EI-5136

Ages 8+
Grades 3+

GeoSafari®

CLASSROOM DINOSAUR DIG

Teacher Guide with Reproducibles

Everything you need to create a realistic *T. rex* dig experience in your school yard!

⚠ WARNING:
CHOKING HAZARD—Small parts.
Not for children under three (3) years.

Educational Insights®

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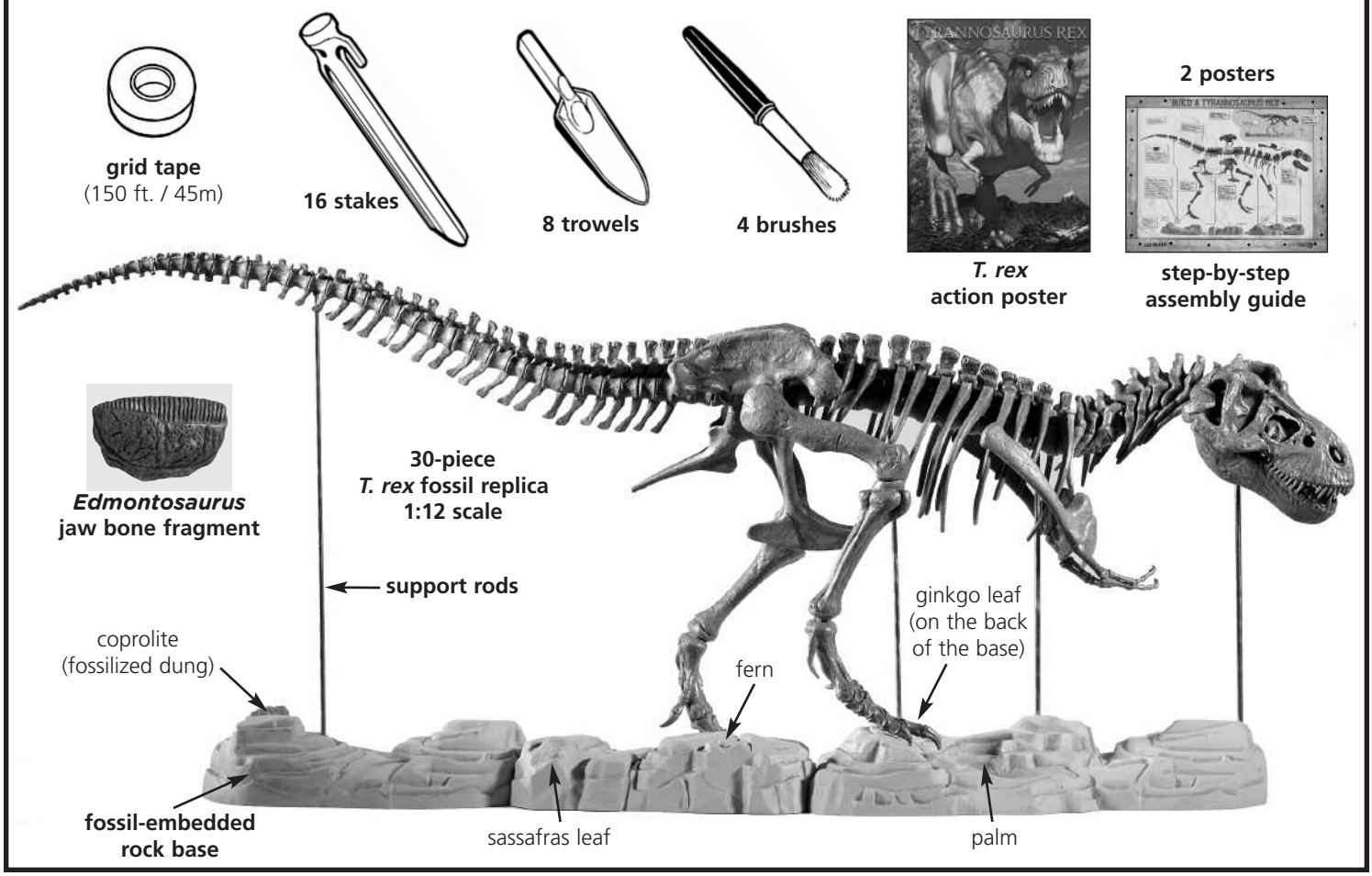
LESSON PLANS

WHAT'S INCLUDED IN THE KIT



TEACHER INFORMATION

Introduction

Get ready to dig up a fantastic learning activity with your students—one they will remember for years to come. This guide explains how to set up a dig in your school yard, sandbox, garden, on a beach, etc. Your 'junior paleontologists' will experience the wonder of excavating fossils and piecing together mysteries of our living past.

How long will the dig take?

OPTION 1: THE ONE-DAY DIG

For a more manageable dig, assign 3-5 students to the dig site at a time with an extra adult, such as a teacher's aide or parent. See page 10 for ideas on what to have the rest of the class do inside while groups are excavating.

Or, take the entire class outside with you at once. You'll need to provide extra shovels if you want to excavate many squares at the same time. Allow 1-2 hours of digging time. We suggest that you bring the skeleton back indoors to assemble it in front of the entire class (see page 18).

OPTION 2: THE FOUR-DAY DIG

If you have another adult such as a parent or teacher's aide, ask that person to supervise students while they dig outside. Each day, send a different group of students outdoors to dig. Meanwhile, you lead the lesson indoors. The students who do the digging outside will miss the class lesson that day. They should complete the missed worksheet at home for homework.

NATIONAL SCIENCE STANDARDS

The activities in this kit are correlated to the National Science Standards listed below.

Grades K-4

- Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.
- All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.
- The surface of the Earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

Grades 5-8

- Fossils provide important evidence of how life and environmental conditions have changed.
- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry.
- Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models.
- In areas where active research is being pursued and in which there is not a great deal of experimental or observational evidence and understanding, it is normal for scientists to differ with one another about the interpretation of the evidence or theory being considered.

DAY 1: DISCUSSING DINOSAURS

Today's objectives:

- Find out what students already know about dinosaurs.
- Learn more about dinosaurs and paleontology.
- Ask students the pre-dig discussion questions and discuss the answers.

Materials Key

✔ items provided in kit

❍ item teacher must supply

Materials for Day 1:

✔ pre-dig discussion questions on page 5.

❍ DVDs, books or articles about dinosaurs and/or paleontology

Introduce the dinosaur paleontology unit today. Most children already know something about dinosaurs because it's a topic that interests them. They'll want to enthusiastically share this information with you—so give them structured class time to do so. By allowing students to share what they already know with the entire class, students learn from each other. As students tell you dinosaur facts, make a list of what they say on the board. Then ask students to tell you what else they might be interested in learning about dinosaurs. List those questions on the board as well.

Read some facts about dinosaurs and paleontology (in your textbook, an article, or another book). There are lots of resources online and in libraries. Or, show students a factual DVD (or video) on this topic.

Ask your students the questions on page 5. Discuss the answers.

For homework, ask students to bring in any books, photographs, or articles they can find about dinosaurs. You might also ask them to bring in figurines or other dino-related toys they own to make a class display of dino-related objects. You may wish to point out and discuss some of the inaccuracies in the objects students bring to class.

DAY 2: SKELETON COMPARISONS

Today's objectives:

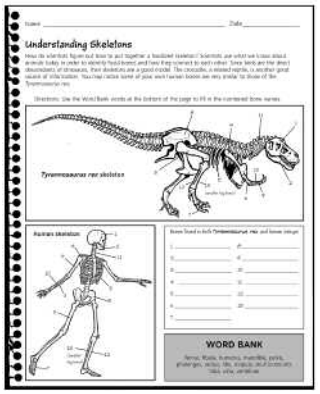
- Learn about (or review) the human skeleton.
- Compare human and *T. rex* skeletons.

