# tiny TITANS
## dinosaur eggs and babies

# Educator's Guide

# Table of Contents

# Educator's Guide Sections

National Science Education Standards are available at the following website http://www.nap.edu/readingroom/books/nses/html/

This Educator's Guide includes the following standards;
- National Standards
- Colorado Model Content Standards
- Connecticut Curriculum Connections
- New Jersey Core Curriculum Content Standards for Science
- Arizona State Teaching Standards

*All teaching standards can be found at the end of this booklet.

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## Introduction

Learn the basics of paleontology and oology (the study of eggs) with fun facts and trivia.

## Dinosaur Sections

The exhibit is divide into six sections that each feature a family of dinosaurs; Ceratopsian, Sauropod, Ornithopod, Theropod, Giant Oviraptor, and an enigma. Learn about the characteristics of each family, what size and shape eggs did they lay, how did they care for their young, where and how did they live.

## Classroom Projects

Explore the educational possibilities of some "egg-tivities" and "egg-speriments" designed for classroom use. The activities on pages 12-24 are best used before visiting the exhibit, the activities on pages 25-66 are can be used before or after, and the activities on pages 20-36 can be used after visiting the exhibit.

# Introduction

Students will use the study of dinosaur eggs to exercise their reasoning and creative abilities to formulate ideas about how we know about dinosaurs, when they lived, how they cared for their young, and the adaptations that enabled them to survive. They can use their insights to think about the adaptations that equip modern egg laying animals for survival in the various environmental conditions that exist today.

- **Paleontologists** study fossil plants and animals.
- **Paleontologists** draw conclusions about dinosaur family life from studying **"life assemblages"** that preserve the behavior of the animal at the moment of its death.
    a. Were Dinosaurs social animals?
    b. Did they care for their young?
    c. What was life like for baby dinosaurs?
- Dinosaur eggs are **fossilized**, and very rarely, some contain **fossilized** baby dinosaurs.
- Some dinosaurs were **Altricial** needing intense parental care when they hatched.
- Some dinosaurs were **Precocial**, ready to fend for themselves when they hatched.
- Dinosaurs were on the earth during the **Mesozoic** era –middle time.
- Mesozoic era includes the **Triassic**, **Jurassic** and **Cretaceous** periods

Words formatted with an underline are listed on the Dinosaur Names page with a brief description.

Words formatted in **Bold** text can be found on the Vocabulary page.

# Myths Uncovered

## Common misconceptions about dinosaurs and eggs.

**Myth** - Giant dinosaurs laid giant dinosaur eggs.

**Truth** - Even though dinosaurs grow up big, they start out small. The largest round dinosaur eggs are the size of a bowling ball. The largest elongated dinosaur eggs are the size of a loaf of french bread. Most dinosaur eggs are much smaller and all are very small compared with the adults.

**Myth** - All dinosaurs lived at the same time.

**Truth** - Different dinosaurs lived at different times; these times were broken up into three geological time periods (Triassic, Jurassic, and Cretaceous), which have about 5-10 million years between them.

**Myth** - Archaeologists dig up dinosaurs.

**Truth** - Archaeology is a branch of Anthropology, which is the study of humans, so they do not dig up dinosaurs; however paleontologists do. Paleontology is the study of ancient life, which includes fossils.

**Myth** - All fossils are dinosaurs.

**Truth** - There are many different types of fossils including dinosaurs, animals with and without backbones, and plants.

**Myth** - If an egg is unhatched then there must be a embryo inside.

**Truth** - There are many reasons why many unhatched eggs do not have embryos. Eggs can only survive in a narrow window of temperature and moisture, any changes in this mean that the baby won't develop. Not all eggs have been fertilized. In the case of dinosaur eggs, the egg may have been fossilized too early in development to have bones sturdy enough to be fossilized.

Q: Which dinosaur slept all day ?
A: The dino-snore!

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# Dinosaur Facts

**Fun facts for a background of dinosaur life and discovery.**

- The word "Dinosaur" is from the Greek word for "terrible lizard". This may be confusing because dinosaurs are not **lizards**. The name "Dinosaur" was given by the first scientists who found the fossil bones of these large animals. They did not know that what they had discovered was really its own class of **reptile**.
- There are more than 1,000 different kinds of dinosaurs.
- Crocodiles and alligators are **reptiles** that have been around since the time of the dinosaurs, and their appearance has not changed much in all that time.
- Dinosaurs were **reptiles**, different from the **reptiles** of today, such as **lizards** and turtles. Some dinosaurs are more closely related to birds.
- Dinosaurs are separated from reptiles because of their hip structure. Their legs do not stick out to the side as **lizards** do; instead, dinosaur legs are positioned straight under their bodies like horses.
- No one knows what color dinosaurs were. Colors are not preserved in the fossil record. They could have been blue, or pink with purple spots. It most likely depends on if they wanted to blend in or stand out in their habitat.
- Dinosaurs were generally named after a characteristic body feature such as the place where they were found, or after a person involved in the discovery.
- Fossil discoveries reveal that dinosaurs lived from late in the **Triassic** Period (225 mya) until the end of the **Cretaceous** Period (65 mya).
- Dinosaurs varied in size. *Brachiosaurus* was one of the largest at over 100 feet long and up to 50 feet tall. *Compsognathus* was one of the smallest at 2 feet long.
- Dinosaurs, such as *Velociraptor*, were considered to be quite speedy, while others, like *Ankylosaurus*, were probably slow.
- There are several theories of how dinosaurs became extinct; here are three:
    1.) Egg-eating **mammals** ate all the dinosaurs' eggs.
    2.) A large **meteor** hit the earth and wiped out the dinosaurs.
    3.) Increased volcanic activity destroyed the dinosaurs' environment.
- Dinosaurs laid eggs like modern birds, **lizards**, crocodiles, and others.
- A new dinosaur is found approximately every 7 weeks, but it may take two years or more to get it officially named.

# Egg Facts

## Background on modern eggs of all kinds.

- **Oology** (pronunciation: oo AH lo gee) is the study of eggs.
- Anatomy of an egg.

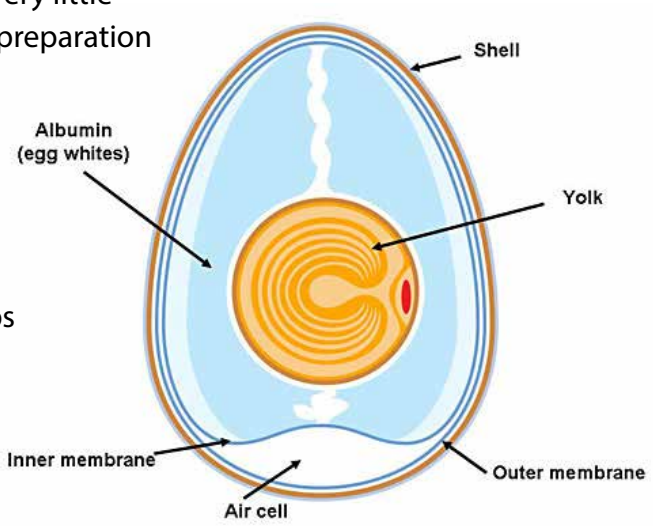
  - **Albumen**: Egg white, contains almost no fat and very little carbohydrates because of this they are used in the preparation of vaccines. The white provides cushioning for the growing **embryo**.

  - **Vitellus**: Yolk, contains most of the vitamins present in an egg, also one of the few foods that naturally contain vitamin D.

  - **Membrane**: Present just inside the egg shell. Helps protect the egg from bacterial invasion.

  - Eggshell: May have as many as 17,000 tiny pores over its surface that allow oxygen in and carbon dioxide out. Maintains the moisture of the interior and protects the growing animal.

  - **Embryo**: The baby that will grow from the red dot (above) or **germinal disc**.




- The **Amniotic egg** is an egg laid on land, it is able to breath, contain water, and remove waste.
- The eggshells of large birds (such as an ostrich) and dinosaurs are quite robust, consisting of several layers of minerals which lends them to fossilization.
- The colors, shapes, sizes, and textures of eggs vary, even with eggs laid by the same mother.
- Hens with white feathers and white earlobes produce white shelled eggs and hens with red feathers and red earlobes produce brown shelled eggs.
- Eggs cannot be infinitely large, not even dinosaur eggs. As eggs get larger, the shells must get thicker so they are strong enough to hold the **embryo**. The thicker the shell, the more difficult the gas and moisture exchange. If the shell is too thick the **embryo** will suffocate.
- Scientists classify eggs of different animals according to size and shape of the egg, and the thickness and texture of the eggshell.
- Some reptile eggs are soft and leathery like turtles, but others have hard shells like birds.
- Spin an egg to tell if an egg is raw or hard cooked. If the egg spins easily, it's hard cooked. If it wobbles, it is raw.
- Living creatures that lay shelled eggs include:

  - Turtles, alligators, crocodiles, birds, platypuses, spiny anteaters, and most snakes.

