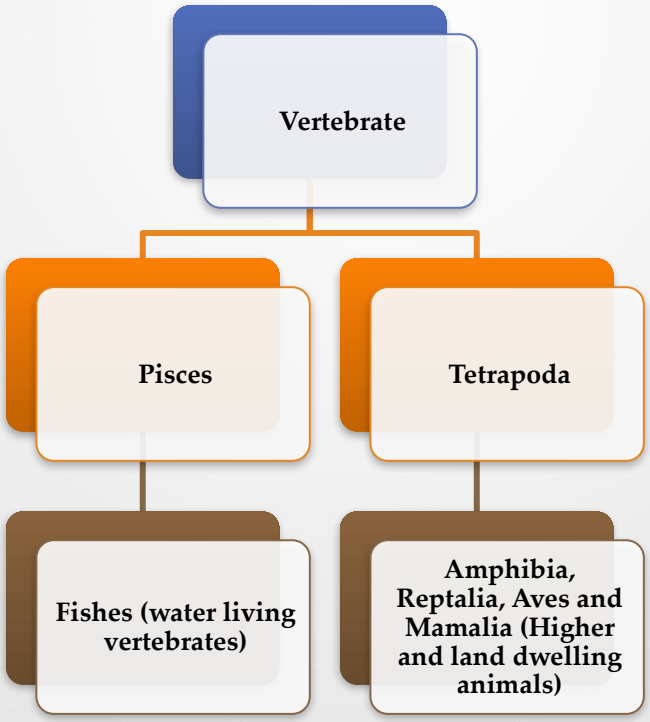
VERTEBRATE

- A vertebrate is an animal that has a backbone and a skeleton.
- *Vertebrate* animals include humans

- vertebrate animals have been found only in Ordovician and younger rocks.
- Evolution of these animals from fishes to mammals is remarkably well understood.
- Vertebrates are mainly classified into **Super Class Pisces and Tetrapoda**



Vertebrate Classification

- **Vertebrates are placed in Nine different classes.**
- ***Five of the classes are Fish.***
- The other classes are ***Amphibians, Reptiles, Birds, and Mammals***.

Major Structural Changes

- ✓ Features Associated with Origin of Vertebrate
- ✓ Features Associated with Origin of Ganthostomes
- ✓ Features Associated with Origin of Tetrapod
- ✓ Features Associated with Origin of Aves
- ✓ Features Associated with Origin of mammals

Major Structural Changes

✓ Features Associated with Origin of Vertebrate

1. Emergence of chordate body plan
2. Origin of brain and paired sense of organ
3. Origin of bone

✓ Features Associated with Origin of Ganthostomes

1. Origin of Jaw
2. Origin of teeth and replacement pattern
3. Origin of paired fins

✓ Features Associated with Origin of Tetrapods

1. Origin of Limbs in Amphibians
2. Origin of Impedance-matching ears

✓ Features Associated with Origin of Aves

1. Origin of wings with feathers

✓ Features Associated with Origin of Mammals

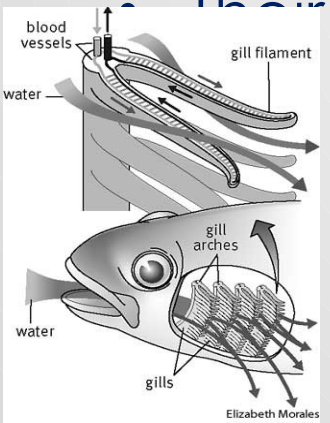
1. Precise tooth occlusion
2. Tribosphenic molar
3. Three auditory ossicles

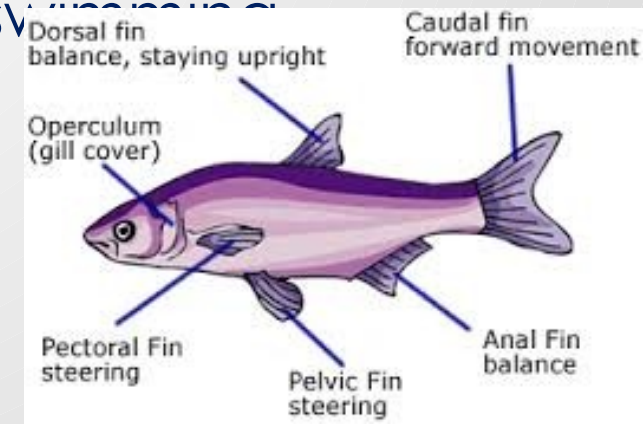
VERTEBRATE

Pisces

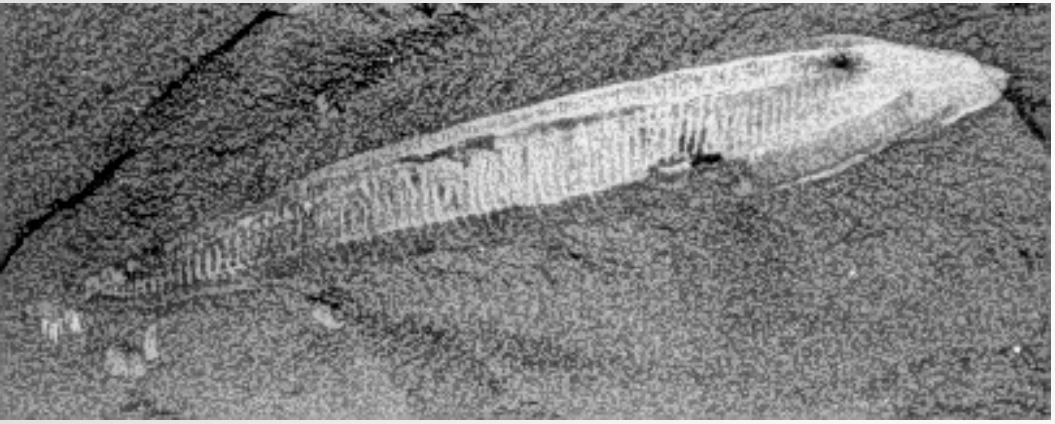
General

- The Pisces includes vertebrates adopted for a life in water.
- They breathe through gills and gill arches
- They have spindle shaped body.
- They have paired and unpaired fins
- Their skin is mostly covered by scales
- Their life started in Ordovician but **age of fish is Devonian.**
- They are ectothermic aquatic vertebrates
- Lays eggs in water
- Their limbs are modified into fins for swimming