Materials for Day 2:

✔ copies of the worksheet entitled Understanding Skeletons on page 6 (one copy per student)

❍ pictures of the human skeleton (or a model)

Take some time to discuss the major bones of the human skeleton with your class. If you have a section in your textbook, review it with your class. Show students pictures of a skeleton—or even a model skeleton if you have one.


Understanding Skeletons

WORD BANK

Have students complete the worksheet entitled Understanding Skeletons. Discuss the answers (see page 20) and ask students to state similarities and differences they note between the skeletons. It's important that students can recognize some of the bones and how they fit together. This will make the excavation process much more realistic because paleontologists fit dinosaur bones together based partly on what they know about the skeletons of animals living today (particularly birds and crocodiles).

Tonight's teacher preparation: Make sure you have the materials ready to set up the dig site tomorrow before students arrive to class. Scout out the location you will use to bury the *T. rex.* See the section on page 7 entitled 'Where should *T. rex* be buried?'

PRE-DIG DISCUSSION QUESTIONS

Possible student answers are written below each question.

What are dinosaurs?

Dinosaurs are reptiles from the Mesozoic Era (248-65 million years ago) that lived on land.

What does the name 'dinosaur' mean?

Dinosaur means terrible reptile (dino=terrible, saur=reptile).

Can you think of some examples of dinosaurs?

Some examples of dinosaurs are ***Tyrannosaurus rex, Triceratops, Stegosaurus, Edmontosaurus, Apatosaurus, Velociraptor, Ankylosaurus***, etc. *Pterodactyl* and other flying reptiles that also lived during the Mesozoic Era are not dinosaurs because they were not primarily land-dwellers and because their bones and posture do not share some features common to dinosaurs. Ocean-dwelling reptiles like *Elasmosaurus* and *Mosasaurus* are also not dinosaurs.

Are there any dinosaurs alive today?

Yes and no. None are alive in the form they existed 65 million years ago. However, scientists now think that birds are the direct descendants of dinosaurs—"modern day" dinosaurs.

How do we know dinosaurs existed?

People find fossils—the remains of living things—such as fossilized bones, footprints, eggs, and coprolites (fossilized dung). Dinosaur fossils have been found on every continent—including Antarctica.

Where do paleontologists look for fossils?

Paleontologists walk in areas where the ground has eroded (worn away) so that dirt from the Mesozoic Era is exposed. They look for fossils lying on or sticking out of the ground. When they find something, they start digging to see what else is underground.

How did the bones get underground?

After an animal died, sediment slowly covered the bones. For example, the animal died in a slow-moving stream or river that was clogged with lots of mud. Or, perhaps it died near a sand dune or mountain and was covered in sand blowing off the dune or a mudslide coming down the mountain. Over millions of years, lots of sediment can build up over a fossil!

Some bones are buried deeper than others. Do you think older or newer bones would be found very deep underground?

Older bones are generally found deeper underground because there has been more time for sediment to accumulate. However, earthquakes and erosion can bring older fossils closer to the surface.

What other fossils do people dig for underground? Do you think those things would be found deeper or shallower than dinosaur bones?

People search for fossilized footprints, coprolites, plants, and other animals (such as clams, corals, insects, woolly mammoths and saber-toothed cats). More recent animals, such as woolly mammoths and saber-toothed cats, would be found in shallower levels of earth. Older dinosaur bones would be buried deeper.

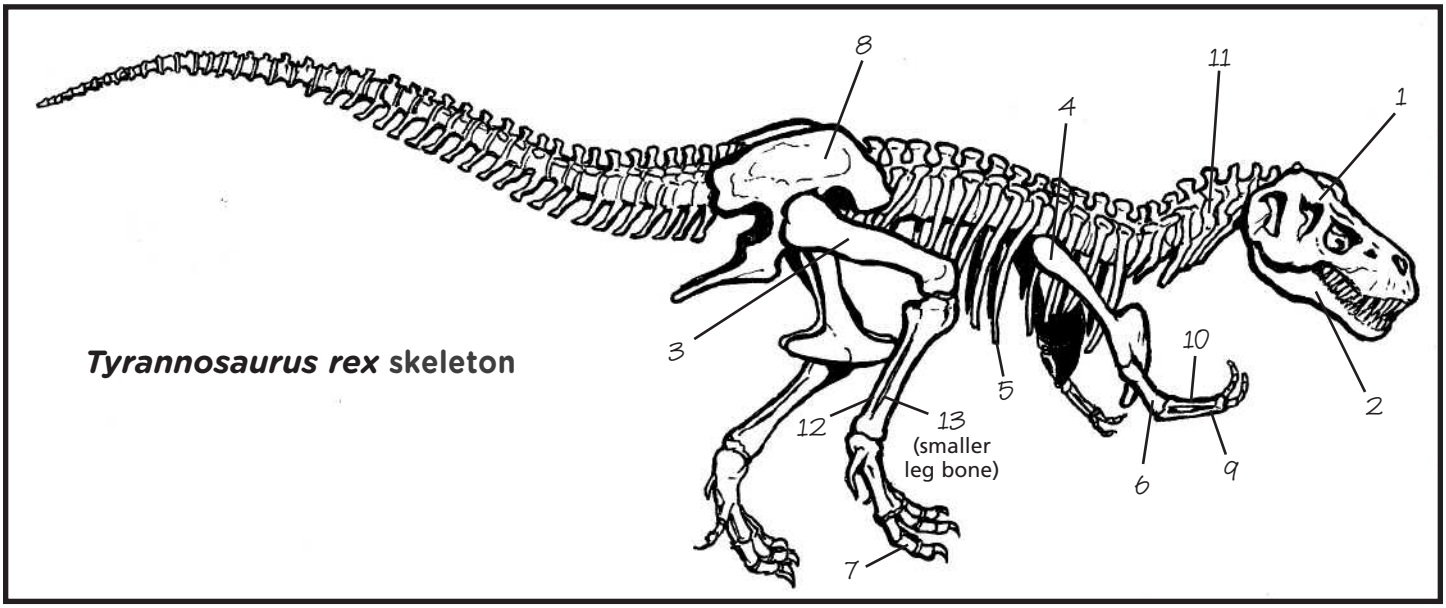
Archaeologists search for the remains of human civilization, such as human bones, shards (pieces) of pottery, ancient buildings, etc. The finds of an archaeologist would generally be located at a shallower depth than those of a paleontologist because humans came much later than dinosaurs. However, the depth of the finds is also dependent on how much the land has been built up or eroded away at the dig site.