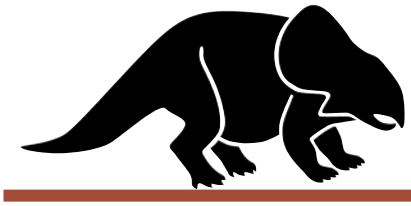
# Dinosaur Egg Facts

## Background on dinosaur eggs and babies.

- The largest dinosaur egg ever found belonged to the *Hypselosaurus*; it was 1 foot long and 10 inches wide. The *Hypselosaurus* egg in the exhibit is 8 inches in diameter. The largest eggs in the exhibit belonged to a giant oviraptor, *Gigantoraptor*. They are 18 inches long and 6 inches wide.
- Dinosaur eggs were hard-shelled.
- We think some dinosaurs may have been **altricial** (al TREH shel) (meaning an animal that needs intense parental care during **incubation** and for a period of time after hatching [like humans]). Theropod dinosaurs were **altricial**.
- Other dinosaurs may have been **precocial** (pree KOH shel) (meaning the animal can take care of itself immediately after hatching [like snakes]). Sauropod dinosaurs were **precocial**.
- Dinosaur eggs are known from all continents, except Australia and Antarctica.
- Early people drilled holes in **fossilized** dinosaur eggshells and used them for jewelry.
- Dinosaur eggs were first identified in the 1920's during an expedition to Mongolia by the American Museum of Natural History.
- The first written account about prehistoric eggs appeared in France in 1859, the egg was mistaken for a bird egg but later recognized as dinosaur.
- Over 200 dinosaur egg sites have been found all over the world.
- Eggs have been found in places such as Mongolia, China, France, India, the United States (Montana and Utah), and Canada.
- Only recently have dinosaur **embryos** or hatchlings been discovered.
- Some dinosaurs laid their eggs in nests.
- Dinosaur eggs could be laid in different patterns which include a spiral pattern, concentric circles, irregular clusters, arcs, parallel rows, alternating parallel rows, and double rows.

Q: What do you get if you cross a pig with a dinosaur ?

A: Jurassic Pork!



# Ceratopsian Section

## Psittacosaurus and Protoceratops

## Psittacosaurus

***Lifestyle and Family Values***

- Probably walked on 2 legs. Did not display the ornate frill or horns of later Ceratopsian dinosaurs.
- Were up to 6 feet long.
- Was an **herbivore**.
- Lived during the early **Cretaceous** period, about 123 to 100 mya.
- One of the most scientifically well known dinosaurs because of the numerous specimens found in a variety of ages from hatchling to adult.
- Young animals are commonly found in large groups and with individuals of varying ages.

***Egg Morphology***

- It is not confirmed what eggs go with *Psittacosaurus* because no one has ever found an embryo inside an egg. There are some small elongated eggs that were found in proximity to *Psittacosaurus* that are likely candidates.

***History***

- Means "Parrot lizard", so named because it possesses a strong parrot like beak.
- Located primarily in China.

## Protoceratops

***Lifestyle and Family Values***

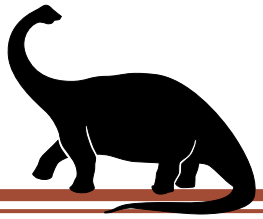
- Walked on 4 legs, had a large head, bulky body, parrot-like beak, cheek teeth, and a small frill on its head.
- Were 6-8 feet long, 3 feet tall, and less than 400 pounds.
- Was a relatively slow moving **herbivore**.
- Lived during the late **Cretaceous** period, about 86 to 71 mya.
- Several individuals have been found in one deposit so we know they probably cared for their young and lived in some type of herd.

***Egg Morphology***

- We don't know what eggs go with *Protoceratops* because no one has ever found an embryo inside an egg. *Oviraptor* eggs were once mistaken for *Protoceratops* eggs.

***History***

- Means "First Horned Face" so named because it was a precursor of the well known *Triceratops* that had 3 facial horns.
- First discovered in the Gobi Desert, Mongolia in the 1920's.
- Was named by Walter Granger and W.K. Gregory.
- Is a member of the order of bird-hipped **herbivorous** dinosaurs, ornitichia.



# Sauropod Section

## The largest animals to walk the earth!

***Lifestyle and Family Values***

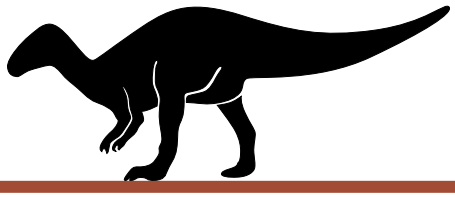
- Sizes range from 7-10 feet long to over 100 feet long. The sauropod *Argentinosaurus* was up to 120 feet long. It was the largest animal ever to walk the earth.
- Usually walked on 4 legs. Had 5 toes on their feet.
- They had very long necks, small heads with blunt teeth, a small brain, and a long tail to counterbalance their necks.
- Different sauropods had different neck stances. Some held their necks vertically, others held it horizontally (or parallel to the ground).
- Was exclusively an **herbivore.** The long neck was probably an adaptation developed by sauropods for an advantage when reaching foliage high in the trees.
- One of the longest lived group of dinosaurs. They were on earth for about 100 million years, from the lower **Jurassic** to the upper **Cretaceous.**
- Fossil evidence suggests that herds of at least one group of sauropod, *Titanosaurus*, returned to the same nesting site year after year.
- Track ways in North America suggest that some sauropods lived in herds with multiple individuals of different ages.
- Hatchlings were probably **precocial**, left on their own as soon as they hatched. The parents may have provided some distant protective function or they may have been more like modern day turtles which lay a large quantity of eggs. Survival of the offspring is due to luck and large numbers.

***Egg Morphology***

- Egg shape is spherical (round) ranging in size from a grapefruit to a bowling ball.
- Laid eggs in a clutch (a depression prepared to keep eggs in until they hatched) and may have been covered with leaves and sticks.
- No sauropod eggs have been found in North America where *Apatosaurus* (formerly *Brontosaurus*) and *Brachiosaurus* lived during the **Jurassic** Period.

***History***

- Sauropod (SAWR-o-pod) means "Lizard Footed".
- Their location was very widespread. Bones and footprints have been found on all continents.
- They are a subgroup of the Saurischid or lizard-hipped dinosaurs.



# Ornithopod Section

## Caring mother or run from the nest?

***Lifestyle and Family Values***

- Walked on two feet (**bipedal**) but sometimes on all four (**quadrupedal**).
- Ornithopods sometimes had a beak or "duck bill".
- The most diverse group of ornithopods were the duck-billed hadrosaurs. Like ducks, the muzzle was wide and flat and lacked teeth. The bones of the snout extended far back into the rest of the skull and sometimes formed crests or horns.
- Lived from the early **Jurassic** to the late **Cretaceous**.
- Probably had an **herbivore** diet.
- They never developed armor and must have relied on speed or large numbers as defense against predators. Most likely lived in large herds.
- Many times ornithopods could have ornate crests or head ornamentation. The crests of some such as *Parasaurolophus* could have produced loud noises as a possible defense mechanism.
- Scientists still debate whether ornithopod dinosaurs were **altricial** or **precocial.**

  1) One type of hadrosaur, *Maiasaura* found in Montana have nests with trampled eggshell, baby bones and adults bones all together in the same beds. This is evidence that *Maiasaura* babies were **altricial** needing intense parental care.

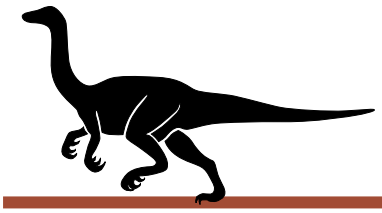
  2) In China, ornithopod nesting sites are filled with nearly complete (not trampled) hatched eggs. This is evidence that the hatchlings were **precocial** ready to run from the nest soon after hatching.

***Egg Morphology***

- Laid spherical shaped eggs.

***History***

- The word Ornithopod (or-NITH-o-POD) means "bird feet".
- Originally discovered in Asia and North America.
- Ornithopods were a sub group of the broader category Ornithischia (Bird hipped dinosaurs).



# Theropod Section

## Carnivores and Oviraptors

***Lifestyle and Family Values***

- All carnivorous dinosaurs are theropods.
- Some theropod dinosaurs could have been **omnivorous.**
- All had feet with three large clawed toes and were **bipedal**.
- They had hollow bones and many had some sort of feathers covering parts of their bodies.
- Birds are living descendants of theropod dinosaurs.
- Well known theropods include *Tyrannosaurus rex, Allosaurus, Oviraptorosaurs* and *Troodon*.

***Egg Morphology***

- Eggshells have 2 distinct layers similar to the eggshell of modern birds.
- Most theropod eggs are elongate shape ranging in size from a walnut to a loaf of french bread.

## Oviraptor

***Lifestyle and Family Values***

- Is bird-like, growing to 6 to 8 feet long and weighing up to 100 pounds.
- Was much like a modern day ostrich; lightly built, fast moving, **bipedal**, long legged, fast runner, running up to 43 mph.
- Had a flexible shaped neck, long tail full of feathers, short arms, claws up to 3 inches long, and a sharp toothless beak.
- There is much debate among scientists about what it ate. It was possibly an **omnivore**, which is unusual for dinosaurs.
- Relatively large brained dinosaur that cared for its eggs and most likely the babies after hatching.
- Lived during the late **Cretaceous** period (88-65 mya).

