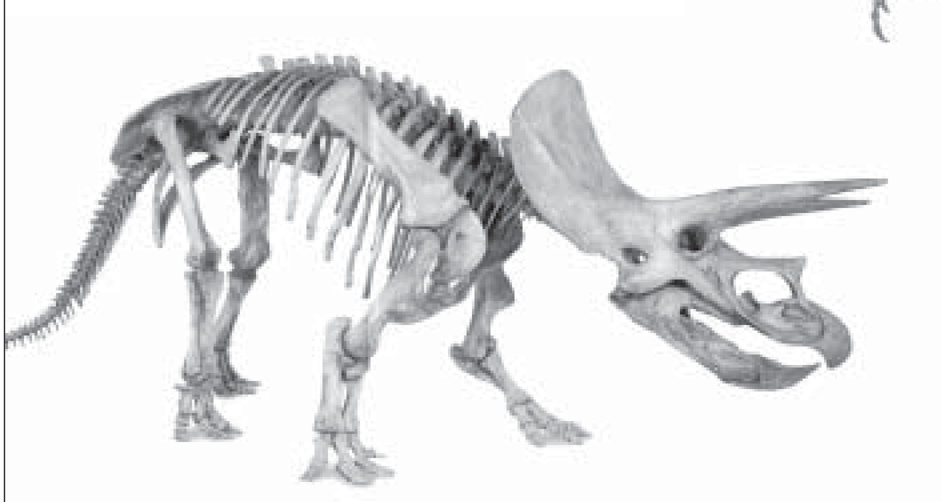
EYEWITNESS KITS

DINOWORKS

Lesson Plan



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CLASSROOM EDITION

DinoWorks

OBJECTIVE

DinoWorks is a fascinating, educational and fun-filled kit designed to give students an appreciation and understanding of the science of paleontology. Students will be introduced to the type of evidence found at a typical dinosaur dig. From excavating fossils in the field to displaying them in a museum, students will learn some of the goals and tasks expected of a paleontologist. Students will cast skeletal parts of three different species of dinosaurs. After reading information about these dinosaurs, students will be challenged to identify and reconstruct three entire skeletons. In the end they will have constructed their own *Tyrannosaurus, Triceratops* and *Velociraptor* skeletons. Finish, glue and magnets are provided to display their creations.

At the completion of this activity students should be able to (1) identify and classify certain dinosaurs, (2) use deductive reasoning to create a complete dinosaur skeleton from scattered evidence and (3) understand some of the complicated techniques used to preserve a paleontological dig site.

MATERIALS PROVIDED

- Casting material (PerfectCast) for six complete skeletons.
- 6 mold trays - 2 for each complete dinosaur skeleton.
- Information about the dinosaurs featured in the kit.
- Instructions on how to use the mold trays.
- Reference diagram to consult while constructing each dinosaur.
- Glue to attach the skeleton pieces.
- Paint and paint brush to finish the skeleton.
- Suggested exercises and topics for class discussion.
- Bibliography.
- Suggested reading list.

MATERIALS NEEDED

- Disposable container to mix PerfectCast. A can or paper cup will work nicely.
- Mixing utensil.

WARNING: Don't place hand in casting material while it is hardening. Don't pour excess material into drain or toilet bowl. Dispose of excess material in garbage.

The students in your class are members of a team of paleontologists. They have just excavated a dig site with a remarkable number of interesting looking bones. It is their job to determine whether this new site is of any scientific importance. Is it worth further investigation?

Dinoworks can be used at two levels of difficulty. Level One is the simplest and will be the one most suitable for younger children. Level Two provides additional challenges for the more advanced students.

Regardless of the level of instruction, the students will enjoy the challenge of creating dinosaur skeletons. By learning to identify the bones of the three dinosaurs, the students will begin acquiring deductive skills necessary to piece together the puzzle of the dinosaur bones. The DinoWorks diagrams can be posted anytime to assist students having difficulty assembling the skeleton sections. Read the information on *Finding a Dinosaur Bone* and *Dinosaurs on Display* out loud to your class. Then refer to the directions on the level you have chosen for your students.

Level 1

1. The level of dexterity of children in grades 1-3 may not be adequate for the task of mixing and pouring PerfectCast. The teacher should mix and pour the mixture into the mold trays before class or be prepared to help the children.
2. Carefully take the pieces out of the molds and mark the back of each piece of the *Velociraptor* with the letter V, mark the pieces of the *Tyrannosaurus* with TY, and mark the *Triceratops* with TR.
3. The various skeletal parts can be painted a natural earth color to give the appearance of fossilized bone. Be certain the letters on the back of the pieces are easy for the children to identify. The students can group the pieces with the same letters together, creating three complete skeletons.
4. It may be desirable for very young children to paint the bones from each dinosaur bright colors for an easier method of identification.
5. Show the class the pictures of the assembled skeletons. Instruct them to arrange the pieces according to these pictures. Read the information about each dinosaur. Have the children draw what they think the dinosaurs would look like when they were alive. Discuss with the class the differences in the various dinosaur skeletons
6. Read the information in Finding a Dinosaur Bone, it may be necessary to simplify information for the appropriate age group.
7. After the students have seen what the skeletons look like when they are correctly assembled, hide the various parts around the classroom or have an assistant bury the pieces in a small area of the playground. This is their chance to be paleontologists. Instruct them to find all the pieces. As they are found, the pieces should be grouped together either by color or by matching the letters the on the back of each piece.
8. Read the information about Dinosaurs on Display.
9. The students should then attempt to assemble each skeleton properly.

Level 2

1. There are six mold trays, two for each dinosaur. Decide how much time you have to devote to this project, instruct the class accordingly. For instance, divide the class into three paleontological groups, one for each dinosaur. Each team will be responsible for casting, painting, assembling and displaying their respective dinosaurs.
2. Give each student copies of the information and casting instructions provided in this classroom kit. They should cast the dinosaur parts according to directions provided. The students should read the educational information on finding dinosaur bones and about the dinosaur on which they are working.
3. The three groups of students should give oral reports about their respective dinosaurs.

Casting Dinosaur Bones

Find an area with a flat, level, stable working surface, such as a counter-top, desktop or table. Make sure the surface is waterproof; some excess water may spill out of your container. Use a disposable container to mix the PerfectCast and water.

1. Place the mold tray on a flat, stable surface.
2. In a disposable container, mix PerfectCast using a ratio (by volume) of 1 part cold water to 3 parts PerfectCast
3. Stir the PerfectCast/water mixture with a spoon or mixing stick until it is evenly mixed (about 1½ minutes). Tap the container on the table several times to remove air bubbles. There should be no lumps.
4. Pour the PerfectCast mixture into the mold.

WARNING: Do not pour excess material into the drain or toilet bowl. Dispose of excess materials in the garbage.

5. Let PerfectCast set for 30 to 40 minutes.
6. After the mixture hardens, carefully press each part out of the mold. If a section should break, use glue to repair it or cast additional sections.
7. Read the information that explains the workings of a dinosaur dig.
8. Let casts dry for 2 hours before painting. Consult color suggestions listed further on in the literature for painting the casts. Separate the paint pots from each other with scissors before painting. Experiment with mixing paints on a palette or other surface to create the desirable colors. Adding a small amount of water to the paint will thin it for easier application as well as insure enough volume to cover the complete item.
9. Glue the sections on a background of your choice.
10. Consult the diagram of the completed skeleton and arrange pieces accordingly.