Name _____ Date _____

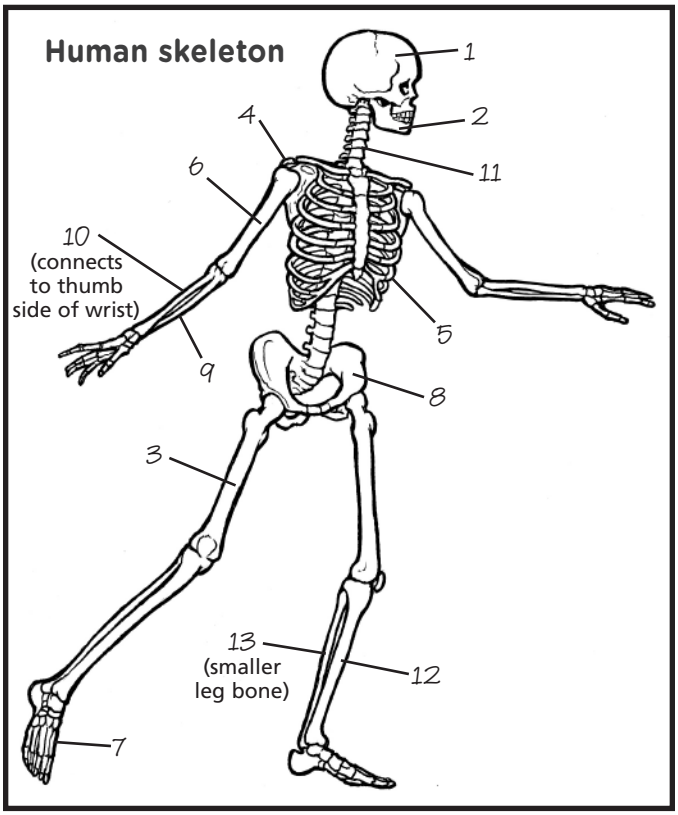
Understanding Skeletons

How do scientists figure out how to put together a fossilized skeleton? Scientists use what we know about animals today in order to identify fossil bones and how they connect to each other. Since birds are the direct descendants of dinosaurs, their skeletons are a good model. The crocodile, a related reptile, is another good source of information. You may notice some of your own human bones are very similar to those of the *Tyrannosaurus rex*.

Directions: Use the Word Bank words at the bottom of the page to fill in the numbered bone names.



***Tyrannosaurus rex* skeleton**



Bones found in both
Tyrannosaurus rex and human beings:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____

WORD BANK

femur fibula humerus mandible pelvis phalanges radius ribs scapula skull (cranium) tibia ulna vertebrae

DAY 3: PREPARING THE DIG SITE

SET UP THE DIG SITE

Where should *T. rex* be buried?

The bones can be buried in dirt or sand (such as the school sandbox). If you plan to do this dig over the course of several days or weeks, choose a site which will not be disturbed by others when the class is not working on it. An enclosed, lockable garden plot which is not currently being used would be a good choice. If you don't have an outdoor area, bring a plastic wading pool or large box into the classroom. Fill it with sand, packing peanuts, sawdust, or mulch and bury the bones.

If you use a wading pool or box, then the stakes will probably not remain securely in place. In this case, simply tape the rope in horizontal and vertical rows across the top of the wading pool. Alternatively, cut squares out of a shower curtain and lay the 'shower curtain grid' over the buried bones in the wading pool to mark off excavation squares.

Materials for Day 3 Set Up:

- ✔ *T. rex* skeleton (30 parts)
- ✔ *Edmontosaurus* jawbone fragment
- ✔ 15 stakes (there is one extra)
- ✔ grid tape
- ❍ shovel
- ❍ optional: tape measure
- ❍ optional: blank stickers or masking tape
- ❍ optional: buckets for sand*

* If you will be doing this dig in the school sandbox, place buckets around the sandbox to deposit sand while you dig a hole to bury the bones. Buckets are also useful for depositing sand during the student dig. When the dig is complete, simply dump the sand back into the sandbox.

- ❍ optional: other items to bury such as modern toys, cleaned chicken bones**, pennies, buttons, litter such as plastic straws and fast food containers, etc.

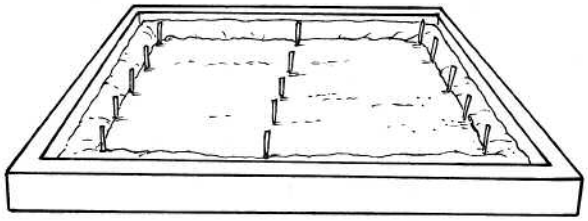
** To make the chicken bones safe for handling, clean off the meat and boil the bones in water for 10 minutes. Then soak the chicken bones for 10 minutes in a 10% bleach solution to thoroughly remove any possible disease-causing contaminants.

Follow this procedure to bury the bones:

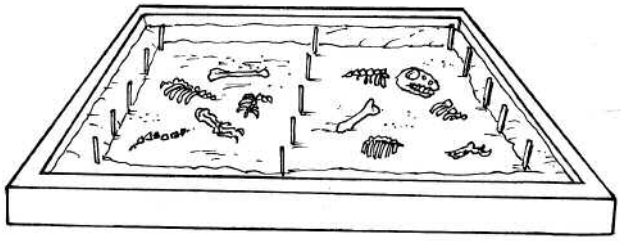
1. Use four stakes to mark a rectangular area. We suggest an area of approximately 3 yards x 2 yards (3 meters x 2 meters).

2. Dig a hole approximately 5 inches (13 cm) deep.

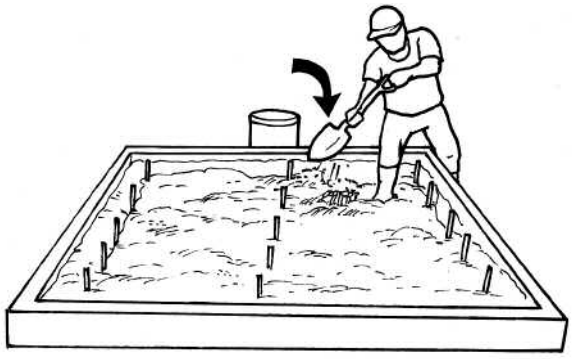
3. Insert the remaining stakes in the sand so they are evenly spaced as shown.



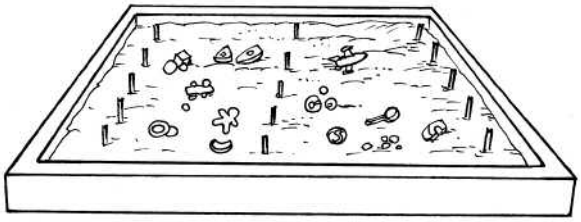
4. Position 29 of the *T. rex* bones in the hole (save one for step 7). Place the bones in a position in which the animal might have died. Place the *Edmontosaurus* jawbone fragment near the abdominal area of the skeleton (as if it might have been in the *T. rex's* belly when the dinosaur died). Try to spread out the bones as much as possible to increase the chances that students will find at least one bone in every marked square. Take note of which areas have fewer bones.



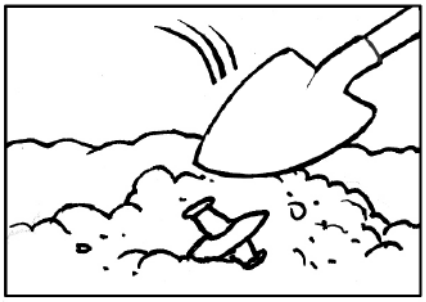
5. Cover the dinosaur bones with about 2 inches (5 cm) of earth.

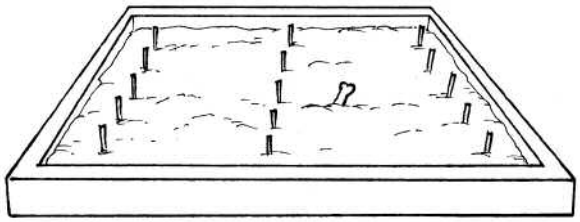


6. Lay the more modern items (plastic toys, chicken bones, buttons, pennies, litter) in the hole. These modern items will be shallower in the sand than the dinosaur bones to show that they were buried more recently. Make sure the items are evenly spaced. If some areas have fewer dinosaur bones, put more of the modern items in those areas to make sure that each group of students finds several things.