Class	Details	Example
Hagfish	➢ They have a cranium (skull) but no backbone; ➢ They do not have jaws; ➢ Their endoskeleton is made of cartilage; ➢ They are ectothermic (cold-blooded).	**Hagfish**



Class	Details	Example
Lampreys	➢ They have a partial backbone; ➢ They do not have jaws; ➢ Their endoskeleton is made of cartilage. ➢ They are ectothermic.(cold-blooded)	**Lamprey**

Class	Details	Example
Cartilaginous Fish	➢ They have a complete backbone. ➢ They have jaws. ➢ Their endoskeleton is made of cartilage. ➢ They are ectothermic.	**shark**

Class	Details	Example
Ray-Finned Fish	➢ They have a backbone and jaws. ➢ Their endoskeleton is made of bones. ➢ They have thin, bony fins. ➢ They are ectothermic.	**Perch**

Class	Details	Example
Lobe-Finned Fish	➢ They have a backbone and jaws. ➢ Their endoskeleton is made of bones. ➢ They have thick, fleshy fins. ➢ They are ectothermic.	**Coelacanth**

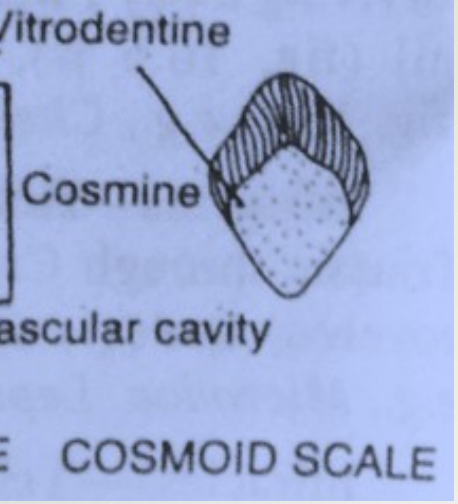
Pisces

- Class Agnatha which includes Hagfish and Lamprey
  - They are earliest vertebrates without typical limbs and jaws
  - They include Paleozoic Ostrocoderms and modern soft bodied Cyclostomes
  - Octrocoderms are fish like vertebrates found in Late Silurian and Early Devonian.
  - Length are varied from few centimeter to 14m.
  - Paired fins are absent or poorly developed
  - Mostly found in freshwater and some were in marine also
- Class Placodermi
  - Devonian and carboniferous age
  - Early jawed fishes with appendages from fresh water
  - Heavily armed
  - It is divided in to six order and all are extinct.

Pisces

- ✓ Class Chondrichthyes
  - ✓ Cartilaginous jawed fishes includes sharks, skates and rays (Elasmobranchia)and ratfishes (Holocephali)
  - ✓ All the fins are present
  - ✓ Sharks evolved in Devonian continued their expansion in carboniferous and Permian till today.
  - ✓ They have four orders

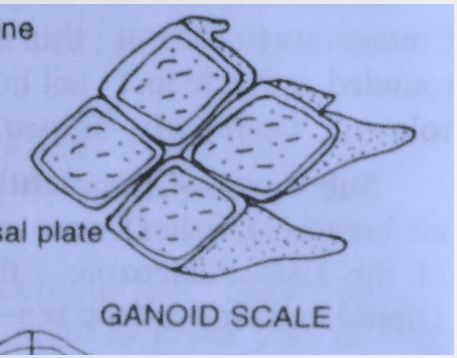
- Class Osteichthyses
  - Include all bony fishes
  - Gill slits covered by Opercula
  - Age: Middle Devonian to present day



Type of Scales

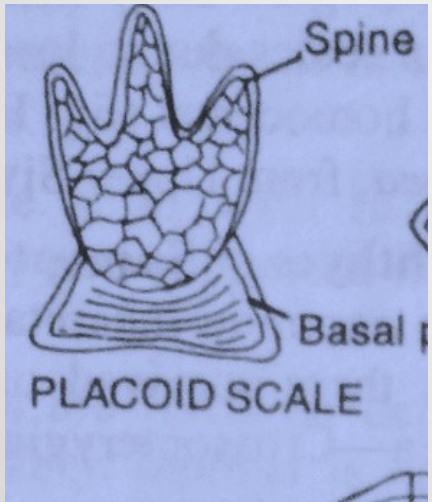
Cosmoid Scale:

- It is rhomboid shape and found in extinct Crossopterygii.



Ganoid Scale:

- It is also usually rhomboid shape overlap each other and articulate by pegs and socket.
- It has regular arrangement of scale and they give rise to tooth like appearance.



Placoid Scale:

- Dish like basal plate with spines projecting outwards
- It is composed of vitrodentine.

Cycloid Scale:

- These are known as bony ridge scales.
- They are thin and transparent due to absence of vitro-dentine.
- Central part of the scale is the focus and first to be formed
- The cycloids are rounded, thicker in the center and thinning out towards the margin

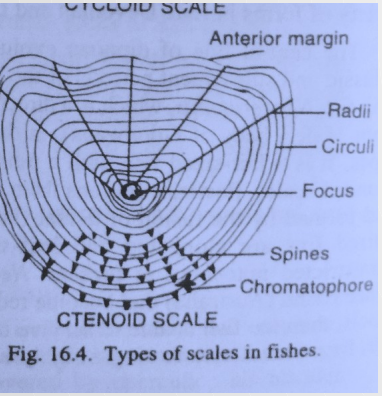


Fig. 16.4. Types of scales in fishes.