Finding a Dinosaur Bone

Imagine you are hiking in the badlands of South Dakota with a group of friends and you trip over a rock. As you struggle to regain your balance, you notice that what you tripped over was not a rock at all. Upon closer inspection, you realize, with increasing excitement, that this “rock” looks much like the bone of a very large animal. Could it be the bone of an ancient dinosaur? What should you do? You want to pick it up and take it home, but should you? What is the harm?

Finding a dinosaur bone is indeed an exciting experience. Many people, upon finding such a unique fossil, would not hesitate to take it home to add it to their collections. The temptation is very great. But removing the fossil from the spot you found it would cause a loss of valuable scientific information. Following up a find of even one bone could lead to the unearthing of a whole dinosaur skeleton, and to the discovery of valuable information about what that dinosaur was like and what it did when it was alive millions of years ago.

Should you be lucky enough to find a fossil bone, it would be best to contact a professional paleontologist. He or she will carefully and systematically excavate the area for more bones and chart the position of each bone found. If necessary, the paleontologist will assemble a team of skilled amateurs and professionals experienced in conducting a systematic search of the area. Armed with a knowledge of geology and dinosaur anatomy, they will prospect the area to determine where the rest of the bones, if any, might be buried.

The bones of a single dinosaur skeleton all generally lie at the same level in the rock. Should the team find such a skeleton, they might need to bring in heavy equipment to remove tons of overlying rock and sediment “overburden.” After most of the “overburden” is removed with pneumatic drills and explosives, the team will work carefully with fine tools to expose the bones. Then, as each bone is uncovered, the team will carefully chart and record its location on a map. The site will be photographed to back up the map’s information. Such photos and maps are essential to the excavation; they permanently record how the skeleton was preserved in rock. This information can later be used to determine how the animal died, whether its skeleton was scavenged, and how it was transported and finally buried.

Each bone will then be carefully jacketed (encased) in plaster for transport to a museum’s laboratory. Once the bones arrive, delicate work will remove the protective coating and remaining rock from the specimen. It may take days to completely clean just a single bone. The bones will then be laid out and compared with field sketches, maps, photographs, and descriptions of known dinosaurs to securely determine their identities. Finally, it will become the paleontologists’ job to identify the dinosaur and perhaps to fit its bones back together for public display.

THE DINOSAUR SKELETON

Fitting a skeleton together is a challenging job but one of the most rewarding tasks for a paleontologist. If most of the bones of the skeleton have been found, the task of identifying it is quite routine. The paleontologist can look at diagrams of known dinosaurs to determine if the skeleton on which he or she is working resembles any known dinosaur. No matter what size, all dinosaurs have many similar features. They all have thigh bones (femurs), shoulder blades (scapulas), and backbones (vertebrae). Armed with that knowledge, paleontologists know where to begin. The shape of the bones in the pelvis will reveal whether the dinosaur was a member of the order Saurischia, “lizard hipped”, or the order Ornithischia, “bird-hipped”. Once it is determined to which order the dinosaur belonged, the paleontologists can make a number of assumptions regarding that particular dinosaur. Dinosaurs in the order Ornithischia are most often bipedal (walk on two hind legs) and are meat eaters (therapods). Dinosaurs in the order Ornithischia walk on four legs and are plant eaters (saurapods).

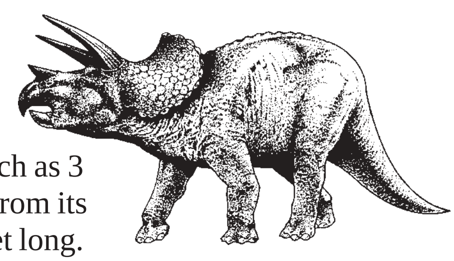
Dinosaurs on Display

By studying complete dinosaur skeletons, paleontologists know where to place each bone. No matter what size, all dinosaurs have many similar features. They all have thigh bones (femurs), shoulder blades (scapulas) and backbones (vertebrae). Armed with that knowledge, paleontologists at least know where to begin. But every so often, mistakes have been made in the reconstruction of a skeleton. As more information is learned about a particular dinosaur these mistakes can be corrected.

Mounting even a medium-size dinosaur skeleton for display is a very large undertaking. Once the entire skeleton is laid out and the position of each bone is determined, the experts are ready to reconstruct or "mount" the dinosaur. Because many dinosaur bones are so heavy, it is very important to create a strong base on which to secure the skeleton. Strips and pillars of steel are constructed for support. In some cases strong, transparent wires suspend from the display room ceiling to hold up parts of the skeleton. When the bones are finally in place, the steel supports and strings will be very hard to see. The dinosaur will look as if it is standing on its own.

Triceratops

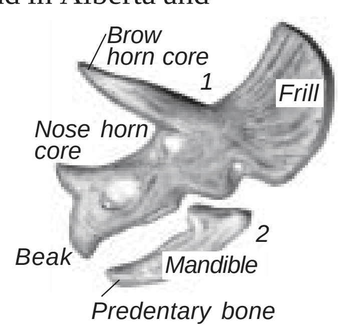
The *Triceratops* is one of the most easily recognized dinosaurs. Its Greek name, when translated to English, means "three (tri), horn (Keratos), face (ops)." Oddly enough, the first fossils found of this dinosaur were the remains of two horns, which at first were thought to be the remains of a bison. As you can imagine it is very difficult to correctly identify a dinosaur from a badly incomplete skeleton. Only when the additional remains were found was it determined to be a *Triceratops.*



Triceratops was enormous. The horns above its eyes were as much as 3 feet long; the frill on the back of its head was up to 7 feet wide! From its nose to the tip of its tail, this awesome creature was at least 25 feet long. Some paleontologists speculate that *Triceratops* used its horns and frill to defend itself against predators such as *Tyrannosaurus.* It may also have used them for fighting with other *Triceratops* for territory or to win mates.

Triceratops was an herbivore (plant eater). Its sharply pointed teeth did not crush or grind ordinary leafy tissue, seeds or fruit. Instead its powerful jaw muscles worked the teeth like cutting blades. It is thought that *Triceratops* consumed fibrous plants, such as palm fronds, by slicing them up with their teeth.

The Triceratops lived during the very end of the late Cretaceous period (68 to 65 million years ago). In the United States, plentiful remains of this fascinating dinosaur are found in Colorado, Wyoming, Montana and South Dakota. In Canada, *Triceratops* are found in Alberta and Saskatchewan.



Skull

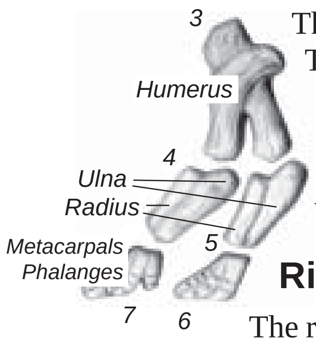
The skulls have a short nose horn core as well as two long brow horn cores. When *Triceratops* was alive, the horn cores were covered by horns. The horns of dinosaurs were made of a protein substance that disintegrates when exposed to the environment. Unfortunately, the true horns are never preserved. It is thought that the horns were used for self-defense.