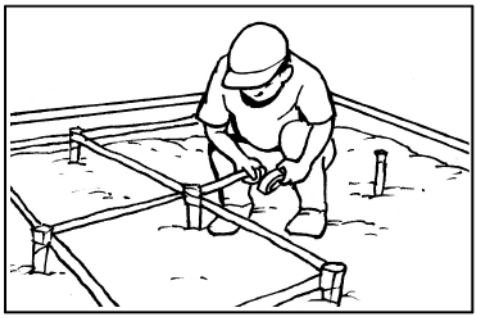


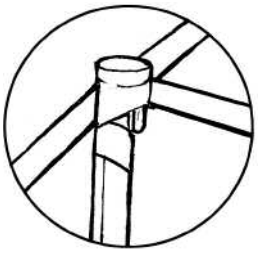
7. Cover the entire site with the rest of the earth. Place the 30th *T. rex* bone so that it is sticking out of the ground.



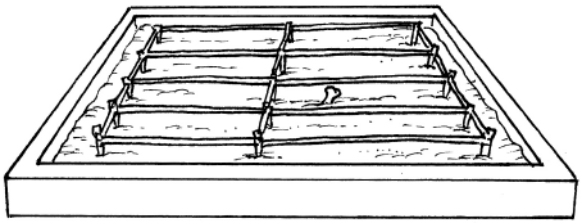


8. Wind the grid tape around the stakes to make the grid.

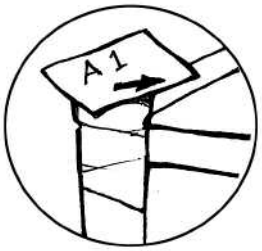




The completed grid should look like this:



9. Optional: label each grid square with a sticker placed on the stake so students can record where they found a fossil. This will make recording student finds on the grid map easier (see page 9).



DAY 3: EXCAVATING A TYRANNOSAURUS REX

Today's objectives

- Begin skeleton excavation with your students.
- Play a Dino Vocabulary game in class OR work on a *T. rex* math activity in class.

Materials for Day 3 Excavation:

- ✔ prepared dig site (buried bones, overlaying grid)
- ✔ trowels
- ✔ brushes
- ✔ 31+ copies of the Fossil Discovery worksheet on page 11 (one worksheet is needed for each buried item—including the modern items)
- ❍ blank stickers (one per buried item). Number the stickers.
- ❍ grid map—sheet of paper marked with the grid squares (see grid map pictured under #4)
- ❍ small plastic bags for students to place the smaller 'found' items (buttons, pennies, etc.)
- ❍ optional: buckets or bins
- ❍ optional: clipboards for students to use as a writing surface, camera to photograph finds
- ❍ optional: flat sheet of cardboard on which to lay the grid map
- ❍ recommended: sunscreen

STUDENT EXCAVATION

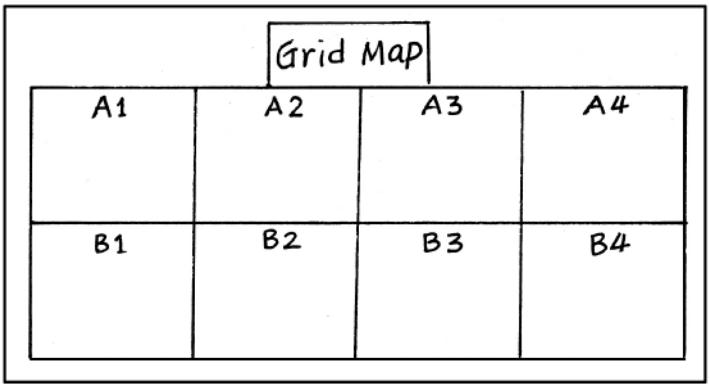
1. Divide students into groups and assign each group at least one square to excavate. Give each group several Fossil Discovery worksheets. Groups will need one worksheet for each item they unearth in their square. Review the Fossil Discovery worksheet with students before they begin excavation.


FOSSIL DISCOVERY

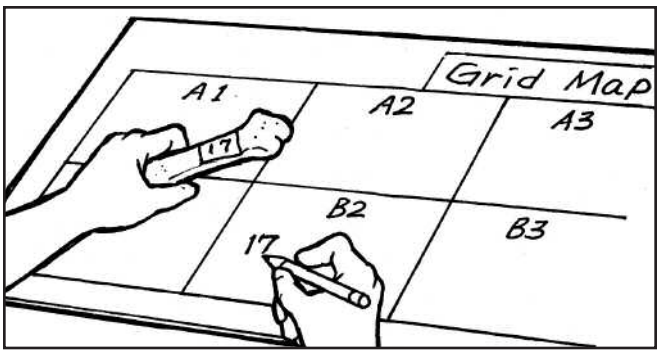
2. Instruct students to carefully remove earth from their square. Earth should be deposited outside the grid and not into other students' grid squares. If you have provided buckets or bins, advise students to dump the earth directly into the buckets.

3. When an item (fossil) is found, students should use brushes to clear away enough dirt above the fossil so that they can sketch the orientation of the item onto their worksheet. The group should designate a recorder to fill out a worksheet each time an item is found. Once the sketch is complete, a student should remove the fossil and clean it off with a brush.

4. Assign one or two students to be Dig Coordinators (DCs). The DCs are in charge of the stickers and paper grid called the grid map. Explain to your students that the grid map is important for recording the location of the bones in the grid. The bone placement can tell a lot about the animal at the time that it died.



5. All found fossils are brought to one of the DCs. The DC puts a sticker on the fossil. The DC instructs the student who found it to record that number on the worksheet and write that same number on the grid map (in the approximate place where the fossil was found). The worksheet and fossil are left with the DC and the student returns to the grid to continue digging.



6. If students find an assortment of similar small items (e.g., buttons), they can be bagged and labeled with a single sticker.

7. If the DCs think they have identified a fossil type, they can write their guess on the back of the worksheet (e.g., "I think this is a dinosaur foot.").

What is the rest of the class doing while some students are excavating outside?

Here are two cross-curricular activities for when students are not digging.

Dino/Paleontology Vocabulary Concentration

This game helps students learn some important vocabulary related to dinosaur paleontology; it's also a fun visual memory activity. Put students into groups of 2-4 and give them copies of the Dino Dig Vocabulary on page 19 and 32 blank index cards. Students work together to write a vocabulary word on one card and the first sentence of the definition on another. Then they shuffle the cards, turn them face down, and line the cards up in rows. Students take turns flipping over two cards. The object is to flip over a word and its definition on the same turn. If a student does so, he/she gets to keep that pair and takes another turn. At the end of the game, the student with the most matched pairs is the winner.

