

Evolution of Tetrapods

Amphibian-like creatures: The earliest tracks of a four-legged animal were found in Poland in 2010; they are Middle Devonian in age. Amphibians arose from sarcopterygians sometime during the Devonian. The recently discovered *Tiktaalik* was probably similar to the amphibian ancestor – this sarcopterygian had foot-like fins with wrist bones and simple fingers that could bear weight. This animal could bend its neck, unlike a fish, and had a sturdy ribcage that it could rest its weight on. These transitional organisms were probably not walking, but could pull itself up onto the shore after food.

Labyrinthodonts: short-legged, large heads with flat thick skulls and teeth with a distinctive folded pattern of dentin and enamel.

Acanthostega (Devonian) had actual webbed feet with toes, but a shoulder and a tail like a fish. This animal's feet were not suitable for weight-bearing, but could be used as paddles. It probably lived entirely in the water.

Ichthyostega (Late Devonian) had both limbs and lungs, but was also not adapted to walk on land (at least as an adult – juveniles may have been able to leave the water)

Temnospondyls (Carboniferous to Cretaceous) had fully developed legs capable of walking on land. In the Permian, some of these organisms became armored land dwellers, but the very dry Late Permian climate doomed these creatures. Other temnospondyls remained as aquatic tetrapods. Some evolved to look remarkably like crocodiles, while others looked like large newts.

Modern amphibians probably arose in the Permian or Triassic, and are only remotely related to the giant amphibians of the Paleozoic.

Reptiles: Reptiles evolved from the labyrinthodonts in **Pennsylvanian** time. Four separate groups of reptiles evolved in the **late Paleozoic** (with different skull structures):

Anapsids: The living anapsids are turtles and tortoises, though early anapsids included a variety of now extinct forms such as small lizard-like organisms (including Mesosaurus) and bulky armored animals up to 2.5 m long. None of these animals except for the turtles survived into the Mesozoic.

Synapsids: These organisms gave rise to mammals. See the section on mammals below.

Diapsids: All other reptiles are diapsids, including snakes and lizards, marine reptiles, pterosaurs, crocodiles, dinosaurs, and birds. Marine reptiles and the snakes/lizard group branched off early in the Mesozoic.

A. The marine reptiles include three groups:

- Ichthyosaurs – reptiles that resembled dolphins. **Triassic to Cretaceous**
- Plesiosaurs – long-necked animals with paddles (like the Loch Ness monster). **Jurassic to Cretaceous**
- Mosasaurs – reptiles that looked something like crocodiles with paddles. **Cretaceous.**

B. **Pterosaurs** were flying reptiles. Their wings consisted of leathery skin that stretched from a very long pinky finger to their body. **Triassic to Cretaceous.**

C. **Crocodylians** are closely related to dinosaurs. They evolved during the **Cretaceous**.

D. **Dinosaurs** evolved from earlier diapsids in the **Triassic**. The earliest dinosaurs were small bipedal predators. By **Jurassic** time, the two large groups of dinosaurs – the saurischians and ornithischians .

- **Ornithischians** were herbivorous, beaked dinosaurs. The group includes both four-legged dinosaurs like **stegosaurs (Jurassic)**, the armored **ankylosaurs (Jurassic to Cretaceous)**, and the horned **ceratopsians (Cretaceous)**; and bipedal dinosaurs like the thick-headed **pachycephalosaurs (Cretaceous)** and the duck-billed **hadrosaurs (Cretaceous)**.
- **Saurischians** range from the largest dinosaurs to the very smallest. They include huge herbivorous **sauropods (Apatosaurus, Jurassic, and Brachiosaurus, Cretaceous)** and carnivorous **therapods (Allosaurus, Jurassic, Tyrannosaurus, Cretaceous)**.

E. **Birds** evolved from theropods in **Jurassic** time. The earliest known bird, *Archeopteryx*, had hands, a bony tail and teeth, as well as feathers.

Mammals: Synapsids separated from other tetrapods in **Pennsylvanian** time.

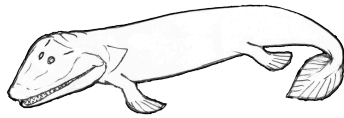
Permian synapsids include the sail-backed *Dimetrodon* and its relatives. By the mid-Permian, a new group of synapsids, the **therapsids**, were the dominant large land animals.

During the **Mesozoic**, synapsids became more mammal-like. At the same time, they became smaller and less important in terrestrial ecosystems as the dinosaurs became dominant. **Modern mammal groups** first appeared in the **Triassic**.

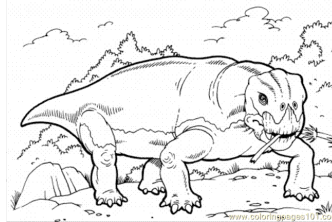
By the middle of the **Cenozoic**, all the major groups of mammals were established.