***Egg Morphology***

- Laid eggs in a wide, shallow nest, two at a time, in a circular pattern up to 3 layers deep.
- Had elongated eggs with a surface that appears bumpy.

***History***

- First found in the Gobi Desert, Mongolia, in 1924 and Named by Henry F. Osborn
- *Oviraptor* means "egg thief", because it was thought to be found stealing eggs from a *Protoceratops* nest. Now it is believed that it was protecting it's own eggs from some form of disaster, such as a sandstorm or powerful thunderstorm that would quickly bury or destroy the eggs if not protected.

# Giant Oviraptor Section

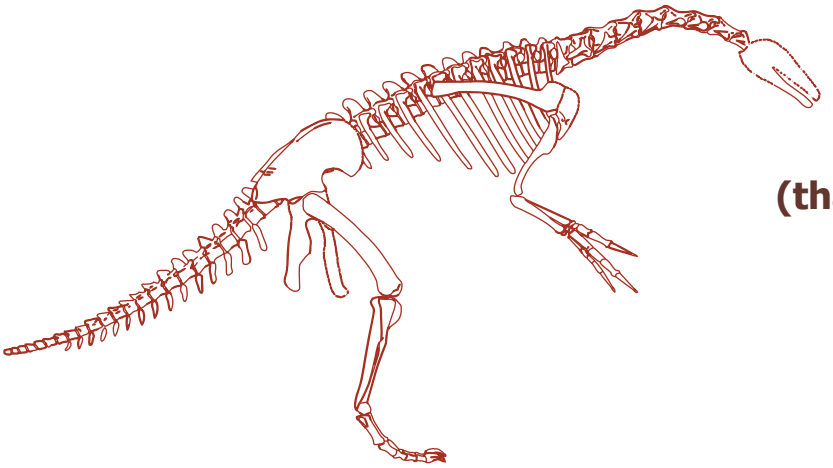
## The incredible embryo "Baby Louie"

### "Baby Louie"

- "Baby Louie" was incubating 65 million years ago but died before he could hatch, was immediately preserved, and fossilized.
- Was the first articulated theropod dinosaur hatchling ever found.
- Discovered by Charlie Magovern while preparing a block of eggs in his workshop.
- Was named after Louie Psihoyos. (sah-HOY-yos), National Geographic photographer and Oscar winning film maker, who photographed the embryo for *National Geographic Magazine*.
- Was excavated from the ancient rocks of the Shinguo Formation in Henan Province, China.
- "Baby Louie" was originally thought to be the Chinese cousin of *T. Rex*, *Tarbosaurus bataar*, but was finally identified as an *Oviraptorosaur*, by recognizing the bone of the lower jaw (a beak without any teeth which is characteristic of oviraptors).
- Its parents were a large species of *Oviraptors* and could have been over 30 feet in length.
- The first artist rendition of "Baby Louie" was created by Brian Cooley and photographed by Louie Psihoyos. The photograph was featured on the cover of National Geographic for May of 1996. "Louie" is depicted as a type of *Therizinosaurus*. (Below left)
- The second rendition was created by Gary Staab several years later after "Baby Louie" was reclassified as a *Gigantoraptor.* In 2017 a study was released stating that Baby Louie is even a more distinct species of Giant Oviraptor called Biebielong seinensis. Scientists had also discovered that *Oviraptors* were covered in some sort of primitive feather. (Below right)

# Enigma Section

## The dinosaur that is a mystery.



**Therizinosaur**
**(thair-uh-ZINE-uh-saur)**

This is a bizarre, enigmatic group of **omnivorous** (ate meat and plants) were theropods that had some characteristics of herbivorous sauropod and ornithopod dinosaurs.

Theropod characteristics
- Hollow bones
- Bipedal
- Three fingered hands equipped with enormous claws.

Ornithopod and sauropod characteristics
- Leaf shape teeth
- Egg shape is round, not elongate like most theropods
- Eggshell pattern is ornithopod-like, not ratite with two layers like theropods.

How are they found?
Fossil preparation requires PATIENCE to expose tiny embryonic bones.
1. Dilute acid is applied to dissolve calcium carbonate (marble) host rock.
2. Preservative is painted on exposed bones.
Steps 1 & 2 are repeated hundreds of times until tiny bones are revealed.

# Egg-tivities

## Dinosaur Poems

### Dinosaur Bones

(Action poem by Nancy Klein)

Let's look for bones,
dig, dig, dig.
Dinosaur bones,
big, big, big.
Back to the lab,
zip, zip, zip.
Clean the bones,
chip, chip, chip.
Put them together,
so, so, so.
We've built a dinosaur,
oh, oh, HO!

### Pretend

(Action poem by Nancy Klein)

Spread your arms, way out wide,
Fly like a Pteranodon, soar and glide

Bend to the floor, head down low,
Move like Stegosaurus, long ago.

Reach up tall, try to be
As tall as Apatosaurus eating on a tree.

Use your claws, grumble and growl
Just like Tyrannosaurus on the prowl.

# Egg-tivities

## How big were dinosaurs?

***Materials:***
* String
* Yardsticks or measuring tape
* Large space to move around
* Graph paper

***Procedure:***
- Have children measure out a dinosaur's length using yardsticks.
- Stretch a string the length of the dinosaurs.
- Get your class to lay head-to-toe along the measured area.
- Count how many children it takes to make a dinosaurs length.
- Mark the results on a graph.

***Sample of dinosaur sizes*** (largest to smallest):

*Argentinosaurus* - average length 36.5 m (120 ft)

*Brachiosaurus*- 24-26 m (80-85 ft) long 7 m (23 ft) tall at the hips, 12-16 m (40-50 ft) tall at the head

*Apatosaurus* - average length of 23 m (75 ft), 3-4.6 m (10-15 ft) tall at the hips

*Tyrannosaurus rex* - 12.3 m (40 ft) in length, up to 4 m (13 ft) tall at the hips

*Parasaurolophus* - estimated at 9.5 m (31 ft)

*Triceratops* - 7.9 to 9.0 m (26.0–29.5 ft) in length, 2.9 to 3.0 m (9.5–9.8 ft) in height

*Protoceratops* - approximately 1.8 m (6 ft) in length and 0.6 m (2 ft) high at the shoulder

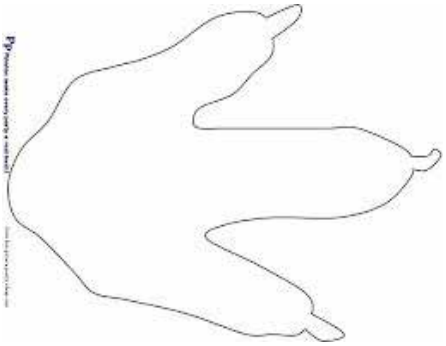
*Velociraptor* - max size was 2.07 m (6.8 ft) long, 0.5 m (1.6 ft) high at the hips

*Compsognathus* - around 1 m (3.3 ft) in length

*Microraptor* - 77–90 cm long (2.53–3.0 ft)

Note: A second way to do this is by seeing how many of your children's footprints could fit into a dinosaurs footprint.

*Tyrannosaurus rex* - 1.55 feet (46 cm) long



# Egg-tivities

## Making Baby Dinosaurs

***Materials:***

* Brown paper bags or pieces of brown butcher paper, one per child
* Dinosaur shape for students to trace
* Hole punch, scissors (if students are able to use them) and/or stapler
* Facial tissues
* Yarn or Colored String

***Activities:***

1. The teacher or the students trace two dinosaur shapes on the paper bag or butcher paper and cut them out.

2. The teacher or students staple the two shapes together to make the stuffed animal, leaving an opening large enough to insert the stuffing.

3. The students decorate their animals.

4. Stuff pieces of crumpled newspaper or facial tissue into the shapes.

5. When the dinosaur is stuffed, staple the opening.

Variation: After using several staples to keep the shapes in place, punch holes around the shapes for the children to loop together with yarn.

6. Make mobiles or hang the shapes from the ceiling or on a wall.

## Variation for older children:

***Materials:***

* Felt
* Yarn or string
* Stuffing
* Large plastic needles (large metal needles work better if children are old enough to use them)
* Elmer's glue (Hot glue guns work better if children are old enough to use them)
* Feathers, google eyes, cotton balls, and anything else that would make fun decorations.
* Dinosaur shapes for students to trace.