Math Connection

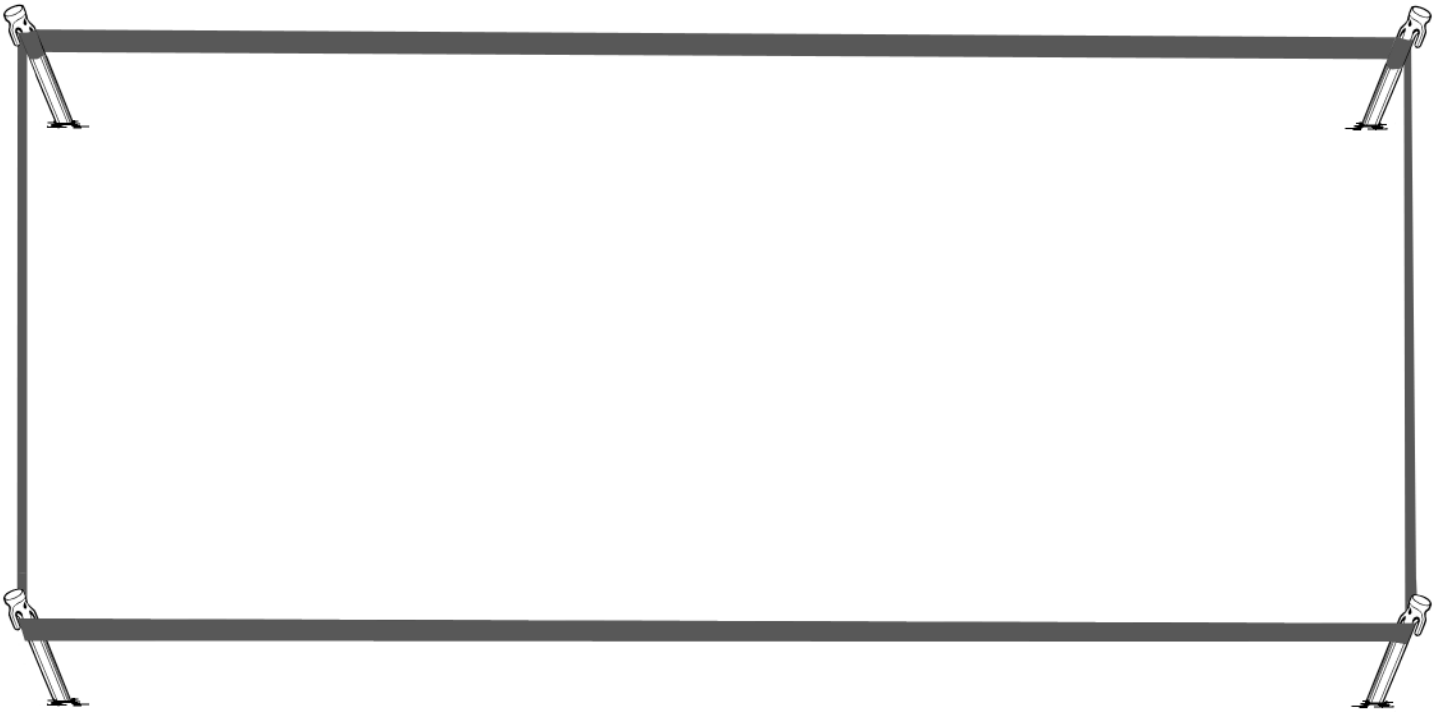
The *T. rex* skeletal model is 40 inches long. Assuming a 1 inch:1 foot scale, ask students, "Approximately how long was a real *T. rex*?" (Answer: 40 feet) Cut sheets of 40-foot butcher paper and lay the paper flat outside on the playground. Tape the sheets of paper together so the paper reaches 14 feet high. Have students use yardsticks to draw a grid on it with 1-foot squares. Let students draw in a full-scale model of a *T. rex.* They will be amazed at the size! If you have the wall space and a ladder, mount the finished drawing in your classroom or the school cafeteria for an awesome sense of scale.

FOSSIL DISCOVERY

Paleontologist team name(s) _____

Date of discovery _____ **Found in grid square** _____

Sketch how the fossil is lying in the ground:



What part of the body do you think this might be? Why? (If it doesn't look like a body part, what do you think it is?) _____

_____

_____

_____

Additional observations: (For example, what color is it? What bones were lying near it? What else was found in the same grid square?) _____

_____

_____

_____

_____

_____

Sticker number _____

DAY 4: THE TRUTH ABOUT DINOSAURS

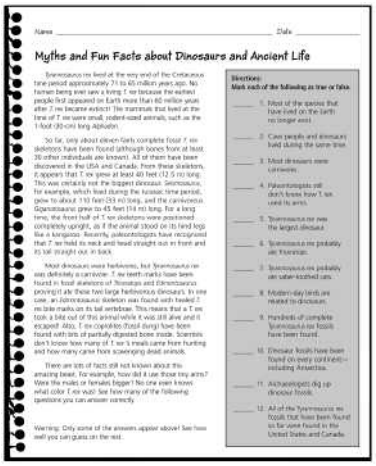
Today's objectives

- Continue skeleton excavation with your students.
- Discuss common misconceptions about dinosaurs by completing the worksheet entitled "Myths and Fun Facts about Dinosaurs and Ancient Life."

Materials for Day 4:

- ✔ dinosaur dig materials (same as Day 3) to continue the excavation
- ✔ copies of the worksheet entitled Myths and Fun Facts about Dinosaurs and Ancient Life on page 13 (one copy per student)
- ❍ geologic time scale

1. Read the worksheet aloud with your class.


Name _____ Date _____

Myths and Fun Facts about Dinosaurs and Ancient Life

Directions:
Mark each of the following as true or false.

_____ 1. Most of the species that have lived on the Earth no longer exist.

_____ 2. Cave people and dinosaurs lived during the same time.

_____ 3. Most dinosaurs were carnivores.

_____ 4. Paleontologists still don't know how T. rex used its arms.

_____ 5. Tyrannosaurus rex was the largest dinosaur.

_____ 6. Tyrannosaurus rex probably ate Triceratops.

_____ 7. Tyrannosaurus rex probably ate water-soaked cars.

_____ 8. Modern-day birds are related to dinosaurs.

_____ 9. Hundreds of complete Tyrannosaurus rex fossils have been found.

_____ 10. Dinosaur fossils have been found on every continent—including Antarctica.

_____ 11. Archaeologists dig up dinosaur fossils.

_____ 12. All of the Tyrannosaurus rex fossils that have been found so far were found in the United States and Canada.

2. Show students a geologic time chart of Earth's life history. There may be a chart in your class science textbook. If not, search for a chart online or in the library.

3. Discuss the different organisms that were alive during different time periods. Many geologic time charts have drawings of organisms that existed during those time periods. Explain that most species that have lived on the Earth no longer exist.

4. Discuss some differences between mammals and reptiles and point out when these groups first appeared on Earth. The Field Museum's Evolving Planet website is one useful place to look for further information:
http://www.fieldmuseum.org/evolvingplanet

5. Assign students to groups. Give students some time to answer the true/false questions. They should discuss the answers to the questions not explicitly answered on the worksheet. Then discuss the correct answers with the entire class. It's important for students to understand that different organisms lived at different times. Many students mistakenly believe that cave people were around at the time of the dinosaurs – particularly because of fictional movies and television shows such as "The Flintstones." It can be difficult to dispel those misconceptions because many students enjoy imagining the fantasy of human beings battling dinosaurs. Emphasize that nothing even close to looking like a human being actually lived during the time of the dinosaurs.

Name _____ Date _____

Myths and Fun Facts about Dinosaurs and Ancient Life

Tyrannosaurus rex lived at the very end of the Cretaceous time period approximately 71 to 65 million years ago. No human being ever saw a living *T. rex* because the earliest people first appeared on Earth more than 60 million years after *T. rex* became extinct! The mammals that lived at the time of *T. rex* were small, rodent-sized animals, such as the 1-foot (30-cm) long *Alphadon*.

