DINOSAURS

AND
OTHER LARGE REPTILES
OF THE MESOZOIC

CLASSIFICATION

- Amniota – amniotic egg
- Reptilia – see p. 381
- Diapsida -2 temporal fenestrae; suborbital fenestra in palate
  - Euryapsida – Ichthyosaurs and Plesiosaurs
- Sauria – eardrum; hearing; locomotion
  - Mososaurs
- Archosauria – includes crocs; pterosaurs; dinosaurs
Classification

- Archosauria – “Ruling Reptiles”
  - Crocodilians
  - Pterosaurs
  - Dinosauria
    - Ornithischians (bird-hipped)
    - Saurischians (lizard-hipped)
      - Sauropods – “Brontosaurs”
      - Theropods - Tyrannosaurs

Ichthyosaurs

Giant marine reptiles that resembled fish and dolphins. Ichthyosaurs thrived during much of the Mesozoic era; based on fossil evidence, they first appeared approximately 245 million years ago (mya) and disappeared about 90 million years ago, about 25 million years before the dinosaurs became extinct.

Abundant in the Jurassic, they were replaced by the Plesiosaurs.
Ichthyosaur Paddle

Grippia longirostrus from Triassic of Spitzbergen

Shonisaurus popularis From the Jurassic of Nevada
Plesiosaurs

Elasmosaur reconstructed

Nichollssauria – At Royal Tyrell Museum
*Dolichorhynchos*, a short necked, long jawed plesiosaur, National Museum of Natural History, Washington D. C.

Restoration of *Plesiosaurus dolichodeirus*
Attenborosaurus

Dolicherhynchos

Mososaurs
Mososaur and Giant Squid
Mososaur Skull

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Crocodiles

- Late Cretaceous to Recent
- Aquatic, carnivorous
- Fast, strong
- Cold blooded, slow metabolism
- Can go long time without eating.

Pterosaurs- Range Triassic to Late Cretaceous

Pterosaurs (pronounced /ˈptərəsɔr/, from the Greek πτερόσαυρος, pterosaurus, meaning "winged lizard", often referred to as pterodactyls, from the Greek πτερόδακτυλος, pterodaktulos, meaning "winged finger" /ˈptərə dæktɪl/) were flying reptiles of the clade or order Pterosauria. They existed from the late Triassic to the end of the Cretaceous Period (220 to 65.5 million years ago).

Pterosaurs are the earliest vertebrates known to have evolved powered flight. Their wings were formed by a membrane of skin, muscle, and other tissues stretching from the legs to a dramatically lengthened fourth finger. Early species had long, fully-toothed jaws and long tails, while later forms had a highly reduced tail, and some lacked teeth. Many sported furry coats made up of hair-like filaments known as pycnofibres, which covered their bodies and parts of their wings. Pterosaurs spanned a wide range of adult sizes, from the very small Nemicolopterus to the largest known flying creatures of all time, including Quetzalcoatlus and Hatzegopteryx.[1][2][3]
Replica *Pteranodon sternbergi*, male and female

Artists impression of *Pteranodon sternbergi*
Cast of female *Pteranodon sternbergi* with smaller head crest

Variations in *Pteranodon* species

*A, Adult male* *P. sternbergi*; *B, Adult male* *P. sternbergi* showing possible premaxilla crest; *C, Young male* *P. sternbergi*; *D, Adult female* *P. sternbergi*; *E, F, G, H, Adult male* *P. longiceps*; *I, Young male* *P. longiceps*; *J, Adult female* *P. longiceps*
Structure of the wing

Pteroid bone is unique to Pterosaurs

Sordes sp. Note membrane connecting legs, note also tail
A photograph of the skull of Anhanguera santanae of the Santana formation, Brazil.

Heads and Crests

“Ingridia” navigans

Tupandactylus imperator

Tapejara wellnhoferi
Engraving of first Pterosaur found in Late Jurassic Solenhofen Limestone, 1784. 29 species have been found since in this site alone.
The mechanics of pterosaur flight are not completely understood or modeled at this time, but it is almost certain that this group of animals was capable of powered flight in at least as wide a range of conditions as modern birds. Pterosaurs display many extreme morphological changes required for flight - lightweight bones, stiffened torsos, and modification of the forelimbs into large, dedicated flight surfaces. It is unlikely that all the highly flight-specialized skeletal features observed in pterosaur fossils were developed and maintained for hundreds of millions of years if the animals did not fly.
The first vertebrates to evolve true flight were the pterosaurs, flying archosaurian reptiles. After the discovery of pterosaur fossils in the 18th century, it was thought that pterosaurs were a failed experiment in flight, or that they were simply gliders, too weak to fly. More recent studies, including work done by UC Berkeley's Dr. Kevin Padian, have revealed that pterosaurs were definitely proficient flyers, and were no evolutionary failure; as a group they lasted about 140 million years (about as long as birds have)!