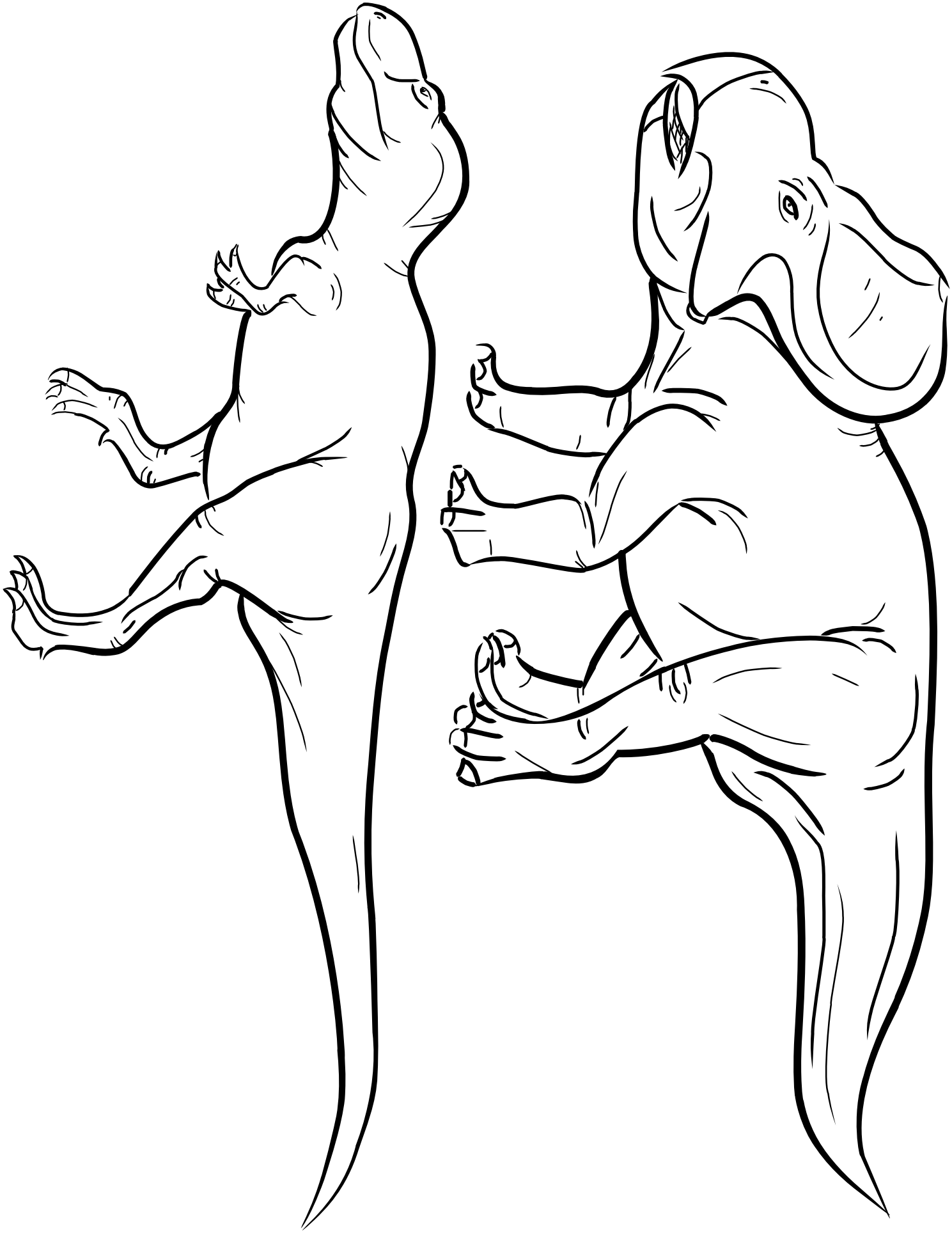
***Activities:***

1. Trace the dinosaur on to the felt and cut them out.

2. Use the string to sew the two halves together, leaving a hole to stuff in the stuffing. Finish sewing closed the hole.

3. Get creative while decorating.

Sample shapes of *Tyrannosaurus* and *Protoceratops* are provided on the following page.

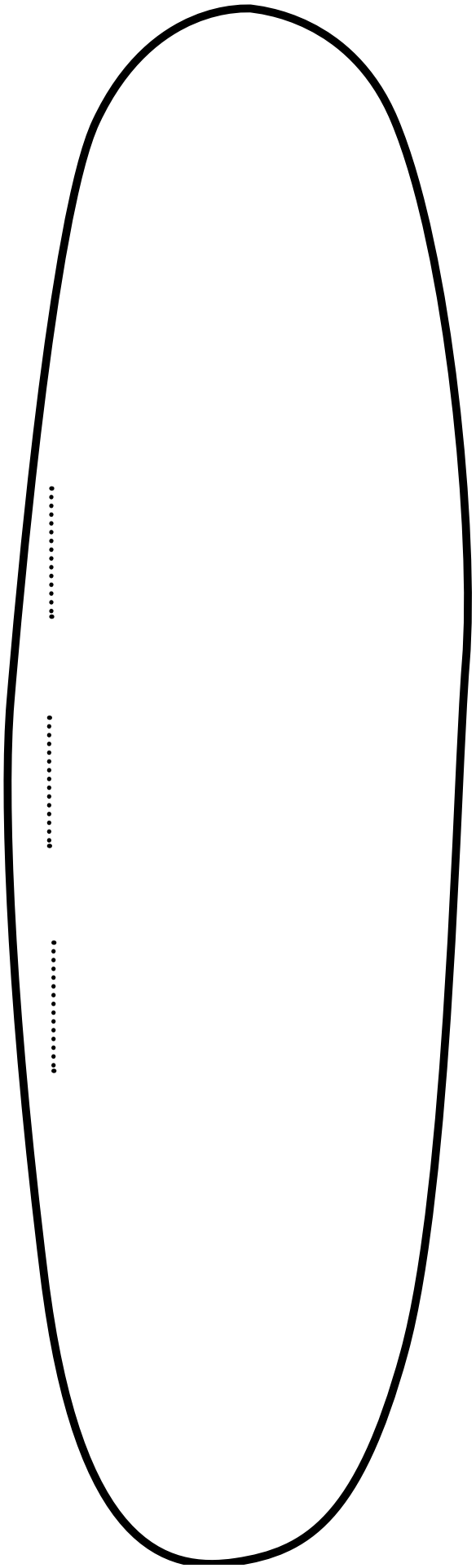


# Egg-tivities

## Coloring Baby Dinosaurs

Paleontologists cannot be sure what color dinosaurs really were, so when paleo-artists are drawing them, they use their imagination. Did they look like modern reptiles in browns and greens, or were they brightly colored like today's tropical birds? Use the images of "Baby Louie" on this page and the next for students to color and create their own paleo-art.

Note: Paleo-art changes as science changes. The drawing on this page is the current science for what "Baby Louie" may have looked like. The drawing on the following page is what "Baby Louie" was originally thought to have looked like.

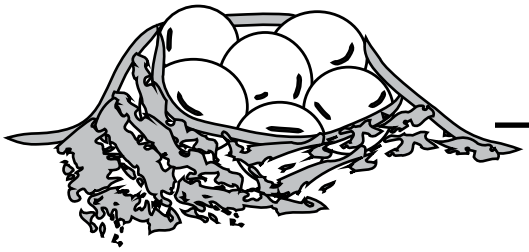


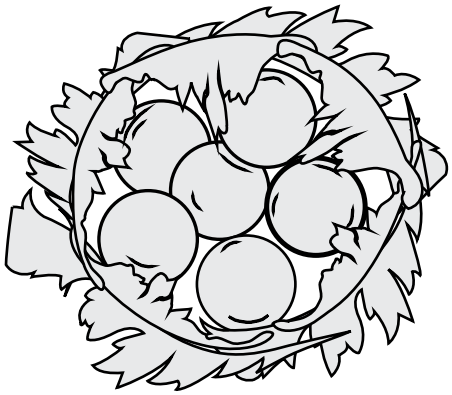
Cut out the eggs. Place the eggshell on top of the egg with "Baby Louie inside. Staple on the dotted lines. Children can open their egg to see the embryo inside.

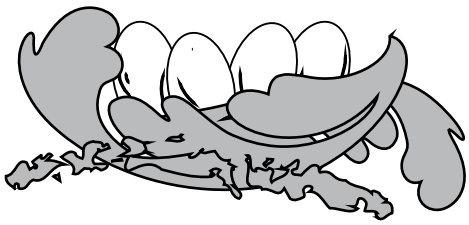
# Egg-tivities

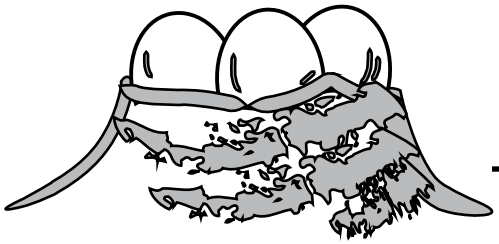
## Count the dinosaur eggs.

Count the dinosaur eggs in each nest. Write the number of eggs on the lines.









# Egg-tivities

## Bone Math

Objective is for children to learn about numbers and patterns.

***Materials:***

* Large bone shape dog biscuits
* Box of variety of colors small dog bones
* Paper, crayons and pencils

***Activities:***

ONE

1. Students use the large bones to explore making patterns.
2. Trace bone shape on white strip of paper and color AB pattern.
3. Use the students' work as a border for class dinosaur mural.

TWO

1. Use small different colored dog bones to make different patterns.
2. Use large and small dog bones to make patterns.

THREE

1. Put 12 small dog bones in a plastic bag with two dice.
2. Students work in pairs rolling dice.
3. With each roll student will remove the number of bones according to the number he/she rolled.
4. Student with the most bones wins.

FOUR

1. Write the numbers 1-12 on twelve large dog bones.
2. Have students close eyes and remove one of the bones.
3. Students look at the remaining bones and must tell which number bone is missing.

# Egg-tivities

## Egg Size

***Materials:***

* One sheet of grid paper for each child (suggest larger squares for younger children)
* Real-sized construction paper eggs. Variety of average size eggs provided below.