So far, only about eleven fairly complete fossil *T. rex* skeletons have been found (although bones from at least 30 other individuals are known). All of them have been discovered in the USA and Canada. From these skeletons, it appears that *T. rex* grew at least 40 feet (12.5 m) long. This was certainly not the biggest dinosaur. *Seismosaurus*, for example, which lived during the Jurassic time period, grew to about 110 feet (33 m) long, and the carnivorous *Giganotosaurus* grew to 45 feet (14 m) long. For a long time, the front half of *T. rex* skeletons were positioned completely upright, as if the animal stood on its hind legs like a kangaroo. Recently, paleontologists have recognized that *T. rex* held its neck and head straight out in front and its tail straight out in back.

Most dinosaurs were herbivores, but *Tyrannosaurus rex* was definitely a carnivore. *T. rex* teeth marks have been found in fossil skeletons of *Triceratops* and *Edmontosaurus* proving it ate these two large herbivorous dinosaurs. In one case, an *Edmontosaurus* skeleton was found with healed *T. rex* bite marks on its tail vertebrae. This means that a *T. rex* took a bite out of this animal while it was still alive and it escaped! Also, *T. rex* coprolites (fossil dung) have been found with bits of partially digested bone inside. Scientists don't know how many of *T. rex*'s meals came from hunting and how many came from scavenging dead animals.

There are lots of facts still not known about this amazing beast. For example, how did it use those tiny arms? Were the males or females bigger? No one even knows what color *T. rex* was! See how many of the following questions you can answer correctly.

Warning: Only some of the answers appear above! See how well you can guess on the rest.

Directions:
Mark each of the following as true or false.

_____ 1. Most of the species that have lived on the Earth no longer exist.

_____ 2. Cave people and dinosaurs lived during the same time.

_____ 3. Most dinosaurs were carnivores.

_____ 4. Paleontologists still don't know how *T. rex* used its arms.

_____ 5. *Tyrannosaurus rex* was the largest dinosaur.

_____ 6. *Tyrannosaurus rex* probably ate Triceratops.

_____ 7. *Tyrannosaurus rex* probably ate saber-toothed cats.

_____ 8. Modern-day birds are related to dinosaurs.

_____ 9. Hundreds of complete *Tyrannosaurus rex* fossils have been found.

_____ 10. Dinosaur fossils have been found on every continent—including Antarctica.

_____ 11. Archaeologists dig up dinosaur fossils.

_____ 12. All of the *Tyrannosaurus rex* fossils that have been found so far were found in the United States and Canada.

DAY 5: MAKING INFERENCES FROM EVIDENCE

Today's objectives:

- Continue skeleton excavation with your students.
- Discuss how paleontologists make inferences about extinct animal behavior.

Materials for Day 5:

- ✔ dinosaur dig materials (same as Day 3) to continue the excavation
- ✔ copies of the worksheet entitled Making Inferences on page 15 (one copy per student)


Making Inferences

If you found (a) fossil... you might conclude...

Read the top of the worksheet aloud with your class and then give students time to complete questions #1-7. If possible, allow students to discuss the answers in groups before going over them as a class.

Then allow students to complete the questions on the bottom of the page and share their answers. If you wish to give them more time, allow students to complete the worksheet for homework and share their answers the following day. It's helpful for students to complete the questions at home where they can look around at their rooms while they write.

For additional homework, ask students to examine their teeth in the mirror and to draw the different shapes of teeth they observe. This will prepare students for tomorrow's lesson.

DAY 6: MAKING DIET INFERENCES FROM TEETH

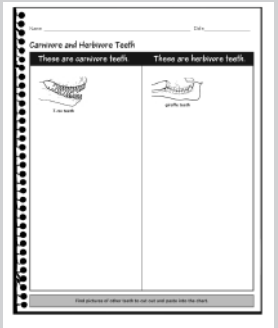
Today's objectives:

- Complete skeleton excavation with your students.
- Study differences in animal teeth to learn about making inferences about an animal's diet.

Materials for Day 6:

- ✔ dinosaur dig materials (same as Day 3) to complete the excavation
- ✔ copies of the teeth worksheets on pages 16-17 (one copy per student)


Examining Teeth


Carnivore and Herbivore Teeth

These are carnivore teeth. These are herbivore teeth.

- ✔ *T. rex* jawbone and *Edmontosaurus* jawbone fragment
- ❍ scissors (one per student)
- ❍ glue
- ❍ optional: mirror

Ask students about their teeth drawings and the various shapes they observed. Ask students why they think some teeth are pointy, such as the canines, and some are flat, such as the molars. See if students can guess which are better for chewing meat and which are better for crunching cereal. While you have this discussion, pass around a mirror and let students examine their teeth again. Discuss what teeth shape they think most carnivores (wolves, dogs, lions, etc.) have and what teeth shape most herbivores (cows, giraffes, etc.) have.

Hold the *Edmontosaurus* jawbone fragment against the *T. rex* jawbone and ask students to note differences in the teeth. Pass the bones around for students to take a closer look. Ask what they think each animal ate (plants or animals).

Allow students time to complete the teeth worksheets and then discuss the answers.

Edmontosaurus jawbone fragment

T. rex lower jaw

Name _____ Date_____

Making Inferences

Human beings were not around at the time of the dinosaurs. This makes it hard to know for sure what dinosaurs were like. Paleontologists study fossils and then compare them to what we know about animals alive today. This is how they make inferences, or educated guesses, about dinosaurs. Scientists do not always agree and often debate with one another about their theories.

Study the fossil facts on the left and match each one to the possible inference on the right. Some questions have more than one possible answer.

If you found (a) fossil...	you might conclude...
_____ 1. skeleton of a *T. rex* with a nest and babies	A. It was a *T. rex* child or baby.
_____ 2. skeleton of a *T. rex* with non-*T. rex* bones near the stomach	B. It once got in a fight.
_____ 3. footprints from the same dinosaur that are spaced far apart from each other	C. It was a carnivore.
_____ 4. jawbone with sharp teeth	D. That dinosaur was a fast runner.
_____ 5. coprolites (fossilized dung) containing leaves, stems, and seeds	E. It was a female (mother) *T. rex*.
_____ 6. skeleton with bite marks in the bones	F. It was an herbivore.
_____ 7. skeleton which was just like another *T. rex* but with much smaller bones and different teeth	G. You have found a *T. rex* along with something *T. rex* ate just before it died.

Do paleontologists ever make the wrong inferences? Sure—sometimes there is not enough evidence to make a decision one way or the other. For example, paleontologists would like to know whether female *T. rex* dinosaurs took care of their nesting babies, like many female animals alive today. Not all female animals do this. For example, male emperor penguins take care of their chicks all through the winter. Perhaps male *T. rex* dinosaurs took care of their babies. No one knows for sure.

Imagine a paleontologist dug up the room where you sleep at night.