It had a large frill pointing back from the skull. This structure helped to support the huge jaw muscles and protected the neck. It had a long narrow snout with a hooked beak which was used for snipping off tough, fibrous plants. It had no teeth in the front of the mouth but had scissor-like teeth in the cheek area.

Neck

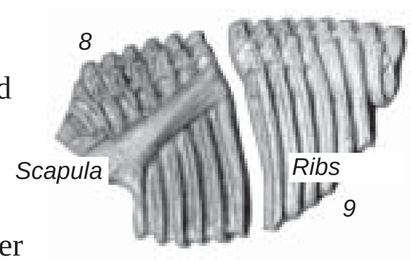
To support its heavy skull, *Triceratops'* neck had to be extremely strong. The first four vertebrae behind the skull were fused together to make one solid bone. This section of the vertebral column is called the syncervical.

Shoulders, arms, and feet



Triceratops had massive shoulders and leg bones to support its gigantic body. The two main shoulder bones were large and fit tightly together for strength. The sturdy humerus was attached at the shoulder joint. The ulna and radius were attached at the elbow joint. The metacarpals (hands) were attached at the wrist joint. There were five phalanges (toes) on both front feet. The first three toes had small hoof bones on the end. The front legs were shorter than the hind limbs.

Ribs

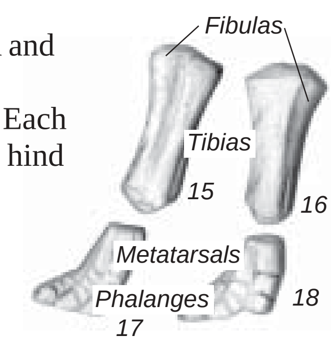


The rib cage was large and deep. It curved around *Triceratops'* middle to protect its vital organs.

Pelvic Girdle

The pelvic girdle was comprised of two sets of three bones on either side of the backbone; a long shelflike bone called the ilium, a long backward slanting bone called the ischium, and a foreword slanting bone called the pubis. The pelvic girdle was attached to the backbone at the sacral area. This attachment of the backbone to the hips was very secure. Ten vertebrae were fused together at the ilium. There were a number of bony rods above the hip area to further strengthen that area.

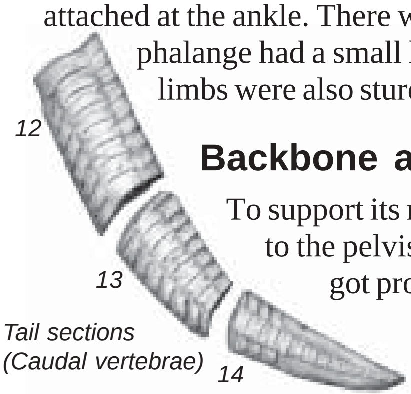
Hind legs



The large femurs were attached to the pelvis at the pelvic girdle. The tibia and fibula were attached to the femur at the knee. The metatarsals (feet) were attached at the ankle. There were four phalanges (toes) on both hind feet. Each phalange had a small hoof bone on its end. Like the forelimbs, the hind limbs were also sturdy.

Backbone and tail

To support its massive weight, ten vertebrae were joined to the pelvis. The tail was made up of vertebrae which got progressively smaller toward the end of the tail.



TRICERATOPS GUIDE

Bones of fossils like the *Triceratops* skeleton take on the color of the minerals contained in the soil in which the fossils are found. In the case of *Triceratops*, many skeletons excavated are reddish brown in color. Experiment with mixing paints for desired color. Add a small amount of water to make application easier.

Velociraptor

This small, carnivorous (meat-eating) dinosaur was one of the principal characters in the very popular movie "Jurassic Park". The size of a wolf, it was very fast and smart; but in reality, *Velociraptor* was certainly not as smart as the ones portrayed in the movie.

The name *Velociraptor* derives from Latin and means, velox "swift (velox) robber (*raptor*)." The distinguishing feature of the *Velociraptor* was the sickle-like claw on its second toe of each foot. These small dinosaurs may have hunted larger prey in packs. They would hold the victim with their long fingers while slashing with sickle claws on their feet. They had long, narrow mouths and many sharp teeth with which to eat their prey. *Velociraptor* had relatively large eye sockets, which leads scientist to believe that this dinosaur had extremely good eye sight, perhaps even night vision for hunting at dawn or dusk.

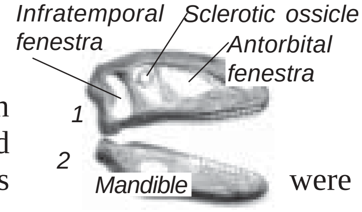
Velociraptor lived during the middle of the late Cretaceous period (85 to 80 million years ago). Skeletons of this rare dinosaur have been found in Mongolia, China and perhaps Russia.

Deinonychus

A close relative of *Velociraptor, Deinonychus antirrohopus* inhabited the Early Cretaceous landscape 100 to 135 million years ago and is classified as a therapod dinosaur along with *Allosaurus* and *Tyrannosaurus*. A smaller dinosaur at about 3½ feet tall and 8 feet in length, *Deinonychus* was a quick, agile, and aggressive birdlike predator that probably hunted in packs. Its mouth was full of sharp, knifelike teeth, but most impressive is the large, sickle-like retractable talon on each foot; the "terrible claw" that gives *Deinonychus* its name. The first *Deinonychus* fossils collected by the Yale Peabody Museum were found in Montana by John H. Ostrom in the 1960s.

Velociraptor and *Deinonychus* were both dromaeosaurids. The best example of the dromaeosaurid type is *Deinonychus*. It is considered one of the most complete skeletons of a dromaeosaurid ever found. The remains of this skeleton were so well preserved and described by John Ostrum that it is often used to describe the skeletal anatomy of *Velociraptor*. The most striking difference between these two dromaeosaurids is in the skull. *Velociraptor's* skull is depressed, while the skull of *Deinonychus* is more rounded on top. The following is a description of the *Deinonychus* skull and skeleton.

Skull



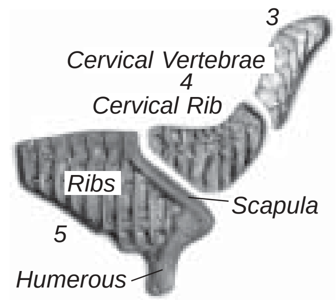
Deinonychus had a rather large skull. There were large openings on each side for the eyes and the muscle attachments. The bones in the head were arranged to make the skull both strong and light. The eye sockets were large and contain a bony ring (sclerotic ossicle) which supported each eyeball. *Deinonychus's* sharp teeth curved backward. The shape of these teeth confirm the theory that this dinosaur could tear off large chunks of flesh of its prey.

Neck

The neck consisted of a series of cervical vertebrae (bony segments which compose the backbone) . It was slender and flexible, giving the head a wide range of movement.

Shoulders, arms, and claws

The arms of *Deinonychus* were relatively long for a bipedal dinosaur. The humerus was broad and had evidence of powerful shoulder muscle attachments. It is thought that the strength of the shoulders and arms enabled the dinosaur to grab and hold on to its struggling prey. *Deinonychus* had three exceptionally sharp claws on each of his "hands."