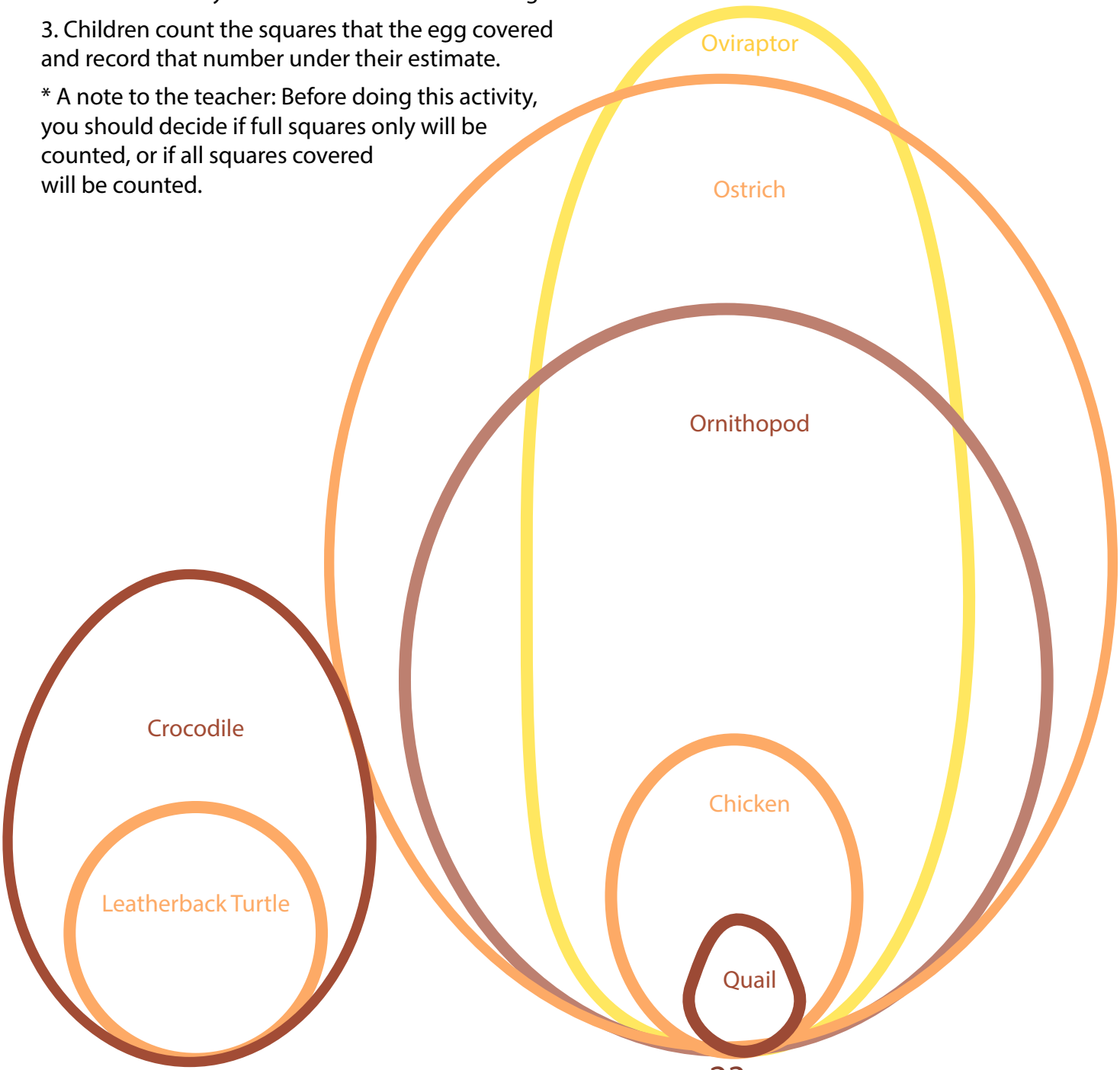
***Activities:***

1. Have each child look at the construction paper egg and estimate how many squares will be covered when it is laid on the grid. Put their guess on the bottom of the grid.

2. Let the children trace their construction paper egg onto the grid and then color it. Children should use soft colors so they can still see the boxes on the grid.

3. Children count the squares that the egg covered and record that number under their estimate.

* A note to the teacher: Before doing this activity, you should decide if full squares only will be counted, or if all squares covered will be counted.



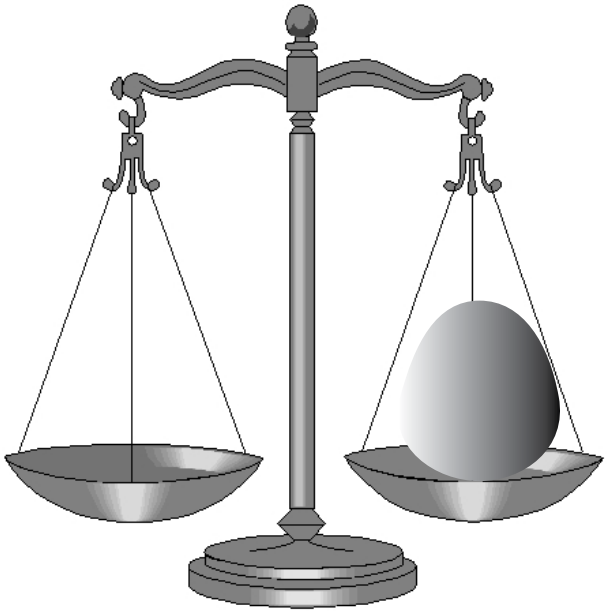
# Egg-tivities

## Egg Weight and Egg Roll

### Egg Weight

***Materials:***

* Balancing scale
* unifix cubes, crayons, tiles, or anything else you desire to use for balancing
* How many will balance my egg? worksheet
* Egg for each group of students



***Activities:***

1. Put the children into groups of four.
2. Pass out the estimation sheet to each child. Have them estimate how many of each of the objects it will take to balance the egg.
3. Color the number of squares in each column.
4. Pass out another sheet for their actual count. Color the number of squares it took to balance the egg.
5. Cut out the squares of estimates and actual amounts and glue the two next to each other on a large piece of construction paper.
6. Discuss the results.

### Egg Roll

This activity is to test how eggs move or roll and why the way they roll is important.

***Materials:***

* An egg for each student

***Activities:***

1. Have each student sit on the floor or have plenty of tabletop room (trying to find a floor or table that is as level as possible)

2. Give each student an egg and have them gently push it away from them and watch how it rolls.
3. Ask the students how they would describe the way the eggs roll and move. Why do they think they move in that way?
4. Explain the rolling in a large circle and wobbling means that the eggs won't roll far away. Ask students why it is important that eggs do not roll far away from the nest? Explain that it is important because staying in the nest is safe and often provides protection and warmth from the mother.

# Egg-speriments

## Are all eggs the same size?

This experiment is to demonstrate that while all eggs in a carton (or in a dinosaur nest) may appear to be the same size, when measured they are all different sizes.

***Materials:***

* 3-4 eggs per student or group of a variety of sizes (buy small, medium, large and extra large eggs at the grocery store and mix them up so students pick their eggs)
* 6 inch piece of string
* Ruler
* Paper to record results

***Procedure:***

1. Allow each student (or group) to pick 3-4 eggs that appear to be the same size to them.

2. Explain to the students that while the eggs may appear to be the same size, if we measure each egg vertically and horizontally and record the results we will see that the eggs are not all the same size.

3. Demonstrate how to measure the egg using a piece of string. Measure the egg by holding the string at the top of the egg and wrapping the string around vertically until you reach the string end. Hold the string at the place where they meet or you can mark it with a marker. Lay the string down next to a ruler to measure the length of string and record it on the paper for Egg 1 vertical. Do the same for the horizontal measurement.

4. Have the students measure their eggs as in step 3, recording all their measurements.

5. Share measurements of eggs that appeared to be the same size.

6. If you have time, have students trade eggs and repeat the process with the new eggs to demonstrate the scientific process of repeating experiments for scientific accuracy.

# Egg-speriments

## Why don't mothers break their eggs?

This experiment is to demonstrate the strength of eggshells. It visually demonstrates to children that mothers can sit on nests of eggs without breaking them.

***Materials:***

* Six large raw eggs
* 3-4 heavy books (such as dictionaries)
* Plastic food wrap
* A soft depression in the grass outside or a sandbox (if you can not travel outside, fill a large plastic storage bin a few inches of sand or dirt, making sure there is enough room to stack the books over the depression without the books resting on the storage container)

***Procedure:***

1. Ask the students if they think eggs are strong. Have a student crack an egg to demonstrate that they do break easily.

2. Tell the students you are going to perform an experiment to test how strong the eggs are to try and understand how a mother can sit on a nest without breaking the eggs.

3. Gather the materials and students and head outside. Find or make a small depression in the ground so the eggs won't roll away but still stay above ground.

4. Cover the eggs with a piece of plastic food wrap (just in case the eggs break the books won't get damaged).

5. Slowly and gently set one book on top of the eggs. Observe the eggs to make sure they are still whole. Continue putting on books (until you have about 3 or 4)

6. Ask the students if they know why the eggs did not break. Explain that eggs have an arc-like structure which supports the weight in several places, not just one single point. The weight travels along the curve of the egg to displace the weight to the widest part of the dome.