What items would be found? _____

_____

Would it be possible to tell if you were a boy or girl from the stuff in the room? _____

_____

What other inferences might the scientist make about you? _____

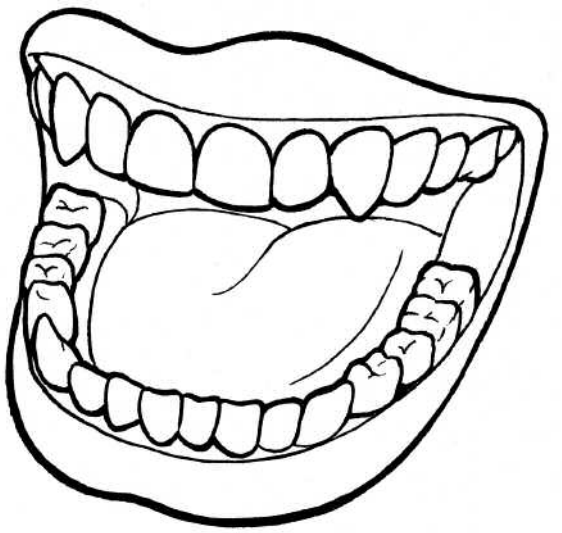
_____

Would all of those inferences be right? (Hint: Does everything in the room belong to you?) _____

_____

Name _____ Date_____

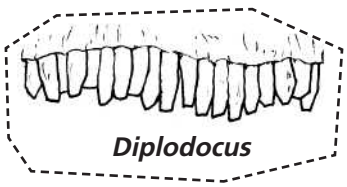
Examining Teeth

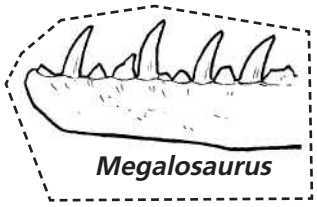


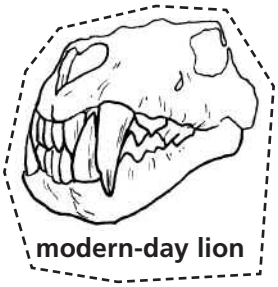
You can tell a lot about an animal from its teeth. Among other things, scientists use teeth to determine how and what an animal ate. Look at your own teeth. Do you see different shapes? Human beings are omnivores. We can eat both plants and animals. Which of your teeth is best for cutting meat? for chewing cereal or salad?

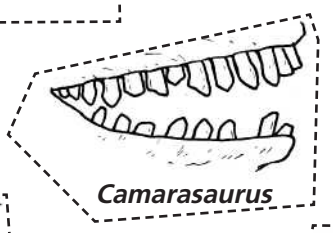
Many animals eat only one kind of food—either plants or animals. Look at the *T. rex* and the *Edmontosaurus* teeth fossils. In what ways are the teeth different? A scientist can tell that one of them was a plant eater and one was a meat eater. We know that because the carnivore's teeth are pointy. Pointy teeth are good for biting, gripping, and tearing meat. Herbivore teeth are flat and have ridges, which are good for grinding up plants. We compare the teeth from dinosaurs to those of modern animals to determine what dinosaurs ate.

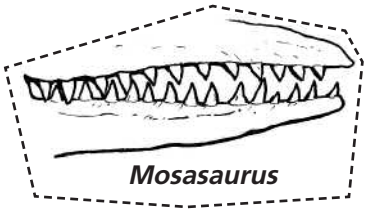
Can you tell whether each of the animals was a carnivore or an herbivore?
Cut out the images of the teeth below and paste them on the Carnivore and Herbivore Teeth chart in the box where they belong. An example of each has been drawn in for you.

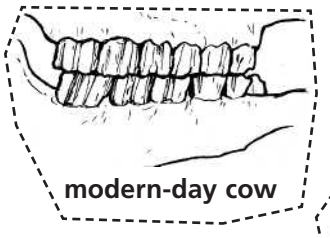

Diplodocus

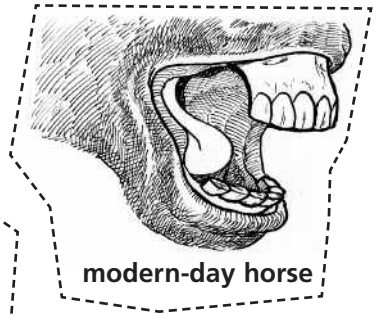

Megalosaurus

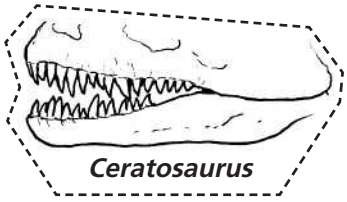

modern-day lion

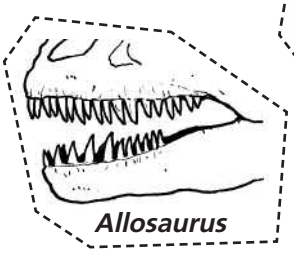

Camarasaurus


Mosasaurus


modern-day cow

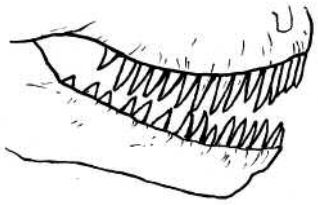
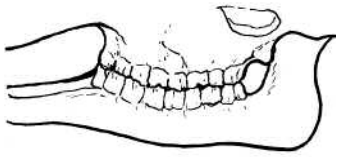

modern-day horse


Ceratosaurus


Allosaurus

Name _____ Date_____

Carnivore and Herbivore Teeth

These are carnivore teeth.	These are herbivore teeth.
 *T. rex* teeth	 giraffe teeth

Find pictures of other teeth to cut out and paste into the chart.

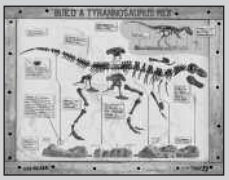
DAY 7: ASSEMBLING THE SKELETON

Today's objectives:

- Assemble the skeleton.
- Discuss the experience and make inferences about this dinosaur based on its excavation site.

Materials for Day 7:

- ✔ 30 *T. rex* bones, all excavated
- ✔ step-by-step assembly guide
- ✔ completed worksheet from Day 2 entitled Understanding Skeletons
- ❍ completed grid map



Now that all the grid squares have been excavated, assemble the skeleton. If necessary, use the included assembly guide. Assembly can be done inside the classroom. Call students up to help assemble the *T. rex*. As you identify bones, compare them to the bones in the human body. Show students how they can use their knowledge of the human skeleton to figure out how *T. rex* bones likely fit together. Refer back to their completed worksheets entitled Understanding Skeletons.

Discuss the dig with your students. Ask them if they enjoyed it and what they found challenging or different from their expectations. Here are some post-dig questions to discuss with your students. Possible student answers are written below each question.

Post-Dig Discussion Questions

Suppose a paleontologist had been walking around, scanning for fossils. What clue would have led her/him to begin digging in the spot where we unearthed our *T. rex*?

Answer: There was a bone sticking out of the ground.

What was on the lower level—the dinosaur fossils or the modern items? Why?

Answer: The dinosaur fossils were on the lower level because older things are buried earlier. New rock and younger materials/fossils are deposited on top of old rock.

Were all the bones you found *T. rex* bones?

Answer: No, we found a jawbone from another dinosaur.

How did you figure out that one of the bones didn't belong to *T. rex*?

Answers: The teeth didn't look like those of a carnivore such as *T. rex*; a bone was left over after we finished constructing *T. rex*, etc.

Why do you think the non-*T. rex* bone was so close to the *T. rex* skeleton?

Answers: The *T. rex* had recently eaten it and this skeletal fragment was being digested in its stomach; the *T. rex* was in the process of killing or eating the other dinosaur when it died; the two animals died together at the same time from fighting or from natural causes; both animals died in or near the same stream and their skeletal remains were carried together by the water. It's possible the two animals may have lived at the same time in the same general area, never interacted during their lives yet were buried in the same rock layer.

Does *T. rex* have any bones that look similar to human bones which enabled you to figure out how it might be put together?

Answers: skull, arm, leg, fingers, jaw, teeth, etc.

As a class, study the grid map. Does the location of the bones on the grid tell you anything about how the animal might have died? Is it possible some or all of the bones moved after its death? How?

Answers: Scavenging animals, running water, mudslides, and collapsing sand dunes are just some of the many environmental forces that may have moved the bones from their original position at the time of death.