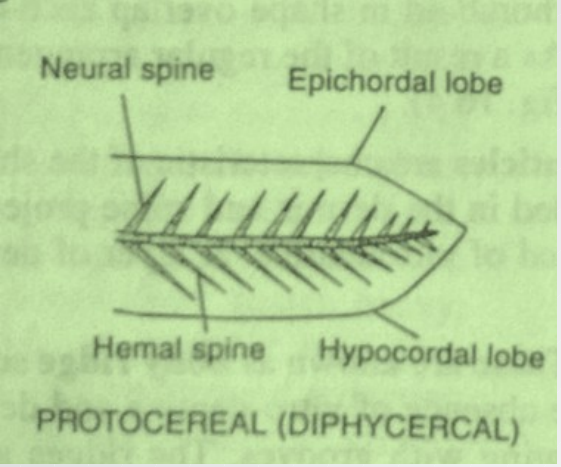
Ctenoids Scale:

- Circular in shape and have more or less serrated free edge
- Several spines are present on the posterior area of the scales

Fins

- ✓ Fins may be paired or unpaired
- ✓ Pectoral and Pelvic fins are paired
- ✓ Dorsal, Anal and Caudal fins are unpaired
- ✓ The position of all fins except caudal fins are fixed
- ✓ Caudal fins are classified on the basis of verbal column into four types.

- ✓ **Protocercal (Diphycercal)** is the most primitive (first tail). The hind end of the notochord is straight and divides the caudal fin in to two equal lobes.
- ✓ **Hetrocercal (unequal)** The hind end of the verbal column bend ubwards and continues almost upto the end of caudal fin,
- ✓ **Homocercal (equal)** The tail is symmetrical externally but internally the hind end not reach the tip of tail end
- ✓ **Hypocercal** Tail is asymmetrical and the hind end of the verbal column is bend downward



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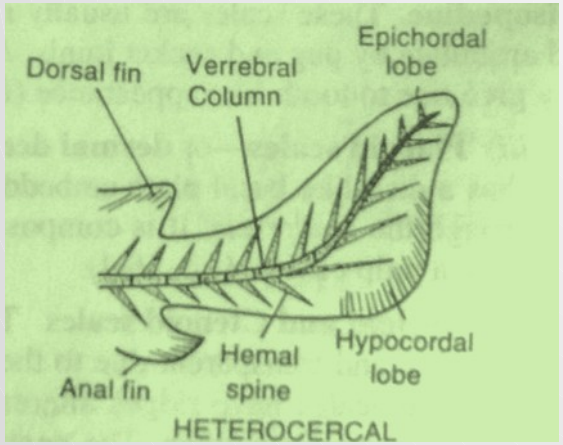


- ✓ **Hetrocercal (unequal)** The hind end of the verbal column bend ubwards and continues almost upto the end of caudal fin,

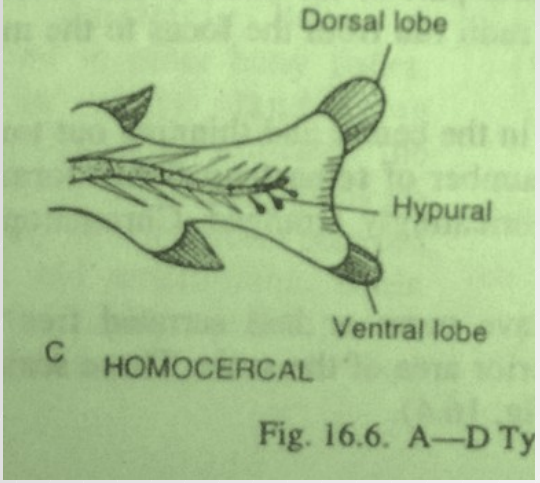
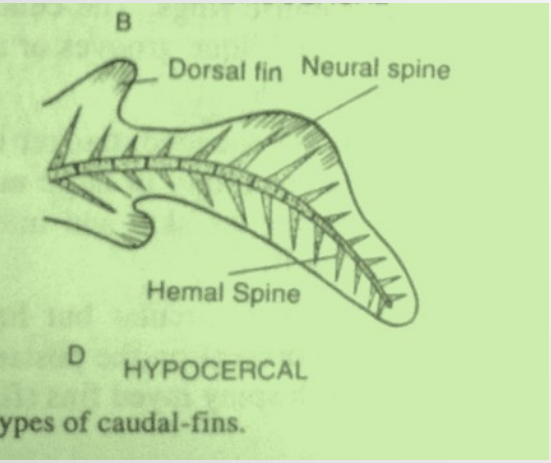


Fig. 16.6. A—D Ty

- ✓ **Homocercal (equal)** The tail is symmetrical externally but internally the hind end not reach the tip of tail end



ypes of caudal-fins.

- ✓ **Hypocercal** Tail is asymmetrical and the hind end of the verbal column is bend downward

VERTEBRATE

Tetrapoda

Amphibians	➢ They have a bony endoskeleton with a backbone and jaws. ➢ They have gills as larvae and lungs as adults. ➢ They have four limbs. ➢ They are ectothermic.	**Frog**

Reptiles	➢ They have a bony endoskeleton with a backbone and jaws. ➢ They breathe only with lungs. ➢ They have four limbs. ➢ Their skin is covered with scales. ➢ They have amniotic eggs. ➢ They are ectothermic.	**Alligator**

Eggs that contain an amnion to protect the embryo are referred to as **amniotic eggs**

Aves	➢ They have a bony endoskeleton with a backbone but no jaws. ➢ They breathe only with lungs. ➢ They have four limbs, with the two front limbs modified as wings. ➢ Their skin is covered with feathers. ➢ They have amniotic eggs. ➢ They are endothermic (Warm-blooded).	**bird**

Mammals	➢ They have a bony endoskeleton with a backbone and jaws. ➢ They breathe only with lungs. ➢ They have four limbs. ➢ Their skin is covered with hair or fur. ➢ They have amniotic eggs. ➢ They have mammary (milk-producing) glands. ➢ They are endothermic.	**bear**

Class Amphibia

- During the late Devonian certain descendants of **Crossopterygian fishes** came out from water on the land and adapted themselves to the new mode of life.
- These fishes gave rise to primitive amphibians.
- According to **Romer**, the reason for migration of fishes from water is the droughting during Late Devonian period.
- It was moved to reach the fresh water and for more food.
- The first amphibian **Ichthyostega** is reported from freshwater deposits of Eastern Green land.