Pterosaurs are thought to be derived from a bipedal, cursorial (running) archosaur similar to Scleromochlus in the late Triassic period (about 225 million years ago). Other phylogenetic hypotheses have been proposed, but not in the context of flight origins. The early history of pterosaurs is not yet fully understood because of their poor fossil record in the Triassic period. We can infer that the origin of flight in pterosaurs fits the "ground up" evolutionary scenario, supported by the fact that pterosaurs had no evident arboreal adaptations. Some researchers have proposed that the first pterosaurs were bipedal or quadrupedal arboreal gliders, but these hypotheses do not incorporate a robust phylogenetic and functional basis. The issue is not yet closed.
Late Triassic to Late Jurassic – considered a more primitive form, *Rhamphorinchus* sp.

Middle Jurassic to Late Cretaceous, considered a more advanced form, *Zhejiangopterus linhaiensis*
Fossil trackways suggest that giant Quetsalcoatlus northrupi were quadrepedal.

True Dinosaurs

- Dinosaurs, one of the most successful groups of animals (in terms of longevity) that have ever lived, evolved into many diverse sizes and shapes, with many equally diverse modes of living. The term "Dinosauria" was invented by Sir Richard Owen in 1842 to describe these "fearfully great reptiles," specifically Megalosaurus, Iguanodon, and Hylaeosaurus, the only three dinosaurs known at the time. The creatures that we normally think of as dinosaurs lived during the Mesozoic Era, from late in the Triassic period (about 225 million years ago) until the end of the Cretaceous (about 65 million years ago). But we now know that they actually live on today as the birds.
Shared Derived Characteristics

- Completely vertical limbs supporting body (bipedal or quadrupedal)
- Thigh bone with right angle bend; hip socket perforated through middle
- Other specializations of the ankles, skulls
- Achieving great size (come in many sizes)
- Land animals only
- Carnivores and herbivores
The first dinosaurs, in the Late Triassic period (about 230 million years ago), apparently were not major components of the fauna. However, by the Early Jurassic (about 30 million years later), after many other Triassic vertebrates had gone extinct, dinosaurs were diversifying rapidly. By then they had become dominant occupants of many major terrestrial adaptive zones, judging from their frequently large size and considerable morphological and taxonomic diversity. The Late Jurassic (about 145 million years ago) through the Late Cretaceous (about 65 million years ago) was the heyday of the dinosaurs. It was also the Late Jurassic that saw the bird lineage diverge from its flightless theropod ancestors, and birds enjoyed an explosion in diversity in the Cretaceous period and beyond.

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Classification of Dinosaurs

- Superorder Dinosauria Owen 1842
  - Ornithischia “bird-hipped”
    - Cerapoda (Iguanodons, Hadrosaurs, Pachycephalosaurs, Ceratopsids & others)
    - Throphora (Stegosaurs, Ankylosaurids & others)
  - Saurishia “lizard-hipped”
    - Sauropods (Brachiosaurus, Diplodocus, Apatosaurus)
    - Theropods (Raptors, Tyrannosaurs)

Ceropoda - Iguanodon

![Iguanodon bernissartensis]  
10 m

- Iguanodon bernissartensis
Hadrosaur “Duck –billed” dinosaur

Pachycephalosaur

Different species or ontogentic stages?
Ceratopsids

Triceratops
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Throphora - *Stegosaurus*
Stegosaurus skull and reconstruction

Ankylosaurus — armored dinosaur
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    - Sauropods (*Brachiosaurus*, *Diplodocus*, *Apatosaurus*)
    - Theropods (Raptors, Tyrannosaurs)
Brachiosaurus

Brachiosaurus – Artist’s impression
Diplodocus carnegii, artist Michael Skrepmick

Sauropod; longest dinosaur

Diplodocus – artist’s conception
Diplodocus skull

Diplodocus skeleton
**D. hallorum**, first described in 1991 by Gillette as *Seismosaurus halli* from a partial skeleton comprising vertebrae, pelvis and ribs. George Olshevsky later attempted to emend the name as *S. hallorum*, citing incorrect grammar on the part of the original authors, a recommendation that has been followed by others, including Carpenter (2006). In 2004, a presentation at the annual conference of the Geological Society of America made a case for *Seismosaurus* being a junior synonym of *Diplodocus*. This was followed by a much more detailed publication in 2006, which not only renamed the species *Diplodocus hallorum*, but also speculated that it could prove to be the same as *D. longus*. The position that *D. hallorum* should be regarded as a specimen of *D. longus* was also taken by the authors of a redescription of *Supersaurus*, refuting a previous hypothesis that *Seismosaurus* and *Supersaurus* were the same.

