SYNAPSIDA

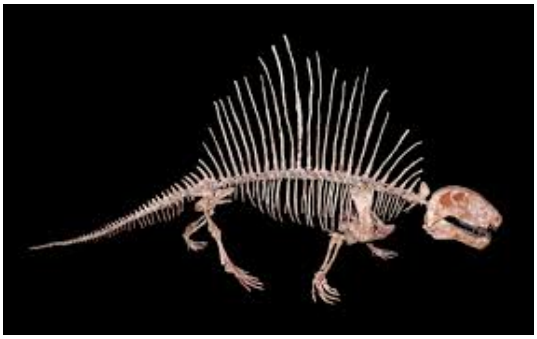
The Synapsida includes a clade characterized by a single temporal opening on either side of the skull. These first appeared during the Mid-Carboniferous and diversified during the Permian and became the dominant land vertebrates. This group ultimately gave rise to the mammals.

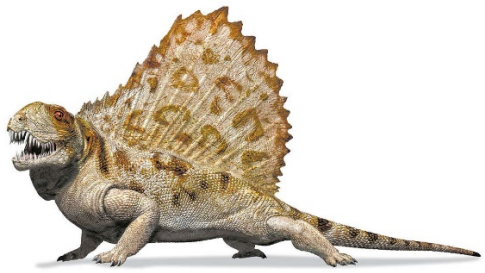
The Synapida may be subdivided into two orders –

(1) Pelycosauria
(2) Therapsida

Pelycosauria

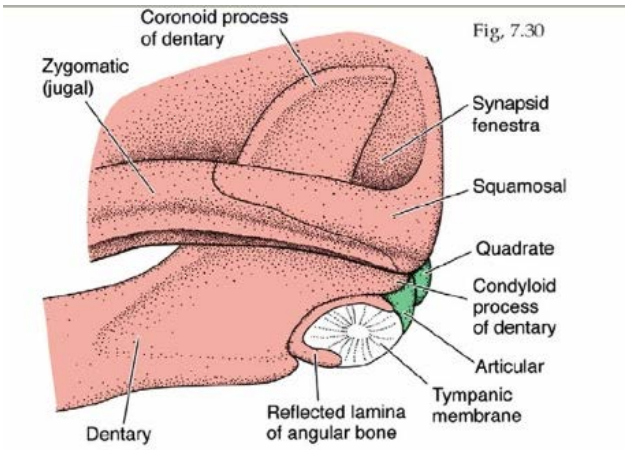
The pelycosaurs are a paraphyletic group, which first appeared during the Mid-Carboniferous, and became extinct by the Permian. The group included different types of land vertebrates, most of which were carnivorous. They are known from the sediments of North America, Russia and China. Two pelycosaur groups are characterized by massive sails on their backs. These are actually highly elongate neural spines on the vertebral column. It is hypothesized that these bones were attached with a thin membrane/skin, which acted as a thermoregulatory mechanism. As these were cold blooded animals, the sail was used to absorb heat from the sun. Example: *Dimetrodon*.





Therapsida

From the late Permian of Russia, China and Gondwana countries such as southern Africa, Madagascar, India, Australia, Antarctica and South America appeared a much more diverse group called Therapsida. The group is characterized by the reflected lamina of the angular bone, which is found in the lower jaw. The mammals appeared from the Therapsida.



Most reptiles, even the present-day snakes, lizards and crocodiles, can hear with the help of ground vibration. Reptiles do not have external ear or ear membrane to catch sound vibration for air, which is a feature found in the mammals. As mammals have evolved from the therapsids, it is hypothesized that the earliest form of a thin ear membrane evolved in the therapsids. This ear membrane is considered to be attached to the reflected lamina and posterior part of the lower jaw.

Therapsida includes diverse taxa, which included:

(a). **Dicynodontia** – an extinct group of terrestrial herbivores that ranged from Late Permian to the end of Triassic. These animals were mostly edentulous (without teeth), have tusks and are characterized by the backward and forward movement of the lower jaw.

All fossil and extinct reptiles could not chew their food. They catch hold of their prey, and swallow the food. Unlike mammals, these reptiles could not chew their food, that is these could not move their lower jaw sideways or backward and forward. However, the dicynodonts were the first animal to move their lower jaw backward and forward to chew the food into pulp matter.

Example: *Lystrosaurus*, an index fossil of Early Triassic, known from different Early Triassic sediments of the Gondwana continents, including India. In India, it is known from the Panchet Formation of the Raniganj Basin.

(b). **Cynodontia** – This is an advanced group of therapsids, which have many anatomical changes that ultimately led to the emergence of the mammals. Cynodonts first appeared in the Permian and diversified into several groups during the Triassic. The first cynodont, *Procynosuchus* is known from the uppermost Permian of South Africa and Germany.