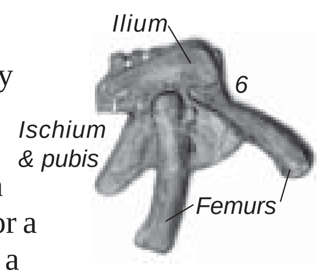


Ribs

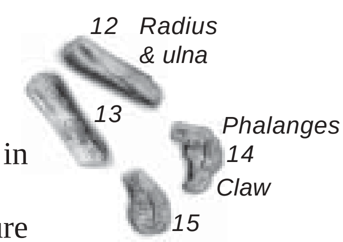
The ribs were arranged to protect the internal organs of *Deinonychus*.

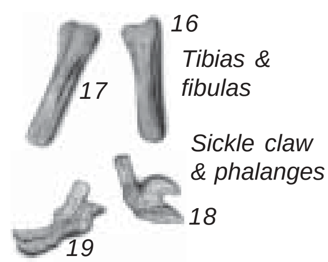
Pelvic girdle

The large, blade-like upper bone, or ilium, is connected to the backbone by a strong row of ribs. The lower edge of the ilium formed the upper edge of the hip socket. The ischium was located beneath the ilium and pointed down and backward. In the case of *Deinonychus,* the pubis bone has been a source of confusion. When first reconstructed, the pubis was mistaken for a shoulder bone. It is now known that it should be placed under the ilium in a backward slanting position.

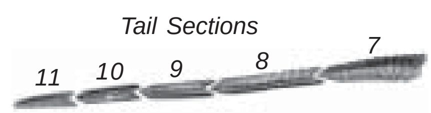


Legs, feet, and claws





Deinonychus was built for speed! The femur is shorter than the two lower bones (tibia and fibula). This is a common feature in animals capable of running very fast. The unique hind feet of *Deinonychus* are a feature typical of dromaeosaurids. Although it had four toes on each hind foot, the second toe was most striking. The claw on the second toe was enormous! The joint of this toe was enlarged so that the toe could be be raised up and backward while running. Because the first toe was small and could not touch the ground, the third and the fourth toe were the only toes used for running. When *Deinonychus* was in attack mode, the claws could be flicked forward to slash and kill its prey.



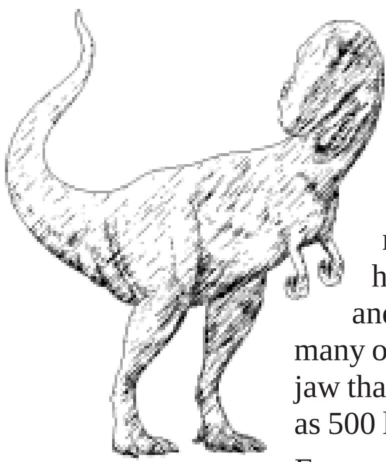
Tail

The last three quarters of the tail was held rigid by powerful ligaments and muscles. When *Deinonychus* ran and walked, its tail was held stiffly and straight out back. *Deinonychus* used its long stiff tail to maintain its balance. It is thought that the tail was also used as a rudder to help change directions quickly.

VELOCIRAPTOR COLOR GUIDE

Bones of fossils like the *Velociraptor* skeleton take on the color of the minerals contained in the soil in which the fossils are found. In the case of *Velociraptor*, many skeletons excavated are reddish brown in color. Experiment with mixing paints for desired color. Add a small amount of water to make application easier.

Tyrannosaurus



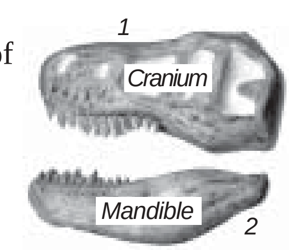
Tyrannosaurus rex is without a doubt the most famous and popular of all dinosaurs. On land it was the most powerful and largest carnivore (meat eater) that ever lived. A large *Tyrannosaurus rex* would measure more than 40 feet long. The name *Tyrannosaurus* comes from Greek, meaning “tyrant (*tyrannos*) lizard (*saurus*).”

The skull of *Tyrannosaurus rex* was enormous; large ones measured nearly 5 feet long. The jaws were massive and contained huge, thick teeth. Some teeth were 11 inches long from root to tip, and were serrated and able to punch through meat and bone. Like many of its relatives, *Tyrannosaurus rex* had a movable joint in the lower jaw that allowed it to open its massive jaws wide enough to rip off as much as 500 lbs of meat in one bite.

From studying the skull, scientists think that *Tyrannosaurus rex* had keen eye sight, good hearing and a strong sense of smell. *Tyrannosaurus rex* was a skilled hunter. Its massive hind legs were very powerful and allowed it to run as fast as 25 miles per hour. It could chase down any prey it might desire, holding the victim with its claws while devouring it with its large mouth. The arms and hands of *Tyrannosaurus rex* were about a yard long—small in comparison with the huge body, but actually very strong!

Tyrannosaurus rex lived during the Late Cretaceous period (68 to 65 millions years ago). Its remains are found in Montana, Wyoming, Colorado, New Mexico, South Dakota and Western Canada.

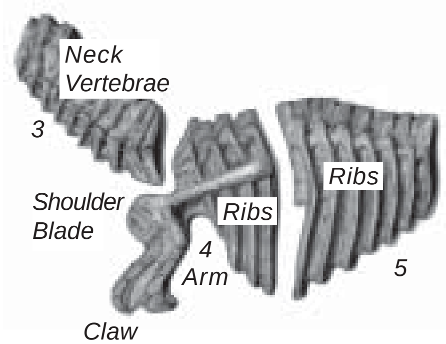
Skull



The skull of a full-size *Tyrannosaurus* is huge and very heavy. The largest of these dinosaurs had skulls that measured nearly 5 feet long. This dinosaur had large and strong muscles in the head for chewing. There are cavities located in front of and behind the eye sockets of the skull. These cavities minimize the weight of the skull and also provide space for large, powerful jaw muscles.

The teeth of the *Tyrannosaurus* are enormous! Some teeth were 11 inches long from root to tip. Each tooth was serrated like a steak knife. There was an extra joint on each side of the jaw to accommodate large bites of large animals.

Neck



The neck of *Tyrannosaurus* was relatively short but flexible and powerful. It had to be strong to hold up such a huge head. Its powerful muscles assisted in ripping the flesh from its prey.

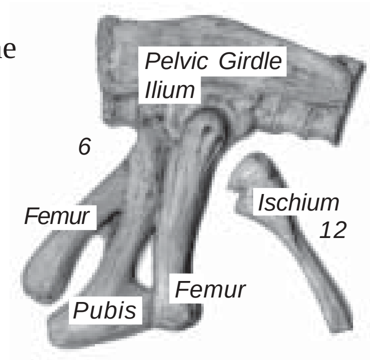
Shoulders, arms, and claws

The arms of *Tyrannosaurus* were short. They were also used to help push him up from a resting position. He had two claws on each of his "hands." They were used to hold on to his prey while eating.

Ribs

Long ribs pointing downward curve around the belly and help hold the backbone in position against the great weight of the belly. They also protect the internal organs of the animal.