**“Seismosaurus” hallorum**

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[1] [Gillette, 1991](#).
[2] [Carpenter, 2006](#).
[3] [Geological Society of America](#).
[4] [Seismosaurus](#).
[5] [Diplodocus](#).
[6] [Supersaurus](#).
[7] [Longus](#).
[8] [Redescription](#).
[9] [Hypothesis](#).
Size of Sauropods

Red- Amphicoelias fragillimus
Blue-Argentinosaurus huinculensis
Orange – “Supersaurus” viviana
Green – “Seismosaurus hallorum

Amphicoelias

Amphicoelias (pronounced /ˈæmfiəliəs/, meaning “doubly hollow”, from the Greek amphi: “on both sides”, and koilos: “hollow, concave”) is a genus of herbivorous sauropod dinosaur that includes what may be the largest dinosaur ever discovered, A. fragillimus. Based on surviving descriptions of a single fossil bone, A. fragillimus may have been the longest known vertebrate at 40–60 meters (131–196 ft) in length, and may have had a mass of up to 122 metric tons (135 short tons), rivaling the heaviest animal known, the Blue Whale.

However, because the only fossil remains were lost at some point after being studied and described in the 1870s, evidence survives only in drawings and field notes. Amphicoelias is present in stratigraphic zone 6 of the Morrison Formation. [1]
Sauropod and Ornithischian (birdhipped) dinosaurs had small teeth indicating that most if not all were herbivores.

Sauropods eating Conifers.

Theropod teeth, on the other hand, retain the primitive archosaurian characteristic of being recurved, serrated, laterally-compressed, and knife-like. There is some variation in tooth structure among extinct theropods, but most are fairly similar and obviously related to a carnivorous diet.
Typical Theropod Dinosaur

Size of the Theropods
Early forms of Theropods – *Hererrasurus* (large) and *Eoraptor*

Mounted replica of *Tyranosaurus rex*
*Allosaurus* large genus of Theropods

*Allosaurus* skull
Restoration of *Allosaurus*

*Albertasaurus* – More specimens
Tyrell Museum depiction of *Albertosaurus*

*Velociraptor*
Areas of Controversy

- Were dinosaurs warm-blooded reptiles?
  - Polar dinosaurs
  - Feathers
  - Blood vessel structure in bones
  - Evidence of active lifestyle

- Against – large size presents heat dissipation problems
- Cold blooded animals can be active, fast

Velociraptor

- Dimensions: 2m x 2m
Dinosaur tracks

From trackway data, we can tell that:
Some non-avian dinosaurs travelled in large groups;
Non-avian dinosaurs moved with their feet held underneath their body (as birds and mammals do); and
Some non-avian dinosaurs moved rather quickly, but some plodded along at a more leisurely pace.

Areas of Controversy - Birds

- Connections between birds and dinosaurs
  - Intermediate forms
    - Feathered dinosaurs
    - Feathered flying “dinosaurs”
    - Flight may have come and gone as in some birds
  - Skeletal features in common
    - Neck, pubis, wrist, arm, pectoral girdle, shoulder blades, clavicle, breast bone
- Reproduction
  - Eggs
  - Adult tending the nest, sitting on it
  - Juveniles without teeth; need for regurgitation.
Juvenile duckbilled dinosaur found in nesting area in Montana

Areas of Controversy – Birds (cont)

- More connections between birds and dinosaurs
- Air sacs that pump air into bones
- Complex chambered heart
- Sleeping position (head under arm)
- Gizzard and gizzard stones
- DNA
Archaeopteryx

Feathered Dionycus
Sinornithosaurus millenii

Areas of Controversy – DNA cloning
“Recreating DNA from a mammoth is one thing,” Milner says. "The remains are recent - around 27,000 years old - and frozen, so it is not surprising they were able to locate a long, undamaged sequence of DNA. By comparison, given that dinosaurs lived millions of years ago, it's extremely unlikely that their DNA will ever be discovered, since DNA is very fragile and can't survive over millions and millions of years.”

### Areas of Controversy

- What kind of movements were possible for dinosaurs?
  - Tree climbing?
  - Rapid herd movement?
  - Floating?
  - Whip-tail sonic boom?
Areas of Controversy

- What caused the extinction of the Dinosaurs?
- Did some survive the K/T event?