Trends in the evolution of mammals

Movement of limbs under body to support body above ground

Increased brain size

Increased efficiency of mastication
  heterodont dentition
  expanded size and mechanical advantages of jaw musculature
  reduction and movement of “post-dentary bones” from jaw into middle ear
Cross-section through head of Fish

- Neurocranium
- Spiracle
- Inner ear
- Operculum
- Hyomandibula
- Quadrature bone
- Articular bone
- Pharynx
Cross-section through head of Tetrapod

- Eustachian tube
- Columella
- Tympanic membrane
- Inner ear
- Pharynx
- Quadrato bone
- Articular bone
## Homologies of Postdentary Bones

<table>
<thead>
<tr>
<th>Fishes</th>
<th>Amniotes</th>
<th>Mammals (among amniotes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyomandibula</td>
<td>Stapes (= “columella”)</td>
<td>Stapes (=“stirup”)</td>
</tr>
<tr>
<td>Quadrat</td>
<td>Quadrat</td>
<td>Incus (=“anvil”)</td>
</tr>
<tr>
<td>Articular</td>
<td>Articular</td>
<td>Malleus (=“hammer”)</td>
</tr>
<tr>
<td>Angular</td>
<td>Angular</td>
<td>Tympanic (=“ectotympanic” or “tympanic ring”)</td>
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<tr>
<td>Dentary</td>
<td>Dentary</td>
<td>Dentary</td>
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</tbody>
</table>

**blue** – middle ear ossicles of mammals

**green** – bones of mandible (= “lower jaw”)

Reduction of post-dentary bones in Synapsids
Mammalian Middle Ear Ossicles

- **Hammer**
- **Anvil**
- **Stirrup**
- **Footplate**
- **Tympanic Membrane**
Increased mechanical efficiency of jaw
use of enlarged braincase and temporal fenestra as areas of
enlarged jaw muscle origin
larger lever arm
movement of mandibular articulation anteriorly

early synapsid

late synapsid

arrow: vector of muscle contraction
Ophiacodon  late Carboniferous-Permian Pelycosaur
Dimetrodon  Permian Pelycosaur
Dimetrodon skull

- synapsid
- temporal fenestra
- mandibular articulation
- homodont dentition
Inostranscevia
Permian Cynodont
Lycaenops
Permian Cynodont
**Thrinaxodon** Triassic cynodont

- **Tendency towards heterodont dentition**
- **Increased area for origin of masticatory muscles**
- **Ring-like shape of angular post-dentary bone**
**Morganucodon**
Triassic cynodont

**Hadrocodium**
Jurassic cynodont
Multituberculates Jurassic-early Cenozoic small non-Therian mammals that superficially would have resembled rodents or insectivores strange highly specialized heterodont teeth
Eomaia
oldest presumed Eutherian – lower Cretaceous of China
Late Cretaceous shrew-like Therians of Asia

Asioryctes

Ukaatherium
Archaic Paleogene Eutherian Mammals
e.g., Pantodons

e.g., Condylarthrs
Archaic Paleogene Eutherian Mammals

e.g., Oreodonts

e.g., Creodonts
Early Paleogene Primates

*Plesiadapis*

*Carpolestes*