Discuss the fossils embedded in the base with your students. Point out the coprolite as well as the plant fossils of some plants that existed during the time of *T. rex:* fern, palm, ginkgo and sassafras. Remind students that just as humans did not live at the time of the dinosaurs, many of the plants we know today also did not exist.

If possible, invite a paleontologist to talk to your class after completing this project.

Name _____ Date_____

Dino Dig Vocabulary

cast If a mold (see mold, below) gets filled in with mud or minerals, the hardened filling is called a cast. It is a natural reproduction that has the exact shape of the animal. Paleontologists sometimes make casts from fossil molds by pouring liquid rubber or plaster into a mold and letting it harden so that it takes the shape—then they have exact copies of the original fossil.

carnivore an animal or plant that eats other animals (like dinosaurs, other reptiles, mammals, fish or animals that live in shells)

coprolite fossilized dung (fossilized 'poop'!)

dinosaur reptilian land animals that lived from 248 million years ago to 65 million years ago. Reptiles from that time that lived in the sea or flew in the sky are not called dinosaurs because they did not live entirely on land. The word dinosaur means 'terrible reptile.'

excavate to dig up out of the ground

extinct describes a group of living things that has completely died out

dig site place where fossils are being dug up from the ground

fossil the remains of living things that lived a long time ago. Fossils form when a dead plant or animal (or a trace of it—such as a footprint) is covered by sediment that fills in the decaying flesh and dissolving air pockets and then hardens into rock.

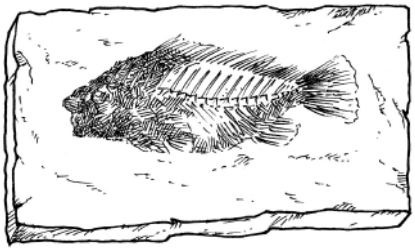
herbivore an animal that eats plants

matrix the rock in which fossils are found. Paleontologists clear away the matrix to get out the fossils.

Mesozoic Era the time period during which the dinosaurs lived (the 'Age of the Reptiles'). The Mesozoic Era is divided into the Triassic, Jurassic, and Cretaceous periods.

mold Molds are made when living things get buried in mud that hardens into rock. Over time ground water dissolves the animal's (or plant's) body, leaving a hole shaped exactly like its body.

fossil fish mold



paleontology the study of ancient life. A paleontologist is a scientist who studies ancient life.

prehistoric from a long time ago—before people were able to write down history

sediment natural mixture of small pieces of rock, dirt, clay, sand, minerals, etc.

trowel a hand-held, scoop-shaped shovel used for digging up fossils

trowel

ANSWERS TO THE WORKSHEETS

Understanding Skeletons (p. 6)

1. cranium **2.** mandible **3.** femur **4.** scapula **5.** ribs **6.** humerus **7.** phalanges
8. pelvis **9.** ulna **10.** radius **11.** vertebrae **12.** tibia **13.** fibula

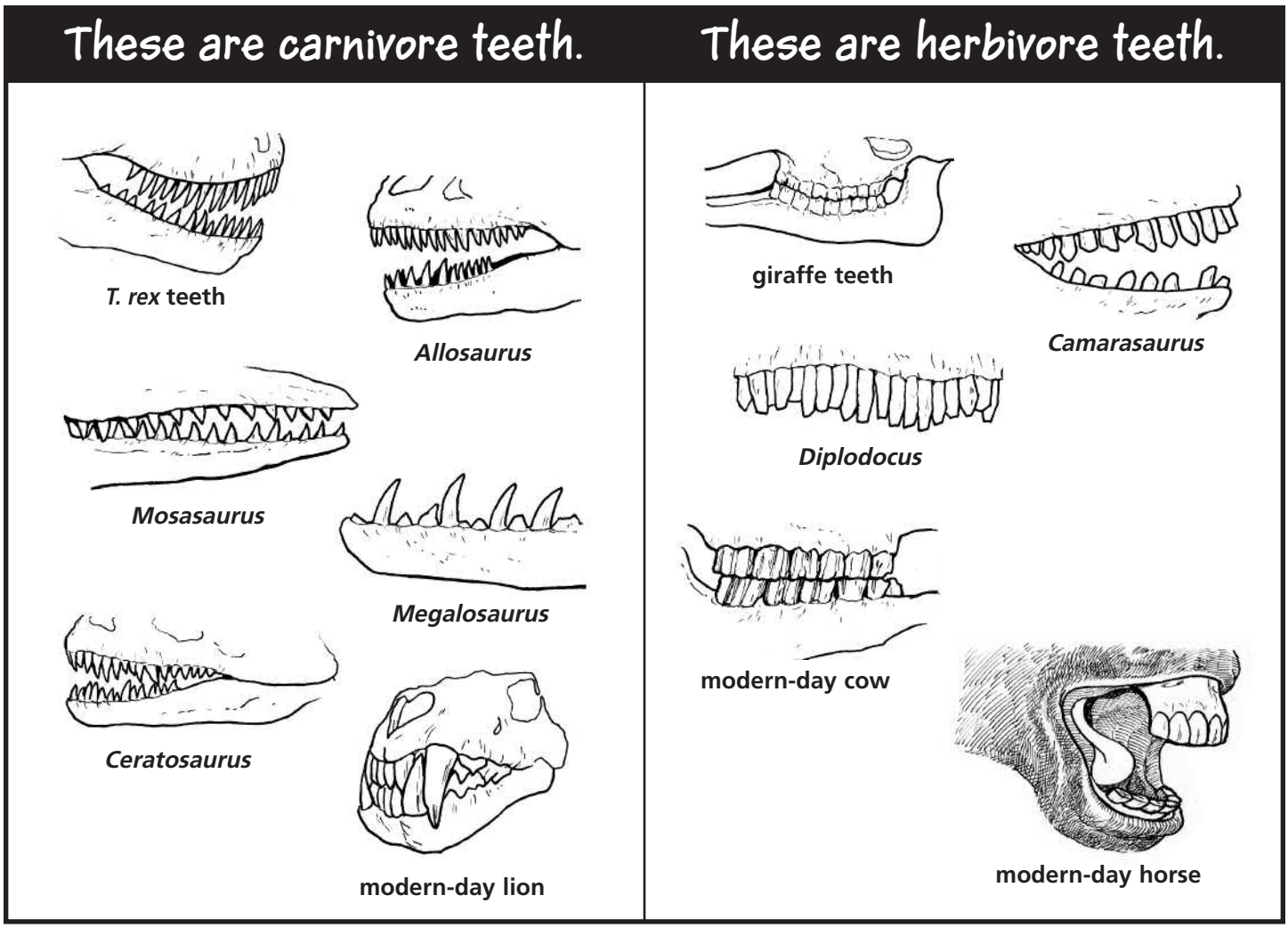
Myths and Fun Facts about Dinosaurs and Ancient Life (p. 13)

1. T **2.** F **3.** F **4.** T **5.** F **6.** T **7.** F (Saber-toothed cats had not yet evolved.)
8. T **9.** F **10.** T **11.** F **12.** T

Making Inferences (p. 15)

1. E **2.** G,C,B **3.** D **4.** C **5.** F **6.** B **7.** A

Carnivore and Herbivore Teeth (p. 17)



Note: If you wish to buy more grid tape, look for it online or in stores under the names flag tape, signal tape, or warning tape.

Special thanks to Sarah Werning, Museum of Paleontology and Department of Integrative Biology, University of California, Berkeley for her collaboration on this guide.

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