***Extension:***

To quantify the amount of weight these six eggs can hold continue placing books on the eggs until one breaks. Then weigh the books placed on top to know how much weight the eggs held. To demonstrate the scientific process, either repeat this experiment several times and compare results or have students break into groups and complete the activity and compare results to get an average for the amount of weight six eggs in a nest can hold. See if you can estimate the amount of weight dinosaur eggs could hold by comparing the size ratio of a chicken egg to a dinosaur egg and then making a weight ratio amount of weight the chicken eggs held and the amount of weight dinosaur eggs might hold. Is the weight approximately the same as a dinosaur that may have laid the eggs? Is this perhaps why some dinosaurs were good mothers and tended to the nests and their young and why other dinosaurs laid the eggs and left the babies to defend themselves?

# Egg-speriments

## Are eggs porous?

### Experiment One: Grades K-4

This experiment is to determine if eggs have holes in the shells and can allow air in and out of the shell.

***Materials*** (needed for each student or group):
* Raw egg
* Wide mouth jar half full of warm water

***Procedure:***

1. Have each student look at the egg. Do the eggshells have tiny holes in them?

2. Explain that now we are going to perform an experiment to see if the eggs do have tiny holes in the shell.

3. Slowly and gently place the egg in a jar of warm water.

4. Carefully observe what happens. What does the egg look like in the water? Watch for about a minute. Are there bubbles escaping from the egg? Where are the bubbles coming from? What do the bubbles tell us?

5. Explain that the bubbles tell us there is air inside the egg that is escaping. How can the air escape? There are tiny pores in the eggshell. This means the eggshell is porous, or it has little holes in it so air can get in and out of the egg to supply air to the bird (or dinosaur) growing inside.

### Experiment Two: Grades 4+

This experiment is to demonstrate how the eggs membrane is strong and yet permeable

***Materials***
* Raw eggs
* Vinegar and corn syrup
* Cups
* Scales and measuring device such as string and ruler

***Procedure:***

1. Place two eggs into cups of vinegar for one to two days. The calcium layer of the eggshell will dissolve leaving the membrane of the egg.

2. Students should compare the weight and size of the eggs to an egg with an intact shell. Place one egg back into the vinegar solution, or a water solution. Place the other egg into a cup with corn syrup. Leave the eggs for another day.

3. Remove the eggs and make comparisons with the size and weight measurements from the previous day.

4. Discuss how the acidic solution of the vinegar dissolved the calcium of the shell leaving a flexible membrane that allows osmosis to occur. The water content inside the egg is less than a vinegar or water solution and higher than the corn syrup solution. The egg in the vinegar/water will increase in size and weight and the egg in the corn syrup will decrease in size and weight.

*If you have extra eggs try testing the strength of the egg with the freshly dissolved shell. It should bounce from a height of about a foot with out breaking. Make sure the test location is easy to clean in case the membrane bursts.

# Classroom Activity

## Geologic time on a football field.

Have students map the major events in the history of the earth on a football field. Sample geologic events listed below. A print out of a football field is provided on the next page.

Variation: Have students map the events using their own age as the scale. Birth represents 4.6 billion years old and today is modern time.

### Geologic Events

Age of the earth (4.6 billion years old)

First plants - algae (3.6 billion years ago)

First bacteria (3.2 billion years ago)

First eukaryotes (2.1 billion years ago)

First multi-cellular organisms (1.5 billion years ago)

First jellyfish (670 million years ago)

First fish (510 million years ago)

First sharks (435 million years ago)

First land plants (430 million years ago)

First insects (385 million years ago)

First amphibians (370 million years ago)

First reptiles (330 million years ago)

Largest extinction with up to 96% of all marine species and 70% of land animals becoming extinct. It is the only known mass extinction of insects (250 million years ago)

First mammals (240 million years ago)

First non-avian dinosaurs (225 million years ago)

First birds (220 million years ago)

Earliest discovered dinosaur eggs (190 million years ago)

First flowering plants (115 million years ago)

Sauropod eggs are the earliest eggs represented in Hatching the Past (85 Million years ago)

Ornithopod and Oviraptor eggs represented in Hatching the Past (65 mya)

Extinction of non-avian dinosaurs (65 million years ago)

First modern humans – Homo sapiens (100,000 years ago)

### Geologic Time

Mesozoic (251.0-65.5 mya) Era of the Dinosaurs

Cretaceous (145.5 - 65.5 mya) Dinosaurs such as T-rex, Triceratops, Velociraptor, and all ornithopods.

Jurassic (199.6 - 145.5 mya) The largest of the Sauropods, Stegosaurus, Allosaurus.

Triassic (251.0 - 199.6 mya) The very first dinosaurs, mostly small theropods. Frogs, turtles, and snakes also appear.

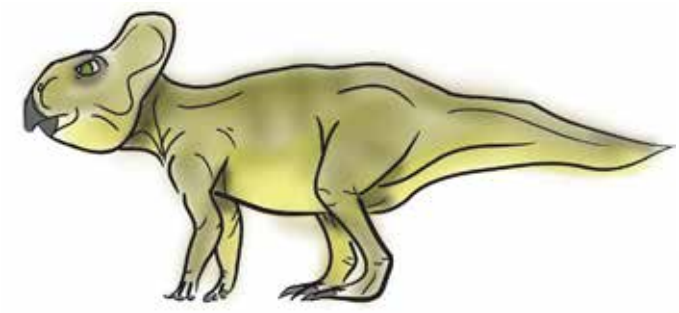
**50 Yard Line**

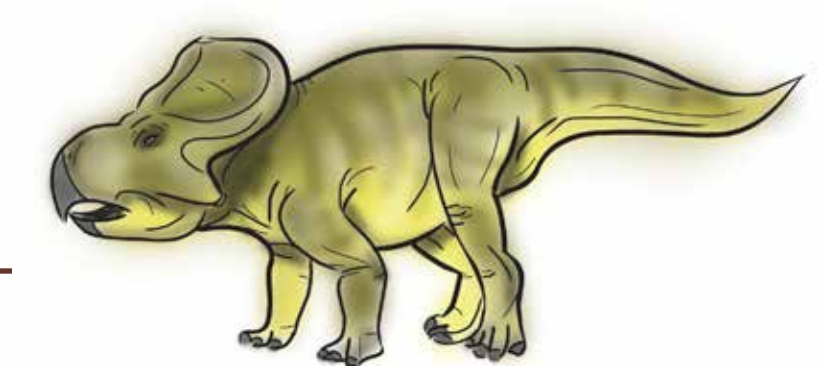
# Hatchlings Grow Up

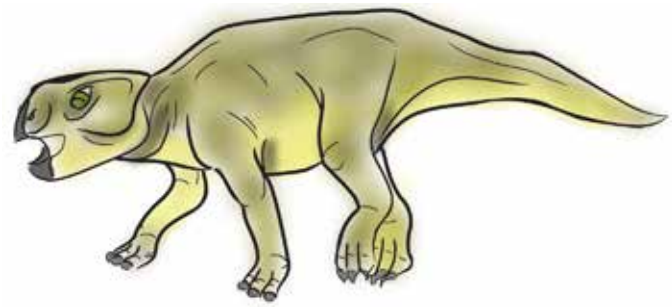
## Did baby dinosaurs look like their parents?

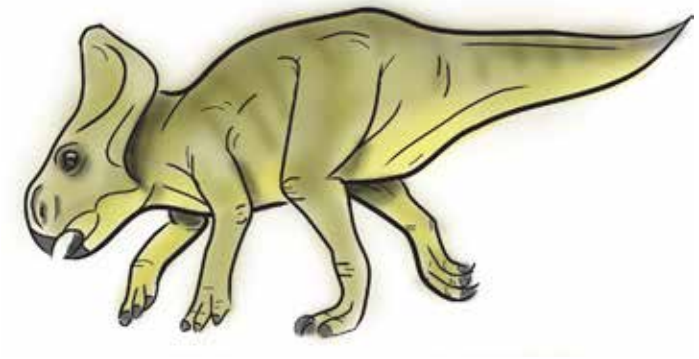
When baby animals are born they don't always look like their parents. Dinosaurs are very similar, some features like horns and fills take time to develop. Number the pictures below giving the youngest hatchling a one and the adult a four.