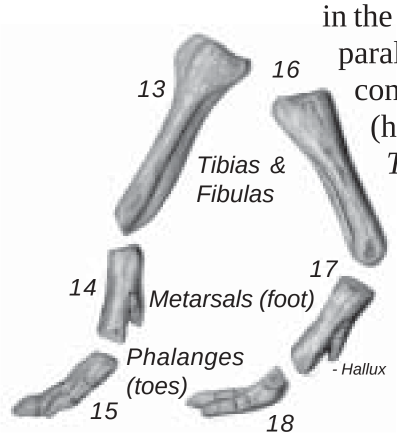
Pelvic girdle



The pelvic girdle is comprised of 2 sets of 3 bones on either side of the backbone. The large, blade-like upper bone, or ilium, is connected to the backbone by a strong row of ribs. The lower edge of the ilium formed the upper edge of the hip socket. The pubis, located beneath the ilium, is pointed down and slightly forward, and the ischium extends backward. The powerful leg muscles are attached to each of these bones. This pelvic girdle is typical of a Saurischian (lizard-hip).

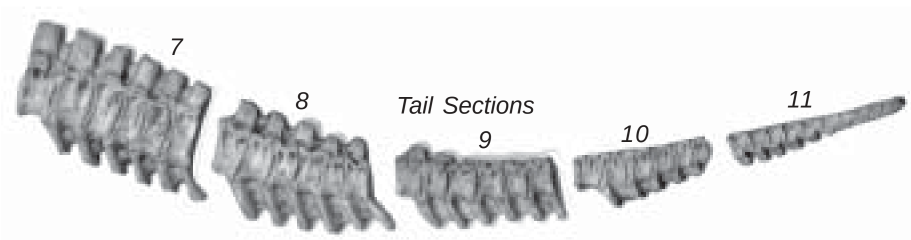
Legs, feet, and claws

The thigh bones are built for strength. The tibia and fibula are located below each knee. The bones in the feet are securely fixed together and point down rather than being parallel to the ground. The feet are narrow and the toes slender, consisting of just three forward-pointing toes and a fourth short toe (hallux) which is located at the back of the foot. The footprint of the *Tyrannosaurus* is birdlike.



Backbone and tail

The *Tyrannosaurus* had a massive backbone structure to support the enormous weight of the neck, tail, and belly. The bones in the vertebrae were hollow for lightness. Narrow spines, pointing upward from the top of the backbone, acted as anchor points for



the powerful back muscles.

The tail provided an anchoring point for the attachment of the large leg-moving muscles, running from the sides of the tail. The tail was also used as a balance against the huge weight of the head.

TREX COLOR GUIDE

Bones of fossils like the *Tyrannosaurus* skeleton take on the color of the minerals contained in the soil in which the fossils are found. In the case of *Tyrannosaurus* , many skeletons excavated are reddish brown in color. Experiment with mixing paints for desired color. Add a small amount of water to make application easier.

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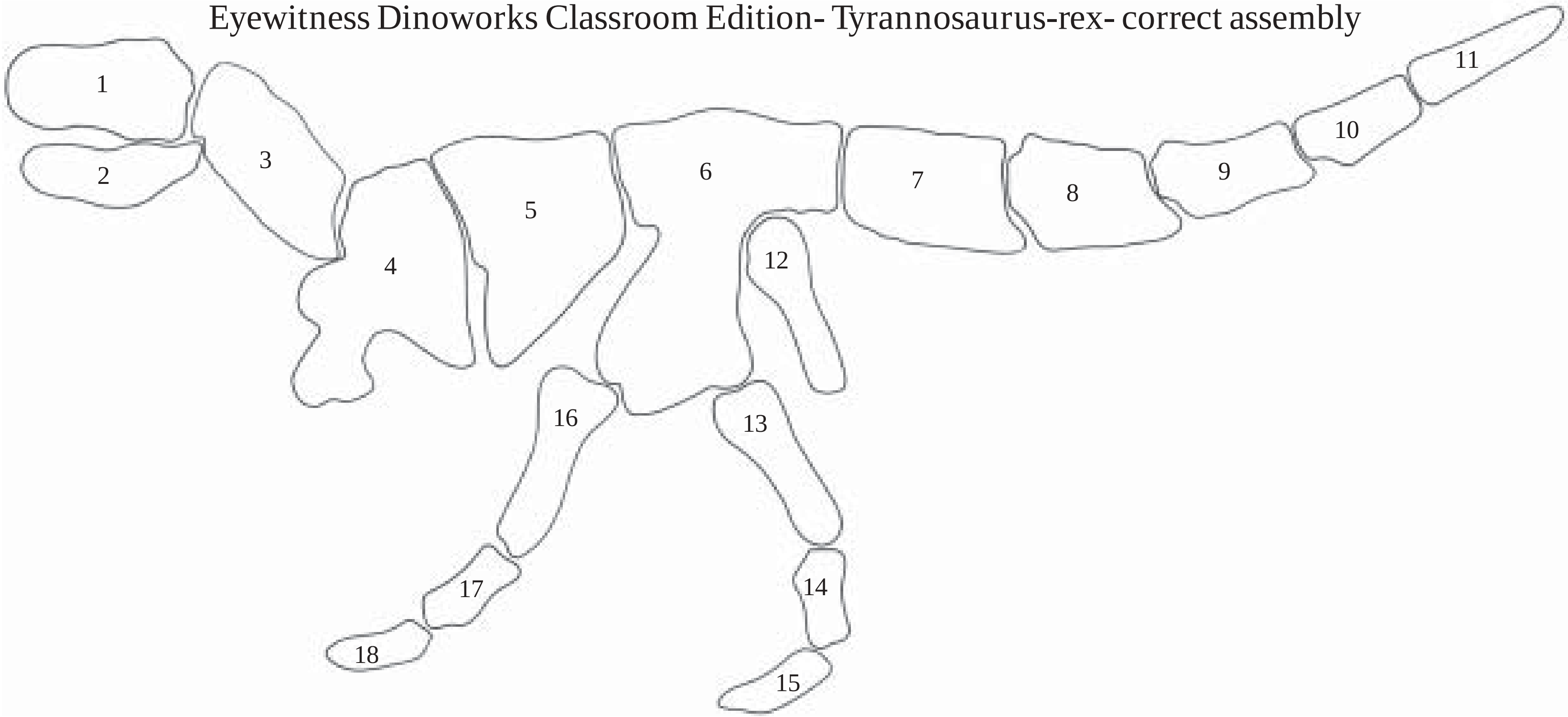
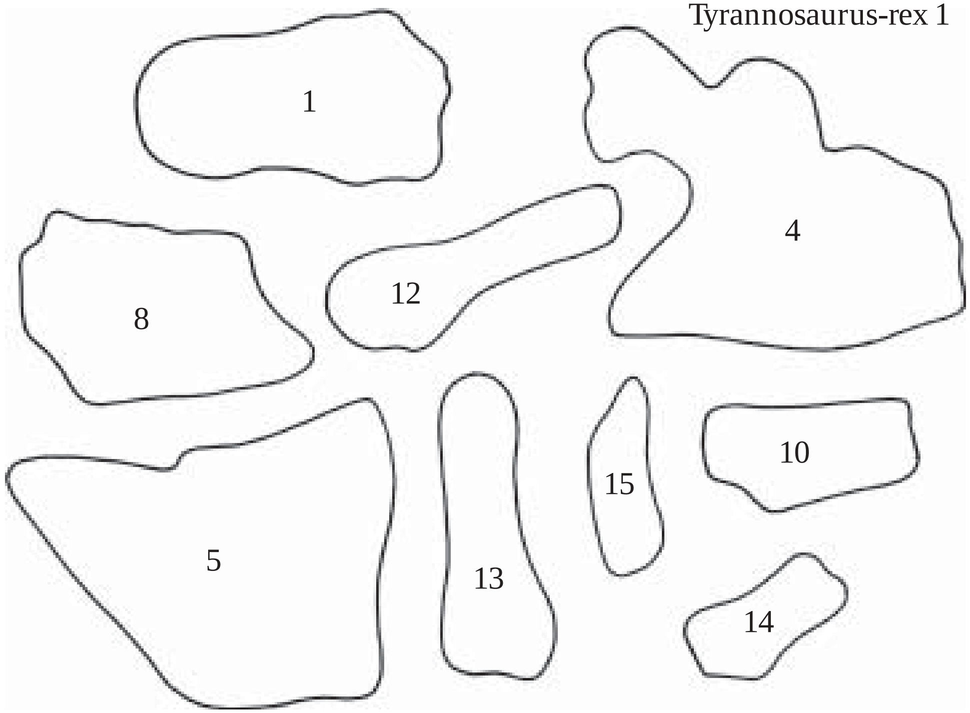
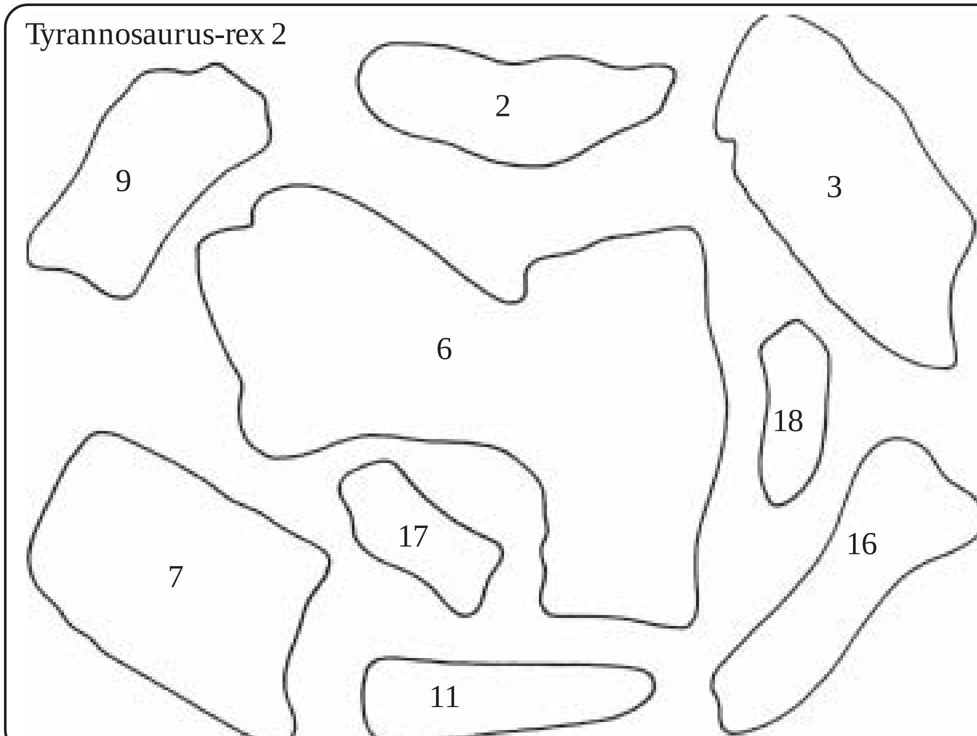
Eyewitness Dinoworks Classroom Edition- Tyrannosaurus-rex- correct assembly