Class Amphibia

- This genus showed some characters of crossopterygian and some of amphibians.
- The caudal region and fin rays in the tail were retained.
- Development of gridles and limbs are took place in the pectoral and pelvic place.
- The limbs are possessed finned toes for swimming and jumping.
- The body is kept above the ground by limbs.
- This animal lead double mode of life that is living in both water and land
- They lay eggs in water
- Amphibians are cold blooded animals and respiration by means of gills in the larval stage

Classification Amphibia

- **Watson** and **Romer** recognized Stegocephalia and it divisions into four orders
    - Labryinthodontia
    - Phyllospondyli
    - Lepospondyli
    - Adelospondyli
- According to **Young**, this was unnatural grouping mainly deals with geologically older and younger amphibians.
- Colbert made 3 sub-classes of which two are of extint amphibians namely Labryinthodontia and Lepospondyli and Lissamphibia includes modern amphibians.

AMPHIBIANS

- live on land & in water.
- webbed feet.
- breathe with lungs & gills.
- cold-blooded.

- moist smooth skin, (no hair or fur)
- 4 legs (sometimes none)
- lay many eggs.

Fun Facts about Amphibians

- Most amphibians have thin, moist skin that helps them to breathe.
- Amphibians are considered vertebrates as they have a backbone.
- Frogs swallow their food whole. The size of what they can eat is determined by the size of their mouths and their stomach.
  Frogs cannot live in salt water.
- All amphibians have gills, some only as larvae and others for their entire lives.
- It is a myth that you can get warts from touching a frog or toad.
- A group of frogs is called an army.
- An Amphibian's skin absorbs air and water. This makes them very sensitive to air and water pollution.
  The world amphibian population is in decline.

FLOURIE MAE O. OJALES

DINOSAURS

- Richard Owen used the term Dinosaur which means fearfully great reptile.
- They have evolved during the Mesozoic period.
- Dinosaurs span from about 252 million years ago to about 66 million years ago.
- It was known as the "age of reptiles" or "the age of dinosaurs".
- Dinosaurs are readily classified in to two orders viz. Saurischia (carnivores) and Orinthischia (herbivores)
- Both orders showed extreme variations and they were Egg laying animals.

DINOSAURS

- The Saurischia is reptile hipped dinosaur ranged from Middle Triassic to the close of Cretaceous time.
- The Orinthischia is a bird hipped dinosaurs have not appeared until Late Triassic.
- North Atlantic Basin connecting Europe and North America, was the place where dinosaurs arose and began their world wide march.
- In India, Herbivores located in Godavari river and was dated 170million years. The same species have also been located in Canada and USA.
- On December 20, 1988, scientist from Indian Statistical Institute and geologist of the Jabalpur University have found fossils of world's first carnivores near the Gun Carriage factory hills at Jabalpur.
- This fossil dated back to 60my
- During May 1996, carnivore fossils were also recovered fro Stark desert of Africa which was dated some 65my to 100my.

DINOSAURS EXTICNTION

- The earliest dinosaurs of 150million years ago were similar across the globe.
- But 90 million years continental drift has made the dinosaurs to follow diverse evolutionary path.
- At the close of Mesozoic, rapid environmental changes in the topography taken place due to
  - 1. Post Cretaceous Mountain Building activity.
  - Ice-Age and consequently reduction in Vegetation
  - Out poring of lava and dust storm
- These are the few reasons for dinosaurs failed to adjust and became extinct.
- Dust storm due to asteroid impact around 65my ago might have also one of the reason for dinosaurs extinction.
- During the Mesozoic period, extensive changes in the elevation taken place which have drained of great inland Cretaceous sea along the low-lying shores on which the dinosaurs had their home.

Extinction

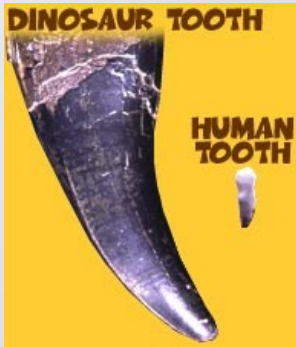
- **Cretaceous-Tertiary Extinction (K/T Extinction)**
  - Active plate movement, mountain-building, volcanism
  - Lowering of global sea level
  - Gentle global cooling
  - Asteroid impact

K/T Extinction

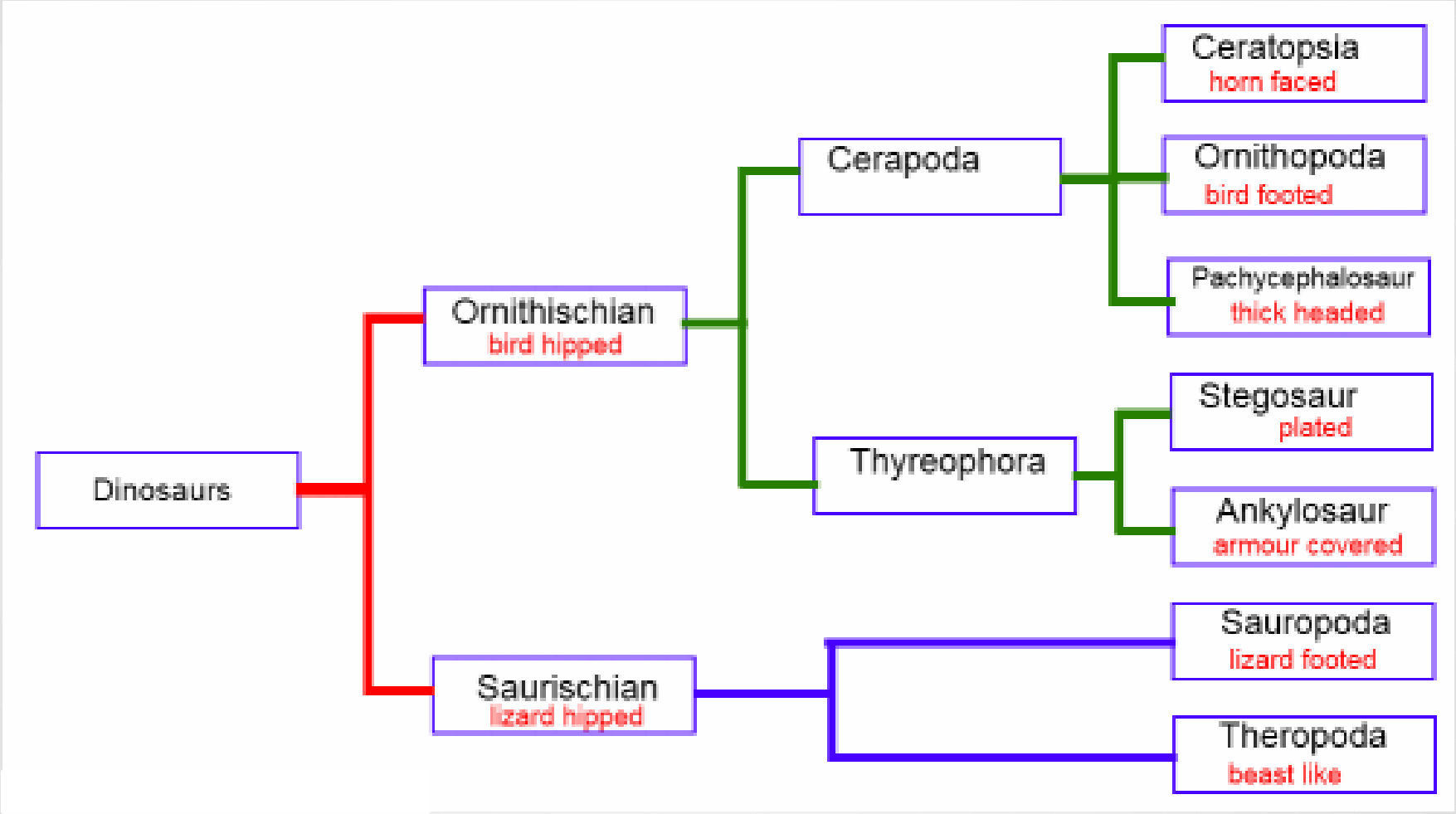
- **Chicxulub (devil's tail) crater- Gulf of Mexico**
  - Block sunlight
  - Short-term global warming
  - Global wildfires
  - Acid rain
  - Long term global cooling