### This is a Protoceratops growing up.







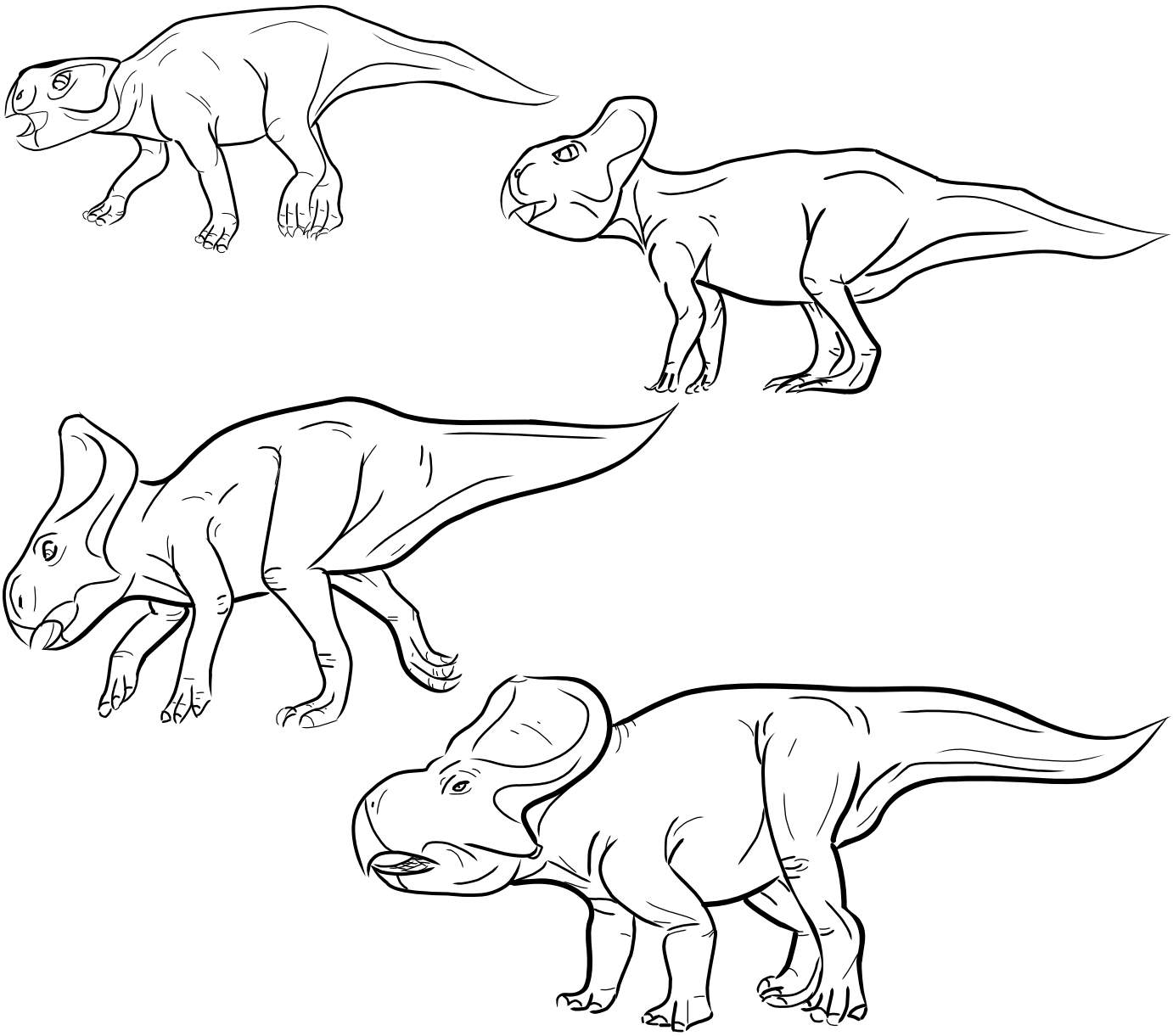


What differences do you see from hatchling to adult? _____

# Hatchlings Grow Up

## Did baby dinosaurs look like their parents?

When baby animals are born they don't always look like their parents. Look at the pictures of the Canada Goose, the babies have different types of feathers in a different color that changes as they grow up. Use your imagination and create a look for the baby Protoceratops that changes as it grows up.



# Post Visit Activity

## What is your favorite?

Students take a survey of the favorite dinosaur, summarize the information on a bar-graph and count the votes in each category to identify the class favorite.

***Materials:***

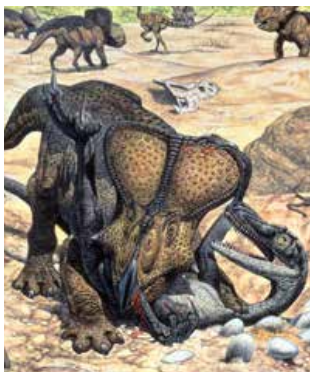
* Chart, with names or illustrations of the dinosaurs. List of some dinosaurs seen in the exhibit provided below.
* A small piece of self-adhesive paper to place on the graph, one per child, with the child's name written on it

***What to do:***

1. Each student places his/her piece of paper on the bar-graph chart to register a vote.
2. Count the votes for each type of dinosaur.
3. Students count the total number of votes to ensure that everyone voted and that no one voted more than once.
4. The students identify the class favorite dinosaur and the one least liked.

Dinosaurs Featured in "Hatching the Past".

Oviraptor



Protoceratops

Velociraptor

Hypacrosaurus

Gigantoraptor

Psittacosaurus

Parasaurolophus

Titanosaur

# Post Visit Worksheet

## How did dinosaurs reproduce?

Scientists think that some dinosaurs stayed with their eggs until they hatched. Small dinosaurs, such as Oviraptor, may have sat on their eggs much like chickens do. Many dinosaurs, though, probably covered their eggs with sand and plants to keep them warm and left them behind. Dinosaur eggs ranged in size. Some were the size of golf balls. Others were the size of footballs. Use what you learned at the "Hatching the Past" exhibit to answer the following questions.

1. How did dinosaurs reproduce?
    - o They laid eggs in the water.
    - o They gave birth.
    - o They laid eggs in caves.
    - o They laid eggs in nests.

2. Why did some dinosaurs sit on their eggs?
    - o To hide the color of their eggs.
    - o To protect them from predators and weather.
    - o To alert predators of their eggs.
    - o To keep them clean.

3. Where did dinosaurs make their nests:
    - o In tree branches.
    - o In the water.
    - o On the ground.
    - o In a cave.

4. Why couldn't dinosaur eggs be too large or too thick?
    - o So air could get in the shells and babies could break out.
    - o So the eggs could be hidden easily.
    - o So the eggs would not roll around.
    - o Because no big, thick eggs have been found.

5. What modern-day animals do not lay eggs:
    - o Emu
    - o Elephants
    - o Eagles
    - o Humming bird

# Post Visit Worksheet

## Did dinosaurs take care of their young?

Scientists think that some dinosaurs simply covered their eggs and walked away. They also think that other dinosaurs protected their eggs and cared for their young. Fossilized nests of *Maiasaura*, a plant-eater, have been found containing the fossils of many helpless baby dinosaurs. Oviraptors protecting their nests have been found in Mongolia. Scientists think that one or both parents protected these youngsters and brought them food. Other baby dinosaurs hatched with well-developed legs. Scientists believe these youngsters left the nest as soon as they hatched to find their own plants to eat. Use what you learned at the "Hatching the Past" exhibit to answer the following questions.

1. What proof do scientists have that some dinosaurs took care of their young?

2. Why do scientists believe that some babies left their nests as soon as they were born?

3. *Maiasaura* means "good mother lizard." Why do you think scientists chose this name?

4. Of the dinosaurs that did not care for their young, do you think there were more or less of them born than the dinosaurs that protected their young? Why?

5. Name some modern-day animals that take care of their young.

6. How did your parents take care of you when you were a baby?

# Answer Sheet

## "How Did Dinosaurs Reproduce?"

1) D
2) B
3) C
4) A
5) B

## "Did Dinosaurs Take Care of Their Young?"

Sample Answers

1) Scientists have found fossilized nests with Maiasaura babies in them. Mother oviraptors have been found protecting their nest when they died in a storm.

2) Some baby dinosaurs were born with well-developed legs and probably left the nest as soon as they hatched to find their own food. Nests have been found to have nearly complete hatched eggs meaning the babies left soon after hatching.

3) Remains of adult Maiasaura have been found with their nest.

4) There were more because they survived by chance and did not have the advantage of being protected by a parent.

5) Cats and birds.

6) Feeding, cleaning, and keeping warm.

# Vocabulary

| | |
|---|---|
| **Albumen** | Egg white, or the protein contained in it. |
| **Altricial** | Being hatched or born or having young that are hatched or born in a very helpless condition so as to require care for some time. |
| **Amniotic Egg** | The amniotes are a group of four-footed animals that have a terrestrially adapted egg. They currently include mammals, reptiles, and birds, as well as their fossil ancestors. |
| **Articulated** | An articulated fossil shows the bones of an animal together, connected in the rock as in life. |
| **Asteroid** | A small rocky body orbiting the sun. Large numbers of these, are found (as the asteroid belt) between the orbits of Mars and Jupiter, though some have more eccentric orbits, and a few pass close to the earth or enter the atmosphere as meteors. |
| **Bipedal** | An animal that uses two feet for locomotion |
| **Carnivore** | Any order of flesh eating animal. |
| **Cretaceous** | The last period of the Mesozoic. Characterized by the dominance of dinosaurs and the diversification of flowering plants and mamals, and the extinction of many organisms at the end of the period. |
| **Death Assemblage** | An animal that died and then was disarticulated in some way prior to fossilization (example, predators, or washed downstream) |
| **Dinosaurs** | A fossil reptile of the Mesozoic era, often reaching an enormous size. |
| **Embryo** | An unborn or unhatched offspring in the process of development. |
| **Fossil** | The remains or impression of a prehistoric organism preserved in petrified form or as a mold or cast in rock. |
| **Fossilized** | Preserved to become a fossil. |
| **Germinal Disc** | A flattened, disklike region of cells from which the embryo begins to develop in the fertilized egg of many vertebrate species. |
| **Herbivore** | An animal that feeds on plants. |
| **Incubate** | To maintain eggs, organisms, or living tissue at optimal environmental conditions for growth and development. |
| **Jurassic** | The second period of the Mesozoic Era, in which dinosaurs continued to be the dominant land fauna and the earliest birds appeared. |
| **Life Assemblage** | When an animal is suddenly killed then fossilized in the act of something in life. (example, protecting eggs) |