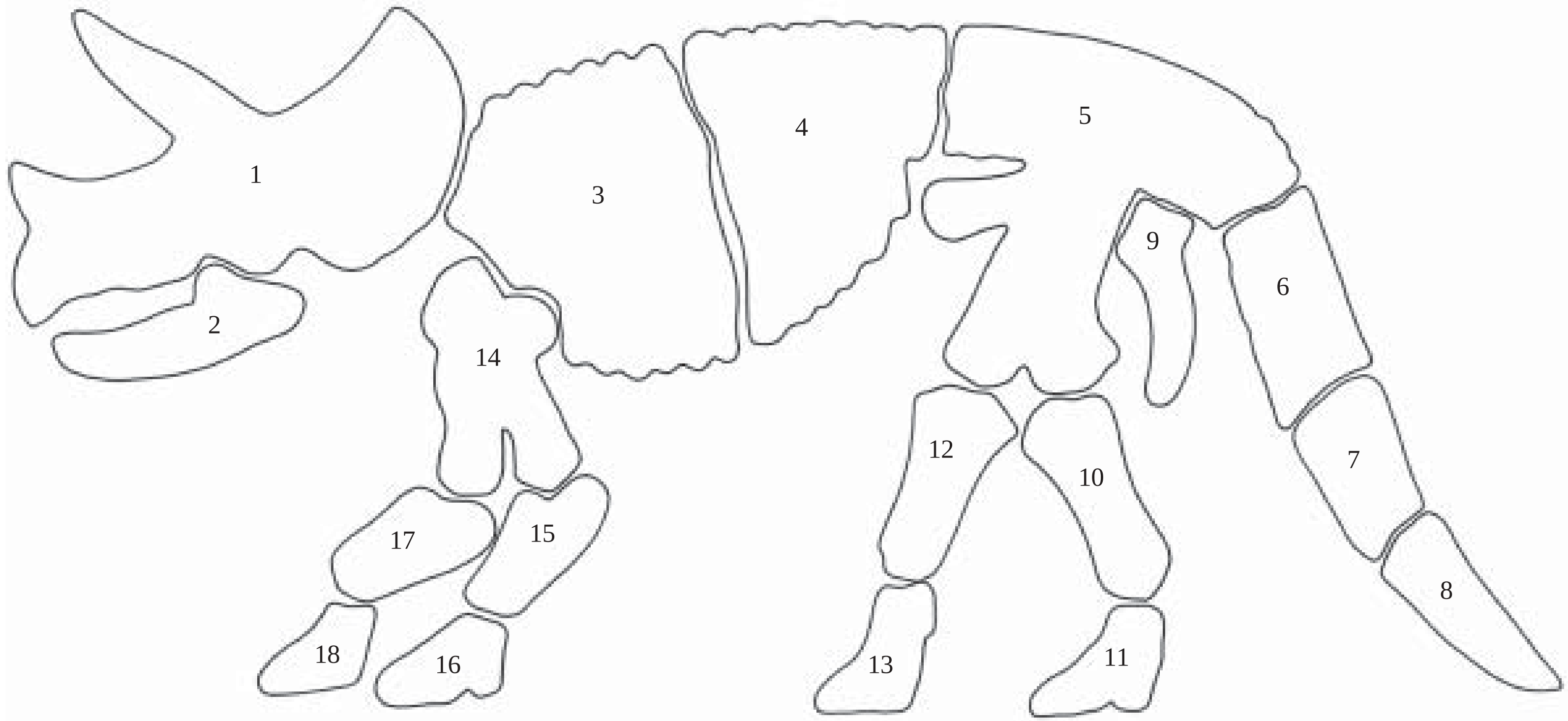
Tyrannosaurus-rex 1

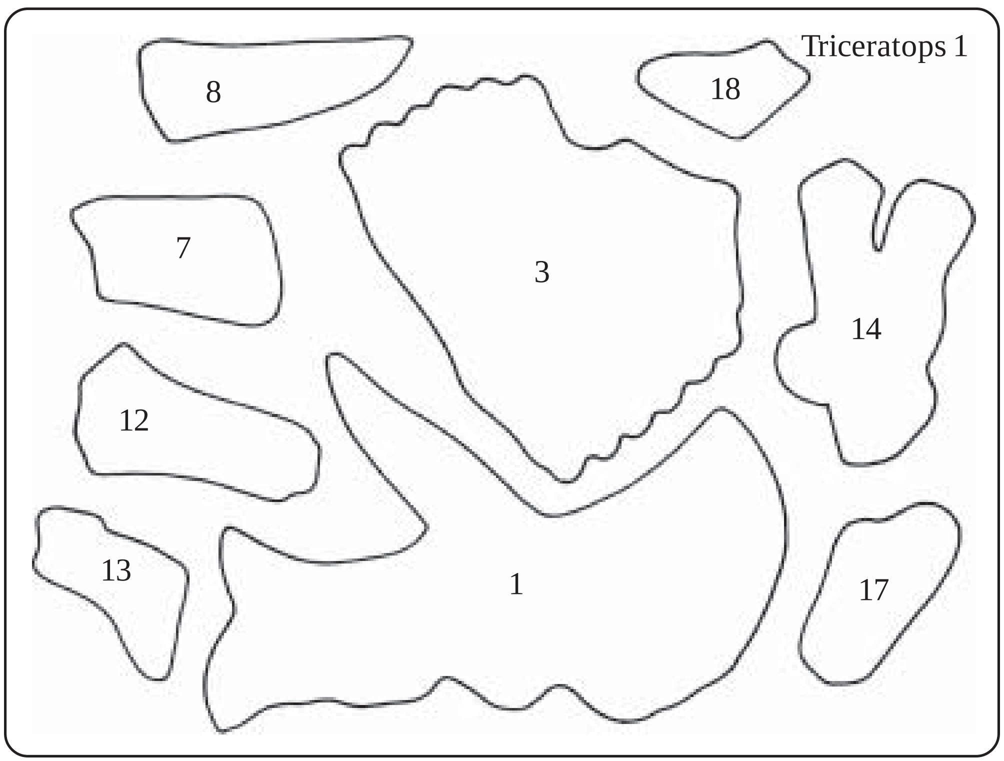


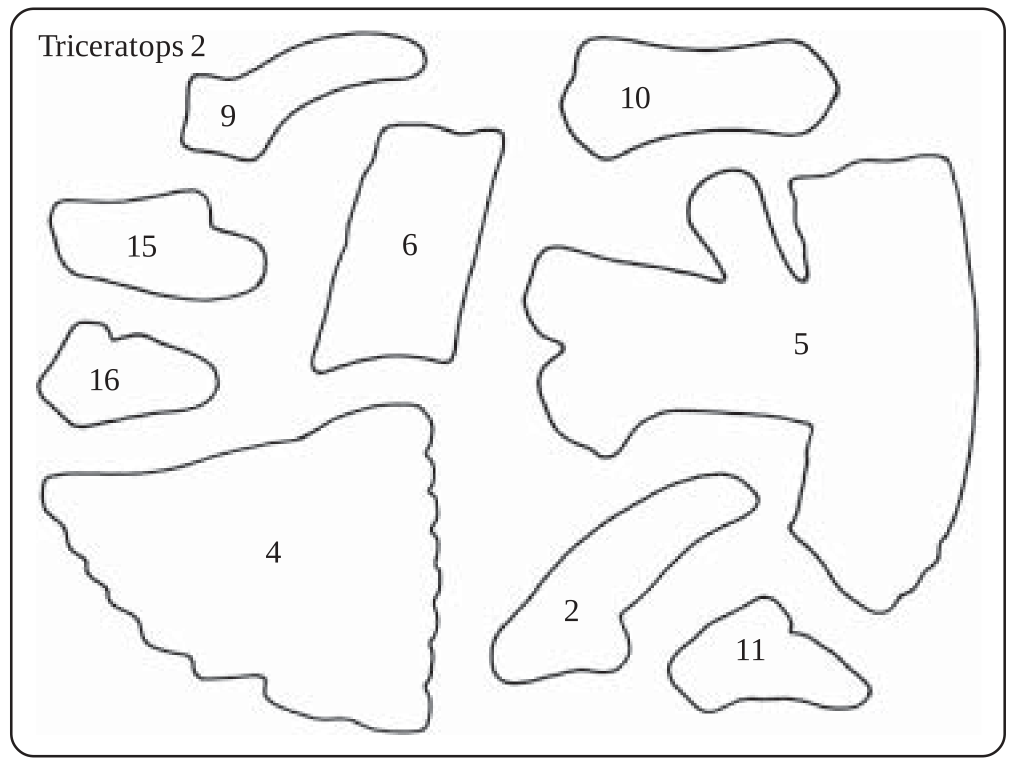