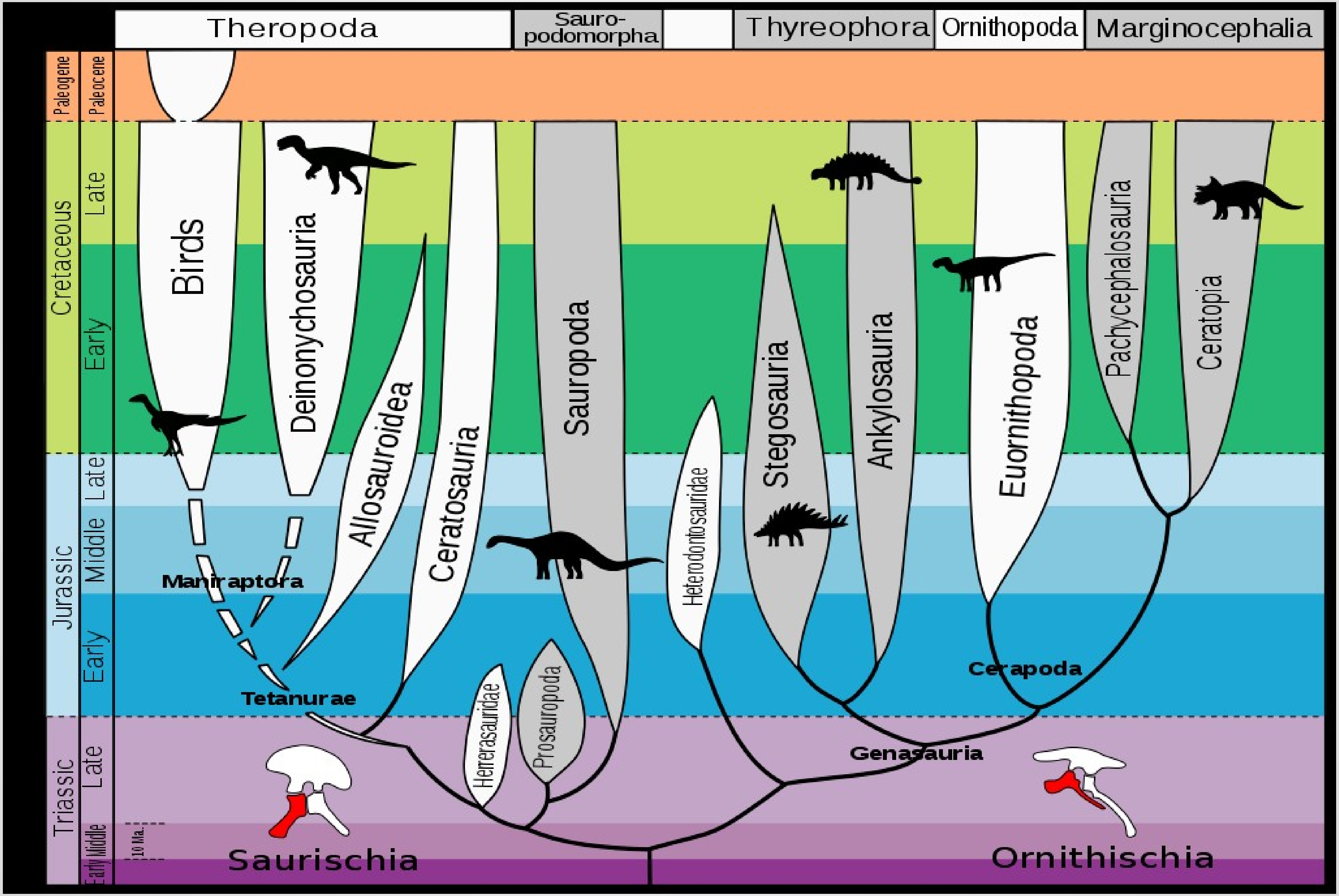
- There were different types of dinosaurs:
  - Some were small
    - Like a chicken
  - Some were tall
    - 3 story building
  - Some were plant-eaters
    - Flat teeth
  - Some were meat-eaters
    - Sharp teeth

- Some walked on 4 legs
  - Like animals today
- Others walked on 2 legs
  - With 2 short arms
- Many could fly like birds
- Others swam like alligators



DINOSAURS CLASSIFICATION




Theropoda
Sauro-
podomorpha
Thyreophora
Ornithopoda
Marginocephalia
Paleogene
Paleocene
Cretaceous
Late
Early
Jurassic
Late
Middle
Early
Triassic
Late
Early Middle
10 Ma.
Birds
Deinonychosauria
Allosauroidea
Ceratosauria
Sauropoda
Heterodontosauridae
Stegosauria
Ankylosauria
Euornithopoda
Pachycephalosauria
Ceratopia
Maniraptora
Tetanurae
Herrerasauridae
Prosauropoda
Cerapoda
Genasauria
Saurischia
Ornithischia

Saurischia - Lizard Hips

Saurischia are divided into two main groups.