# Vocabulary (cont.)

| | |
|---|---|
| **Lizard** | A reptile that typically has a long body and tail, four legs, movable eyelids, and a rough, scaly, or spiny skin. |
| **Mammal** | A warm-blooded vertebrate animal of a class that is distinguished by the possession of hair, the secretion of milk by females for the nourishment of the young, and (typically) the birth of live young. |
| **Mesozoic** | Of, relating to, or denoting the era between the Paleozoic and Cenozoic eras, comprising the Triassic, Jurassic, and Cretaceous periods. The era of dinosaurs. |
| **Omnivore** | An animal that eats food of both plant and animal origin. |
| **Oology** | The study or collecting of eggs. |
| **Paleontologist** | A specialist in the branch of science concerned with fossil animals and plants. |
| **Pecking Order** | The colloquial term for a hierarchical system of social organization. |
| **Precocial** | A young bird or other animal hatched or born in an advanced state and able to feed itself almost immediately. |
| **Quadrupedal** | An animal that uses four feet for locomotion |
| **Reptile** | A cold-blooded vertebrate of a class that includes snakes, lizards, crocodiles, turtles. They are distinguished by having a dry scaly skin, and typically laying soft-shelled eggs on land. |
| **Triassic** | Relating to the earliest period of the Mesozoic era, between the Permian and Jurassic periods. |
| **Vitellus** | The yolk of an egg. |

# Dinosaur Names

| | |
|---|---|
| ***Alectrosaurus***<br>ah-LEK-tro-SOR-us | Is a genus of tyrannosauroid theropod dinosaur from the Late Cretaceous Period of Inner Mongolia. It was a bipedal carnivore with a body shape similar to its much larger relative, *Tyrannosaurus rex*. |
| ***Allosaurus***<br>AL-oh-SAWR-us | Was a top predator with a huge head, sharp, serrated teeth, short arms, and three-fingered hands. Lived in the Jurassic period. |
| ***Ankylosaurus***<br>ang-KIE-lo-SAWR-us | Was a tank-like dinosaur, its entire top side was heavily protected from carnivores with thick, oval plates embedded (fused) in its leathery skin, 2 rows of spikes along its body, and a club-like tail. Was a very slow moving herbivore. |
| ***Apatosaurus***<br>a-PAT-o-SAWR-us | The dinosaur *Brontosaurus* (Marsh,1879) is now called *Apatosaurus*. This large sauropod had nostrils located on the top of its head and would swallow stones to help it digest its large, herbivorous diet. |
| ***Argentinosaurus***<br>ahr-gen-TEEN-oh-SAWR-us | May be the largest dinosaur. It had a long neck, a long tail, and a small head. Very little is known about this giant dinosaur. |
| ***Brachiosaurus***<br>BRAK-e-o-SAWR-us | The front legs of this quadrupedal herbivorous dinosaur were longer than the hind legs. This was the tallest sauropod and one of the largest animals to ever walk the earth. |
| **Ceratopsian**<br>cer·a·top·si·an | a gregarious quadrupedal herbivorous dinosaur of a group found in the Cretaceous period, including triceratops, and protoceratops. |
| ***Compsognathus***<br>KOMP-sog-NAH-thus | Was about the size of a chicken and is one of the smallest known dinosaurs. It walked on two long, thin legs, had three-toed feet, a small, pointed head with small, sharp teeth, hollow bones, and a long, flexible neck. Compsognathus had short arms with two clawed fingers on each hand. A long tail acted as a counterbalance and for stability during fast turns. |
| ***Gigantoraptor***<br>ji-GAN-to-RAP-tor | Approximately three times as long as any other Oviraptor. |
| **Hadrosaur**<br>had·ro·saur | The family of duck-billed, herbivorous dinosaurs. They were the most common dinosaurs. Were the main prey for large carnivores like *Tyrannosaurus rex*. |
| ***Hypacrosaurus***<br>hye-PACK-ruh-SAWR-us | Large duck-billed dinosaur with a crest on its head. Probably lived in family herds and were herbivorous. |
| ***Hypselosaurus***<br>sih-luh-SAWR-us | Titanosaurid sauropod that lived in Europe during the Late Cretaceous HIP-Period. Was the earliest and largest egg ever discovered. |

# Dinosaur Names (cont.)

| | |
|---|---|
| ***Maiasaura***<br>mah-ee-ah-SAWR-uh | Is a large duck-billed dinosaur genus that lived about 74 million years ago in the area currently covered by the state of Montana. Baby bones have been found in association with adults, leading scientists to believe they took good care of their young. |
| **Ornithischia**<br>or-ni-THIS-kee-uh | The bird hiped pubis bone points downward and toward the tail (backwards), parallel with the ischium, with a forward-pointing process to support the abdomen. Includes ornithopods, stegosaurs, ankylosaurus, and triceratops |
| **Ornithopod**<br>or·ni·tho·pod | One of the main types of ornithischian dinosaurs, including the hadrosaurs, duck-billed dinosaurs. Ornithopods walked on their hind legs and had three blunt toes on each foot. They lived from the late Triassic Period until the end of the Cretaceous Period. |
| ***Oviraptor***<br>o-vih-RAP-tor | A bipedal dinosaur of the late Cretaceous period, having a toothless jaw and long forelimbs with clawed fingers. Individuals have been found protecting their nests. Most likely had extravagant plumage they used to protect their nests and attract a mate. |
| ***Parasaurolophus***<br>PAR-a-saw-ROL-o-fus | This hadrosaur had an elongated, bony crest on its head with which it may have made low-frequency, fog-horn-like sounds. The crest was up to 6 feet (1.8 m) long |
| ***Protoceratops***<br>pro-toe-SAIR-uh-tops | A small quadrupedal dinosaur of the late Cretaceous period, having a bony frill above the neck and was ancestral to ***Triceratops***. The fossilized remains of many individuals have been found in Mongolia. |
| ***Psittacosaurus***<br>SIT-uh-ko-SAWR-us | A partly bipedal herbivorous dinosaur of the mid Cretaceous period, having a parrot like beak and was ancestral to other ceratopsians such as ***Triceratops***. |
| ***Pteranodon***<br>ter-RAN-o-DON | Is a genus of pterosaurs which included some of the largest known flying reptiles. |
| **Saurischia**<br>saw-RIS-kee-uh | "The Lizard-hipped pubis points downward and forward at an angle to the ischium, towards the head of the animal. |
| **Sauropod**<br>sau·ro·pod | A very large quadrupedal herbivorous dinosaur with a long neck and tail, small head, and massive limbs. |
| ***Stegosaurus***<br>STEG-o-SAWR-us | Large dinosaur with a small head. Many bony plates were embedded in two rows along the back. Lived in close association with ***Apatosaurus***. |
| ***Tarbosaurus bataar***<br>tar-bo-SORE-us ba-TAR | Closely related to the North American Tyrannosaurus rex. Found in Mongolia. |

# Dinosaur Names (cont.)

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| ***Therizinosaurus***<br>THER-uh-ZEEN-oh-SAWR-us | Had huge arms that were 8 feet (2.45 m) long; it had claws up to 28 inches (70 cm) long. The finger bones are larger than any other animal in history. When ***Therizinosaurus*** was found, it was first thought to be a giant turtle, not a dinosaur. |
| **Theropod**<br>the·ro·pod | A carnivorous dinosaur of a group whose members are typically bipedal and range from small and delicately built to very large. |
| ***Titanosaurus***<br>ti-TAN-oh-SAWR-us | Was an enormous sauropod that had a long neck, long tail, and small head. This quadrupedal herbivorous dinosaur had a heavy body with bony armor on their back. |
| ***Triceratops***<br>try-SAIR-uh-tops | A large quadrupedal herbivorous dinosaur living at the end of the Cretaceous period, having a massive head with two large horns, a smaller horn on the beaked snout, and a bony frill above the neck. |
| ***Troodon***<br>TROH-o-don | May have been the smartest dinosaur, having the largest brain in proportion to its body weight (as smart as a modern bird). It was a fast-moving, light-weight predator that walked on two long legs. It had serrated teeth, long, slim jaws, and a stiff tail. |
| ***Tyrannosaurus rex***<br>tie-RAN-o-SAWR-us rex | A bipedal carnivore, lightly-built fast-running predator, with hollow bones and large brains. Small arms with two claws and a very large head with many teeth. |
| ***Velociraptor***<br>vuh-LOSS-ih-RAP-tor | Had a sharp, deadly, sickle-shaped, retractable, long claw on each foot. ***Velociraptor*** may have been able to run up to roughly 40 mph (60 km/hr) for short bursts. This predator may have hunted in packs. |