Tyrannosaurus-rex 2



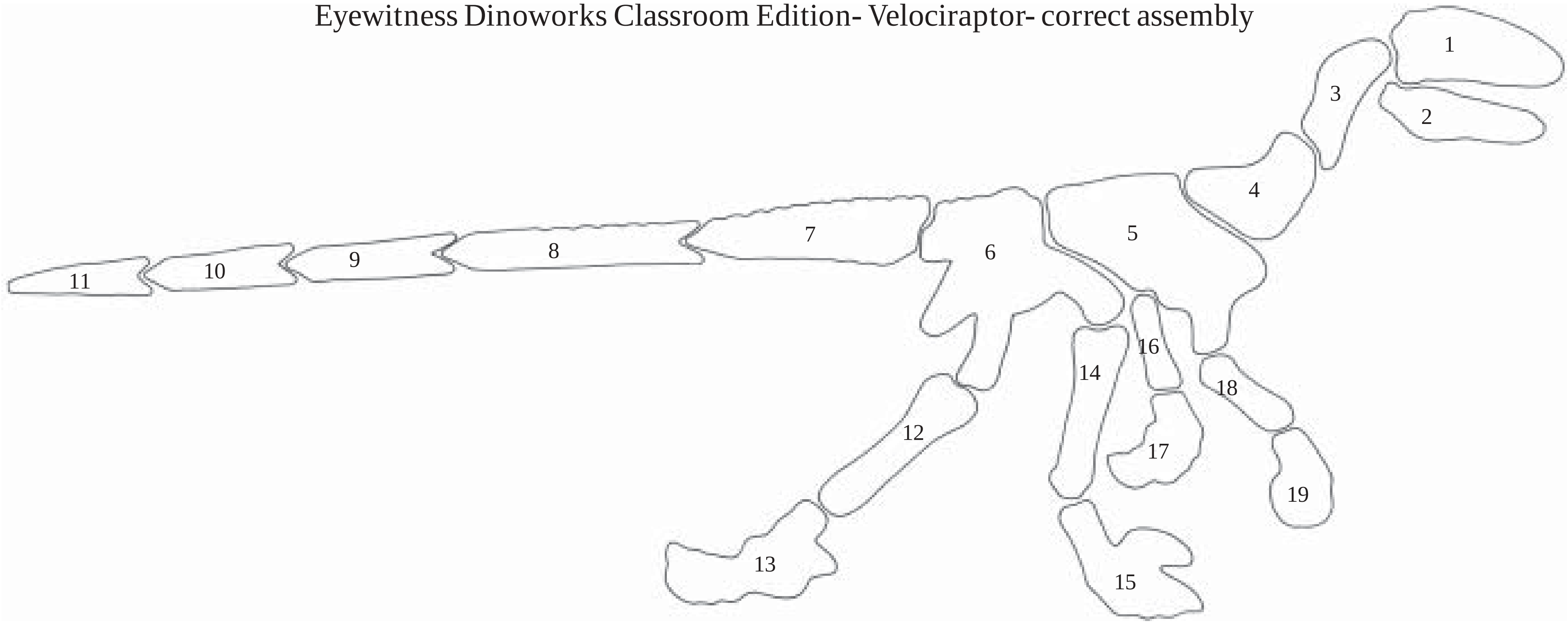
Eyewitness Dinoworks Classroom Edition- Triceratops- correct assembly