- **Theropods** - meaning 'Beast foot'.
- They are the only meat-eating group of dinosaurs.
- They walked on three-toed bird like feet with sharp claws.
- They had powerful legs and short arms.

There is a sub-group of these dinosaurs called **Coelurosauria** that contains dinosaurs closely related to birds.

Most feathered dinosaurs discovered so far have been in this group.

Theropods

- Meat Eaters
- Powerful Legs
- Short Arms

eg. T. Rex

Tyrannosaurus Rex (T-Rex)

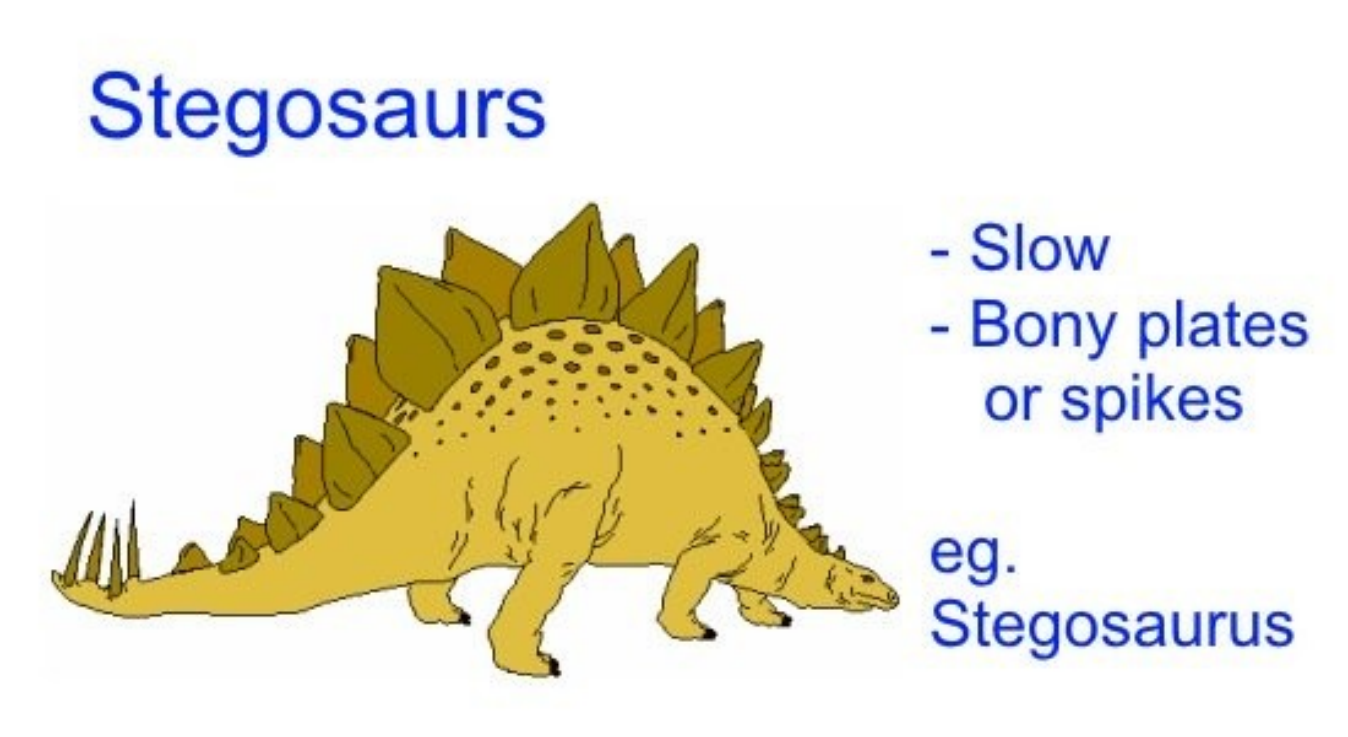
- Tyrannosaurus Rex means "lizard king"
- One of the fiercest of all dinosaurs
- Meat-eater
- About 12ft-16ft. Tall
- Walked on 2 legs

- **Sauropods** - lizard footed reptiles.
- These are the really large herbivores.
- They walked on all four feet, had small heads and long necks and tails.

Ornithischia – bird hipped.

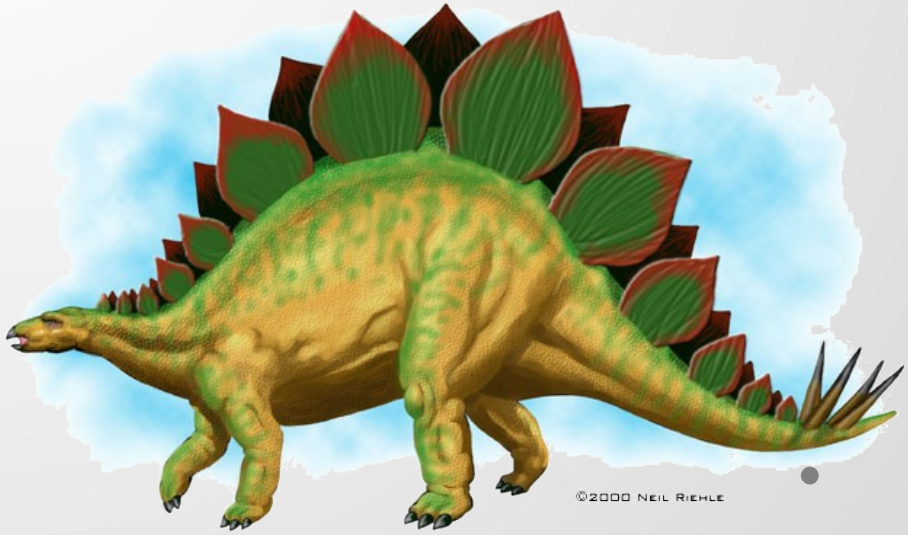
Ornithischia are firstly divided into two groups, with a total of five main subgroups.