Giant mammals appeared during the **Oligocene**, and again in the **Pleistocene**.

Amphibian-like creatures: *Tiktaalik*,



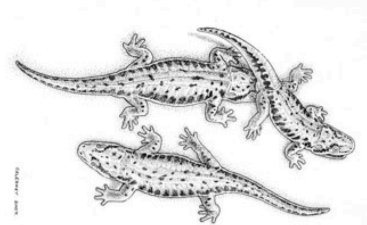
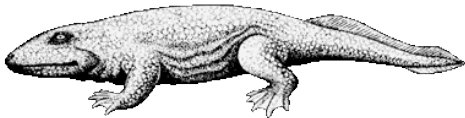
Temnospondyls



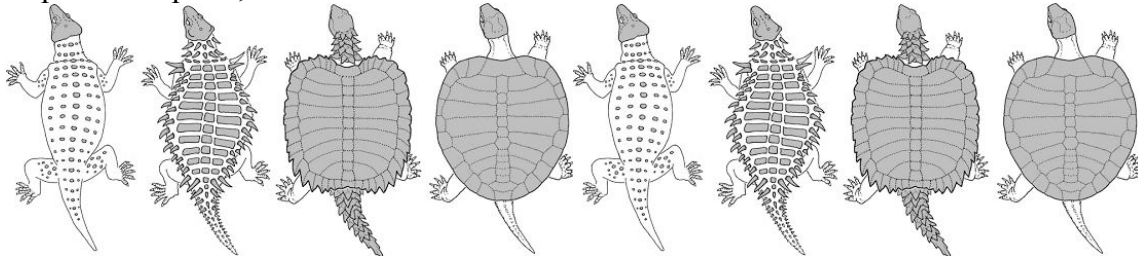
Acanthostega,



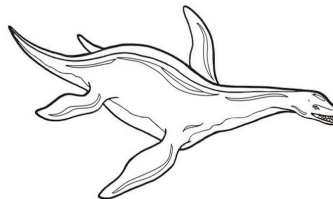
Ichthyostega



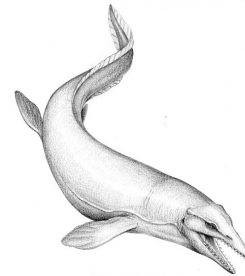
Reptiles: anapsids,



Reptiles: diapsids –
ichthyosaurs

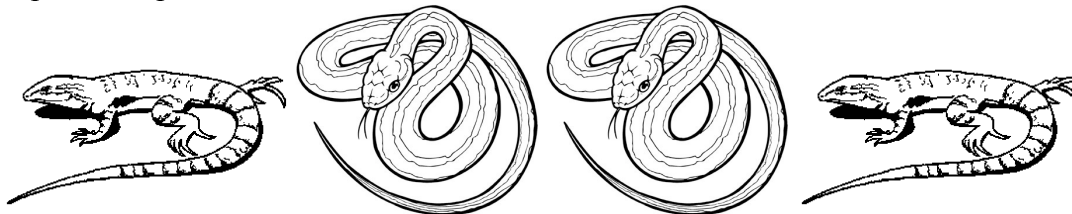


Plesiosaur

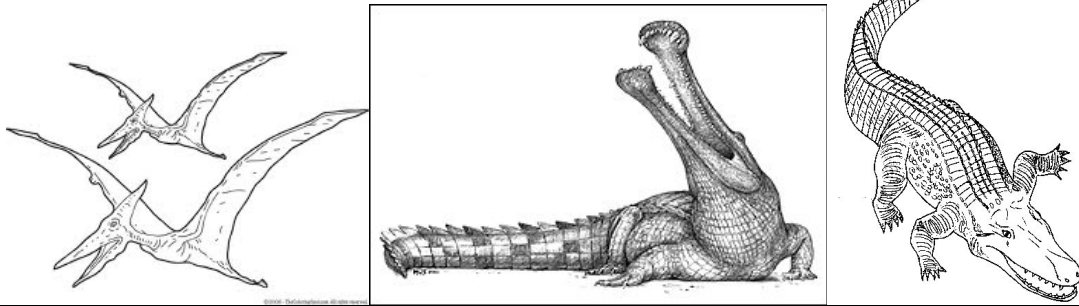


Mososaur

Reptiles: diapsids – snakes & lizards



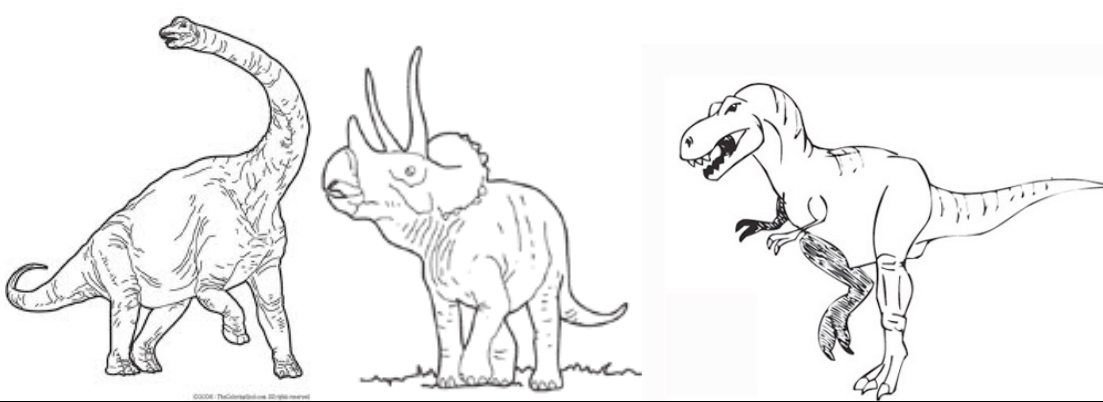
Reptiles: diapsids – pterosaurs & crocs



Reptiles: Jurassic dinosaurs