The anatomical changes that resulted in the evolution of mammals are as follows:

1. First appearance of the secondary palate, which separates the oral cavity/mouth from the nasal passage/nose.
2. Tooth differentiation appeared with the cynodonts. Tooth differentiation means appearance of incisors, canines, premolars and molars based on their functions. This is a characteristic feature of the mammals, which first appeared in the cynodonts. Such

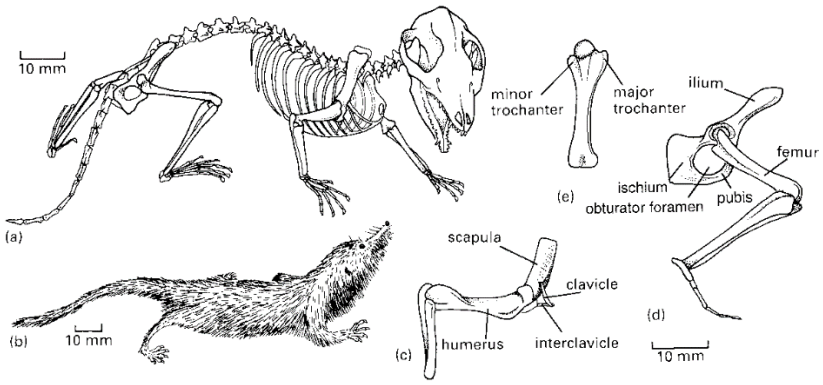
tooth differentiation is not found in other reptiles or lower vertebrates, where the teeth are uniform in shape.

3. Change from polyphyodonty (continuous tooth replacement as found in the lower vertebrates such as the reptiles) to diphyodonty, which is found in the mammals, where deciduous teeth of the juveniles get replaced by permanent teeth.
4. Increase in braincase size.
5. Change of the lower jaw from a mosaic of bones to only 2-3 bones. In case of reptiles, the lower jaw is composed of several bones, which are sutured togethered. However, presence of sutures means existence of planes of weakness, which resulted in dislocation and breakage of the lower jaw during capturing of preys. To avoid this, the mammals evolved lower jaws composed of a single bone. The cynodonts show a drastic decrease in the number of bones to only 2-3 in the course of their evolution to the mammals.
6. Appearance of semi-erect or erect stances in the cynodonts.

   The most advanced cynodonts are the trithelodontids, from which evolved the mammals.

CLASS: MAMMALIA

The first mammals appeared in the Late Triassic, but the first fossils are incomplete. *Adelobasileus* and *Sinoconodon* appear to be the most basal mammals, but the first reasonably well-represented mammals are the morganucodontids (genus *Morganucodon*) from the Early Jurassic. These early mammals were tiny, with 20–30-mm skulls and total body lengths of less than 150mm.



Morganucodon

One of the major features that evolved with the evolution of mammals is the dentition. In the cynodonts and early mammalian forms such as Morganucodontids, the postcanine teeth/ premolars and molars were triconodont, with three cusps arranged linearly (Fig. A).

In the more advanced forms, the three principal cusps of its teeth are arranged in a very shallow triangle (Fig. B). Early mammals diversified during the Jurassic and Cretaceous. The largest group of Mesozoic mammals, and one that survived into the late Eocene, were the multituberculates, rodent-like omnivores that first appeared in the Late Jurassic.

This is followed by the appearance of tribosphenic molars in the mammals, which refers to the derived mortar-and-pestle type of occlusal action of these teeth. The occlusal surface is a triangle of three cusps. The tribosphenic molar defines a group consisting of marsupials, placentals and their immediate extinct relatives. The tribosphenic molar (Fig. C) has six shearing surfaces.

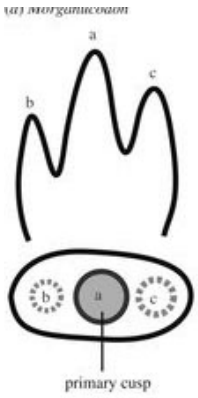


Fig. A

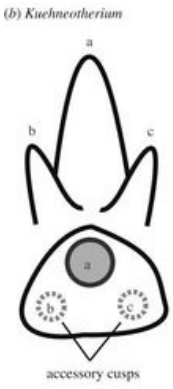


Fig. B

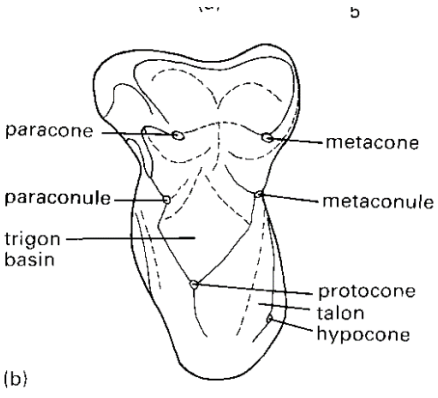


Fig. C

Modern mammals fall into three main groups: (1), monotremes; (2), marsupials and (3), placentals.

1. Monotremes – these mammals lay eggs. Example – duck-billed platypus of Australia. Earliest record of the monotremes are from the early Cretaceous of Australia.
2. Marsupials – these mammals give birth to very small young ones. Example – kangaroo. The first marsupials are known from the Mid Cretaceous of North America.
3. Placentals – these retained their young ones in the uterus to a more advanced stage. The placentals are represented by 10 or more families in the Late Cretaceous of North America, South America and Mongolia. These are the most diverse mammals today.