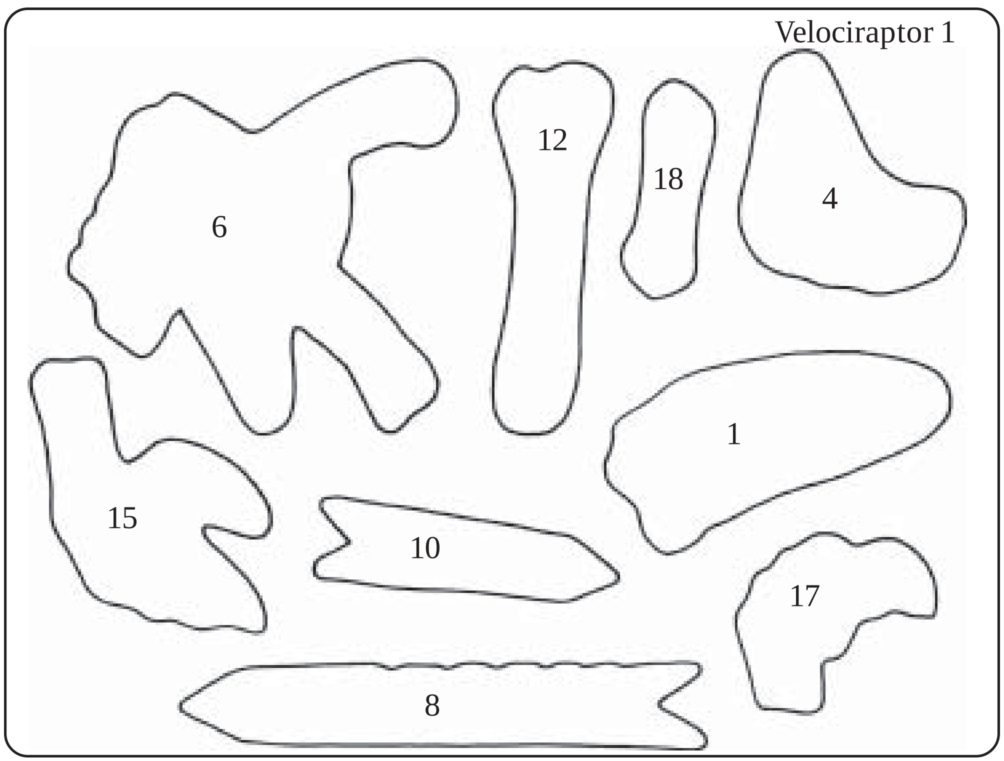


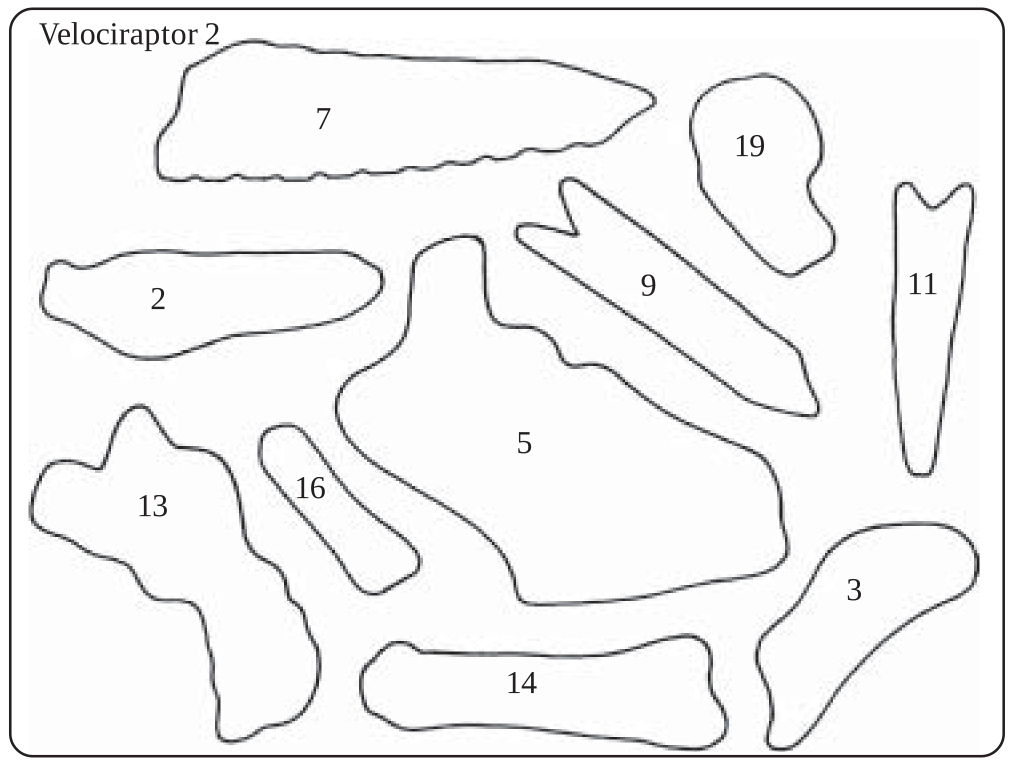




Eyewitness Dinoworks Classroom Edition- Velociraptor- correct assembly







EYEWTINESS CLASSROOM EDITION

Suggestions for Paleontology team make-up

30 Students

- **10 Students** Tyrannosaurus-rex
  - **5 Students** T-rex 1
  - **5 Students** T-rex 2
- **10 Students** Velociraptor
  - **5 Students** Velo. 1
  - **5 Students** Velo. 2
- **10 Students** Triceratops
  - **5 Students** Tri. 1
  - **5 Students** Tri. 2

24 Students

- **8 Students** Tyrannosaurus-rex
  - **4 Students** T-rex 1
  - **4 Students** T-rex 2
- **8 Students** Velociraptor
  - **4 Students** Velo. 1
  - **4 Students** Velo. 2
- **8 Students** Triceratops
  - **4 Students** Tri. 1
  - **4 Students** Tri. 2

18 Students

- **6 Students** Tyrannosaurus-rex
  - **3 Students** T-rex 1
  - **3 Students** T-rex 2
- **6 Students** Velociraptor
  - **3 Students** Velo. 1
  - **3 Students** Velo. 2
- **6 Students** Triceratops
  - **3 Students** Tri. 1
  - **3 Students** Tri. 2