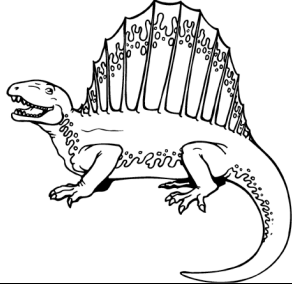
Reptiles: Cretaceous dinosaurs



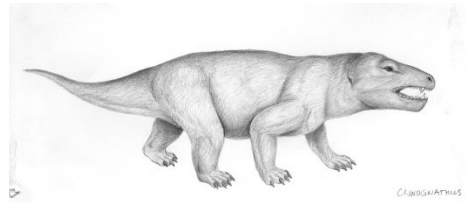
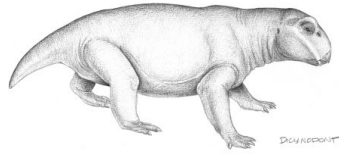
Birds: Archeopteryx, Diatryma (giant Eocene bird), lark



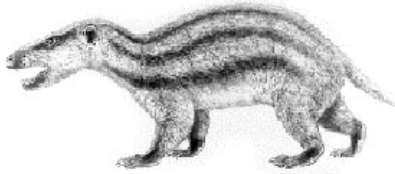
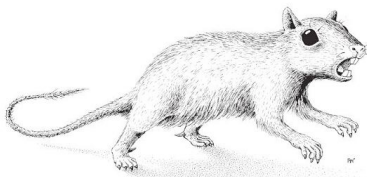
Synapsids: Permian
Dimetrodon,



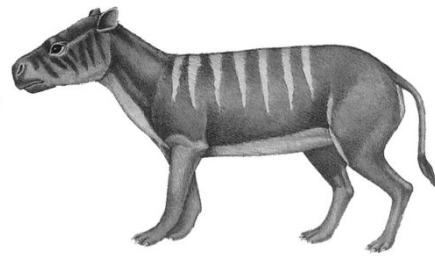
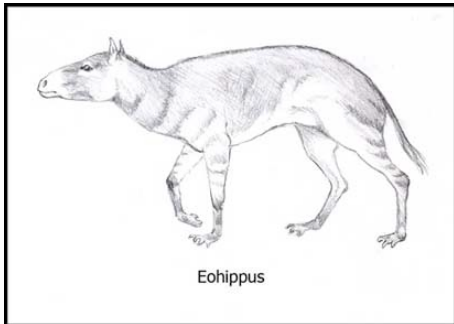
Mesozoic therapsids



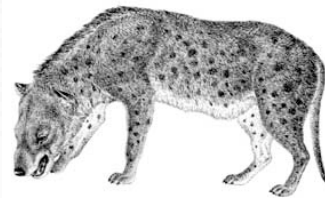
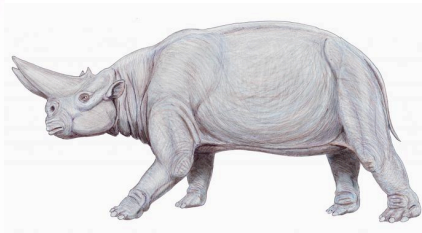
Synapsids: Mesozoic mammals



Synapsids: Early Cenozoic mammals (horse, carnivore, ungulate ancestor)



Synapsids: Middle Cenozoic indricothere, rhino, creodont



Synapsids: Pleistocene megafauna