All of the dinosaurs in this group were herbivores.



STEGASAURUS:

- Walked on 4 legs
- Plant-eater (flat teeth)
- Sharp plates on back
- Spikes on tail



- **Ankylosauria** (armour covered or 'fused together' reptiles).
- Small to medium sized dinosaurs.
- Their bodies were covered in flexible bony armour of slabs or plates.

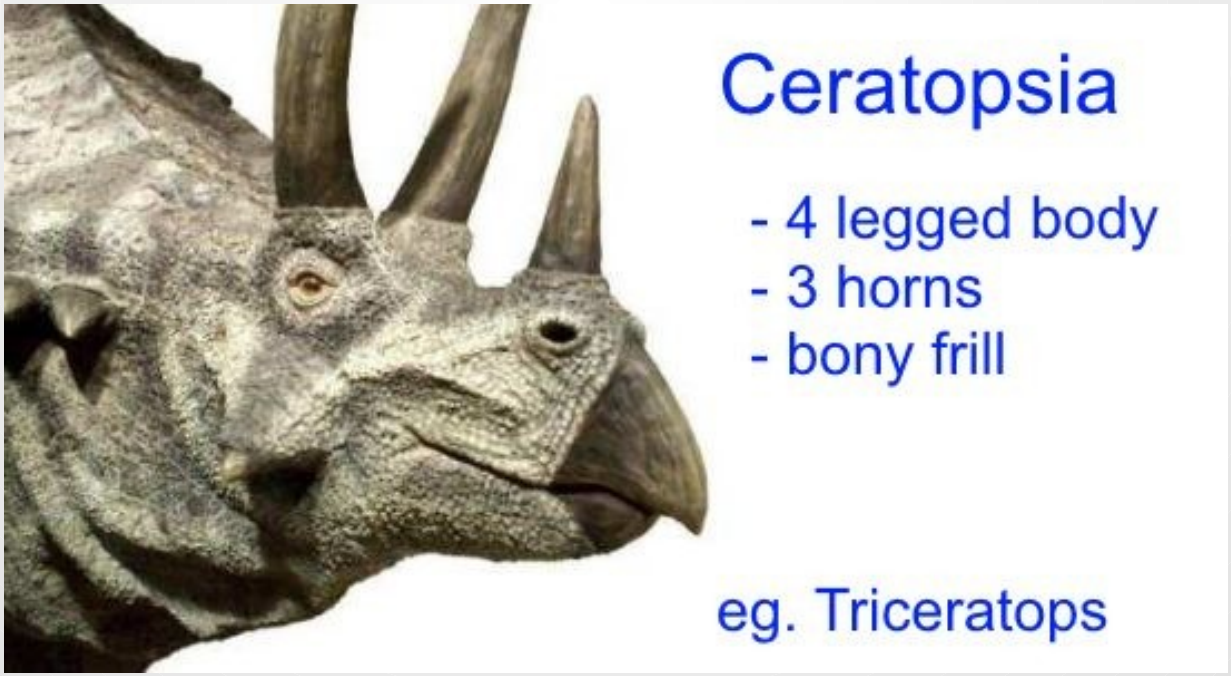
Ankylosauria

- Bony armour

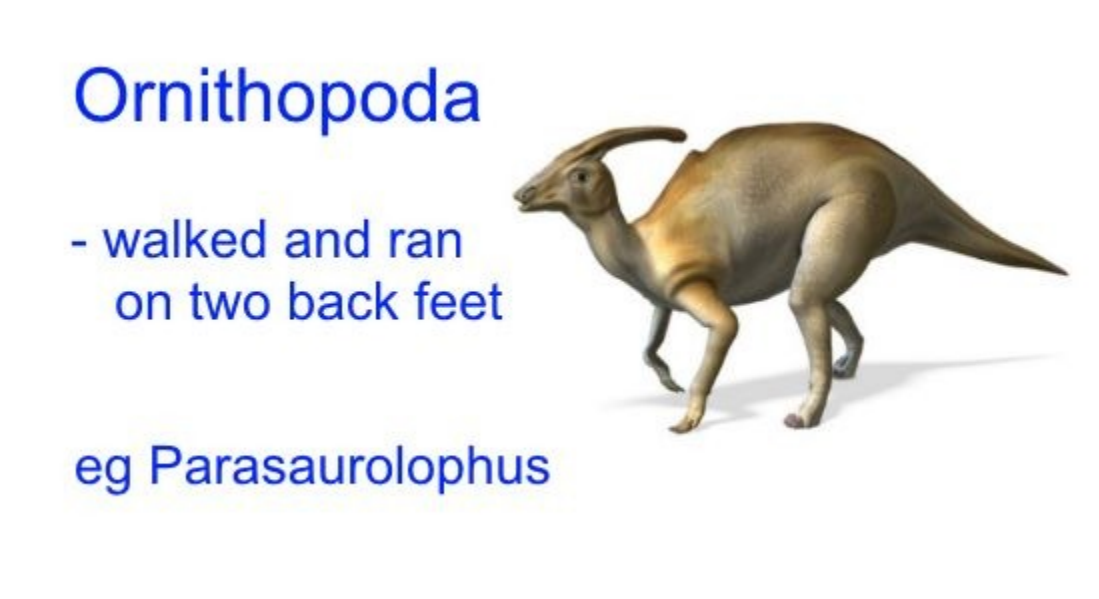
eg. Minmi

Cerapods

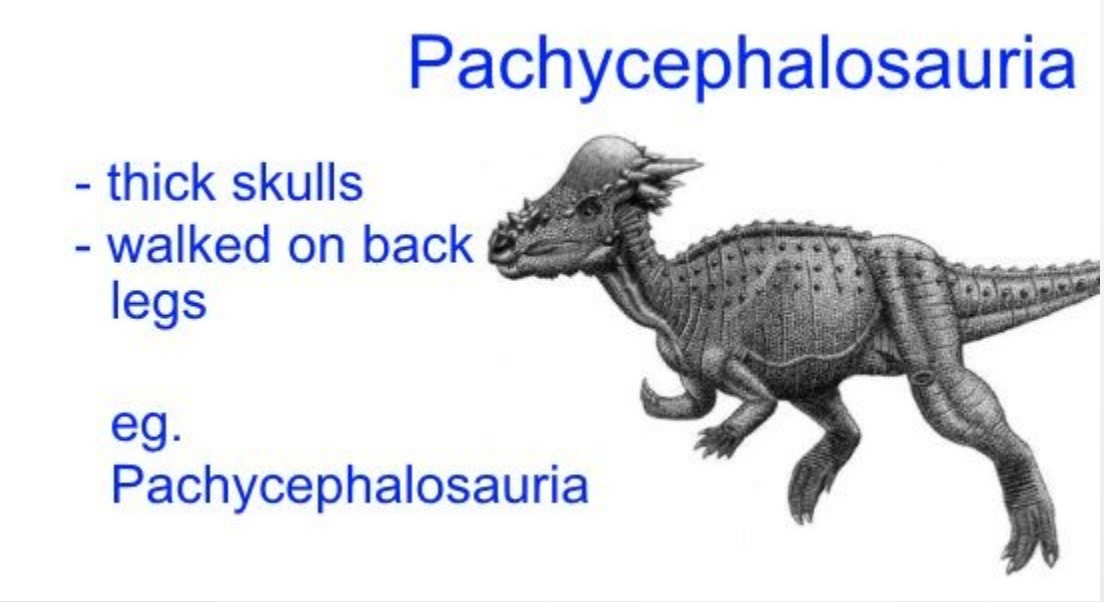
- Ceratopsia (Ceratopsians)- horned face reptiles.
- Small to large dinosaurs.
- Some had horned or frilled heads, and some had parrot-like beaks.
