closest to the opening is occupied by the animal. The rest of the chambers are filled with gases and water and help the animal sink or float. Nautiloids were very numerous during the Paleozoic Era (Age of Ancient Life) but most are now extinct. Today, in the deep waters of the South Pacific Ocean, only six species, called *Nautilus*, remain. Sea Urchins belong to a large group of marine animals called the echinoderms. Their globe shaped skeletons are called tests and surround the animal's soft parts. Some have spines and some do not. Although ancient in origin, sea urchins continue to thrive in the bottom of the world's oceans today. They are found from the tropics to the poles and in deep and shallow waters. Some species feed on plants and others on animals.

Corals belong to a group of animals called cnidarians (nye-DER'-ee-ens). Most live in warm, shallow tropical waters and may be solitary or colonial. The individual animal, or polyp, is a jelly-like organism. Its mouth is at the top of its sac-like body and is surrounded by tentacles, which trap small prey. Each individual animal lives inside a cup-like skeleton, which it secretes around itself. A coral colony is made up by many individuals who live together and whose individual skeletal cups are physically joined together, forming one larger skeleton. All of the corals included in the kit are colonial. Individual cups are seen as small openings in the skeletons.

Starting Out

- Explain to the students that in this activity, animals have been put into five pairs. Each pair consists of one fossil animal and one shell or skeleton of an animal closely related to that fossil.
- Ask the students:
  What is a fossil?
  Are some fossil animals related to animals alive today? (Show them one example of a fossil and the shell of its living relative to illustrate this point.)
  What do all of the animals in this activity have in common? Use this question to introduce the concept of invertebrates.
- Briefly go over the Fossils and Their Living Kin Chart on the blackboard. Explain to the students that they will record the answers to questions in the Observe and Discover Cards on their charts. Use one pair as an example and run the students through at least one question to show them how to fill out their chart.

REMIND STUDENTS TO HANDLE THEIR FOSSILS AND SHELLS WITH CARE!

Action:

1. Divide the class into 5 groups of 4-6 students each. If groups of six appear too large to work effectively in a cooperative manner, divide the class into 6 groups. Have students in the sixth work station go up to the board and identify the different fossils and their living kin on the Geologic Time Scale poster (ancient) and the Life on a Coral Reef poster (modern).
2. Ask students to have their pencils ready.
3. Pass out a copy of Fossils and Their Living Kin Chart to each student.
4. Remind students that they will record the answers to questions in the Observe and Discover Cards on their charts. In order to answer these questions, they must look at their pair carefully. Encourage them to use their senses as much as possible.
5. Ask the students to read their Sea Animal's Life Styles copy. In some cases, these will help them answer the Use your Brain Power question on the chart.
6. After about eight minutes of working with one pair, have the groups switch. Do this until all the groups have observe all pairs (if your class is divided into six groups or work stations skip #7 below).
7. Whenever a group is done looking at their pair early, before it is time to switch, have them go up to the board and find their fossil on the Geologic Time Scale poster. Also, have them find its present day relative on the Life on a Coral Reef poster. Hopefully every group will have had the chance to look at these posters before the activity is completed, if not, allow a few minutes at the end for this purpose.

Tying It All Together:

- Discuss in what ways the fossils were different from the modern day shells or skeletons. If time allows, do this pair by pair and then lead the students to make generalizations of the differences between fossil shells and those that have not been fossilized.
- Discuss whether you can figure out how (or if) an animal moves, what it eats, or where it lives in the sea, based on its shape.

Branching Out:

- Using the pictures on the Geologic Time Scale poster as a source of reference, have the students discover how many millions of years ago each different type of animal appeared in the sea (optional depending on the age of students).

Vocabulary:

Fossils
Mollusks
Sea Urchins
Tests
Gastropods
Bivalves
Corals
Cnidarians
Valves
Polyp
Nautiloids
Echinoderms
Nautilus

Nebraska Science Standards

Activity 1: Time Travel

Objectives: Students learn how to read time charts and time lines and get an overview of the major events that have occurred through geologic time.

Grades 3-5

SC K-12.1 **Inquiry, the Nature of Science, and Technology**

1. Abilities to do Scientific Inquiry

SC 5.1.1 Students will plan and conduct investigations that lead to the development of explanations.

Scientific Interpretations, Reflections, and Applications: SC 5.1.1.f. Develop a reasonable explanation based on collected data.

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 5.4.4 Students will describe environments based on fossil evidence.

Grades 6-8

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 8.4.4 Students will use evidence to draw conclusions about changes in Earth.

Past/Present Earth: SC 8.4.4.b. Describe how environmental conditions have changed through use of the fossil record.

Activity 2: Meet the Sea Life

Objectives: Students discover the types of animals that lived during the Paleozoic Era.

Grades 3-5

SC K-12.3 **Life Science**

4. Biodiversity

SC 5.3.4 Students will describe changes in organisms over time.

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 5.4.4 Students will describe environments based on fossil evidence.

Activity 3: Let's Sort It Out

Objectives: Students understand how to use a key to identify fossils.

Grades 3-5

SC K-12.1 **Inquiry, the Nature of Science, and Technology**

1. Abilities to do Scientific Inquiry

SC 5.1.1 Students will plan and conduct investigations that lead to the development of explanations.

Scientific Observations: SC 5.1.1.d Make relevant observations and measurements.

Activity 4: Jaws

Objectives: Students understand that sharks lived in shallow seas that once covered Nebraska.

Grades 3-5

SC K-12.1 **Inquiry, the Nature of Science, and Technology**

1. Abilities to do Scientific Inquiry

SC 5.1.1 Students will plan and conduct investigations that lead to the development of explanations.

Scientific Observations: SC 5.1.1.d Make relevant observations and measurements.

SC K-12.3 **Life Science**

4. Biodiversity

SC 5.3.4 Students will describe changes in organisms over time.

Biological Adaptations: SC 5.3.4.a Describe adaptations made by plants or animals to survive environmental changes.

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 5.4.4 Students will describe environments based on fossil evidence.

Grades 6-8

SC K-12.3 **Life Science**

4. Biodiversity

SC 8.3.4 Students will identify characteristics of organisms that help them survive.

Biological Adaptations: SC 5.3.4.c Use anatomical features of an organism to infer similarities among other organisms.

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 8.4.4 Students will use evidence to draw conclusions about changes in Earth.

Activity 5: Fossils and Their Living Kin

Objectives: By making observations, students learn about some of the differences between the fossils of ancient sea animals and the shells of their present day relatives.

Grades 3-5

SC K-12.1 **Inquiry, the Nature of Science, and Technology**

1. Abilities to do Scientific Inquiry

SC 5.1.1 Students will plan and conduct investigations that lead to the development of explanations.

Scientific Observations: SC 5.1.1.d. Make relevant observations and measurements.

SC K-12.3 **Life Science**

4. Biodiversity

SC 5.3.4 Students will describe changes in organisms over time.

Biological Adaptations: SC 5.3.4.a Describe adaptations made by plants or animals to survive environmental changes.

SC K-12.4 **Earth and Space Sciences**

4. Earth's History

SC 5.4.4 Students will describe environments based on fossil evidence.

Grades 6-8

SC K-12.1 **Inquiry, the Nature of Science, and Technology**

1. Abilities to do Scientific Inquiry

SC 8.1.1 Students will design and conduct investigations that will lead to descriptions of relationships between evidence and explanations.

Scientific Observations: SC 5.1.1.e Make qualitative and quantitative observations.

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