- Usually lived in large herds
- Dinosaur Classification - Ceratopsia

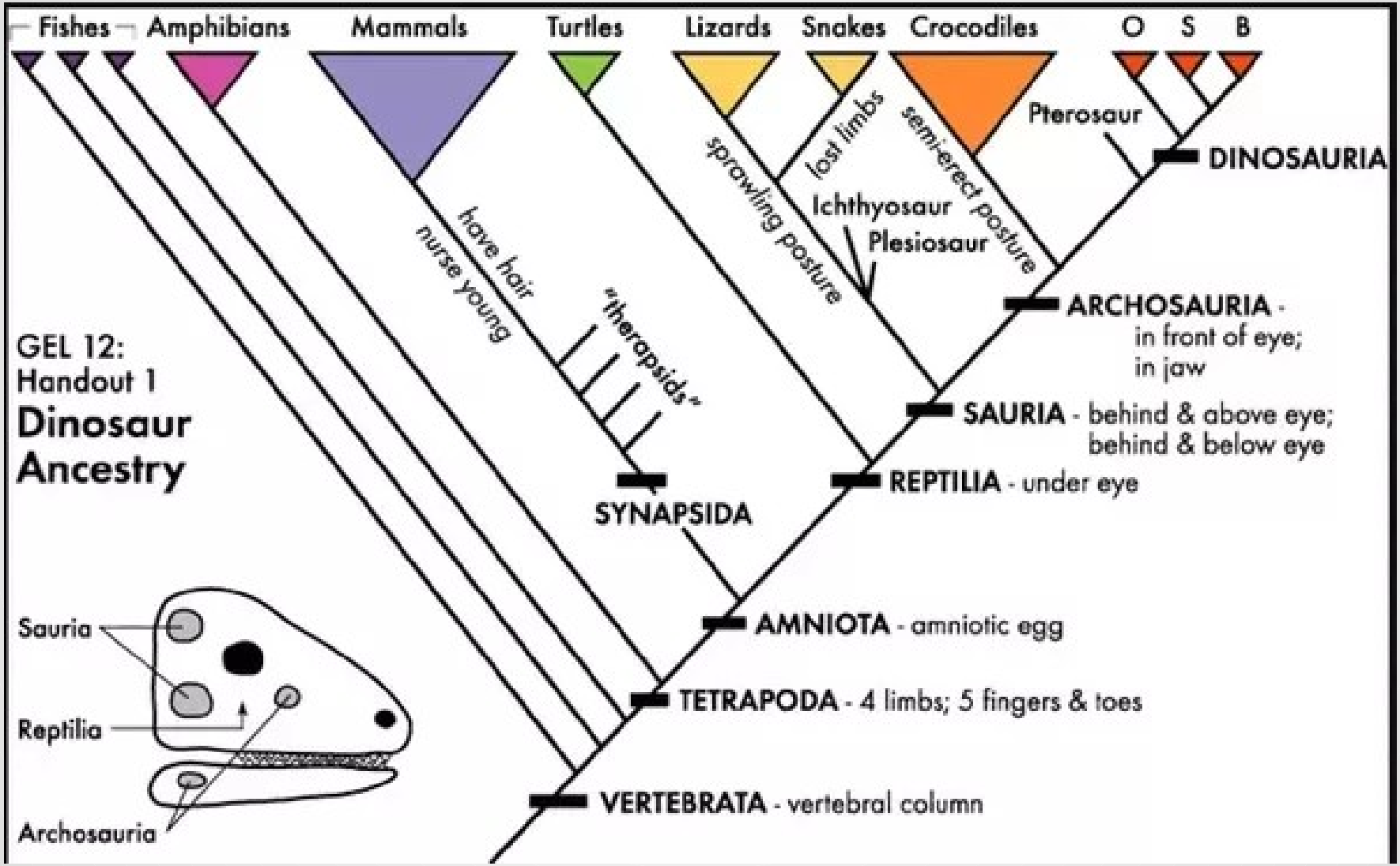


- **Ornithopoda** (Ornithopods) meaning bird feet.
- Small to very large dinosaurs that walked and ran on their two back feet.



- **Pachycephalosauria** - thick headed lizards.
- Small to medium sized dinosaurs that moved slowly on their back legs.
- Usually lived in herds.




Fishes
Amphibians
Mammals
Turtles
Lizards
Snakes
Crocodiles
O
S
B
Pterosaur
DINOSAURIA
lost limbs
semi-erect posture
sprawling posture
Ichthyosaur
Plesiosaur
have hair
nurse young
"therapsids"
ARCHOSAURIA - in front of eye; in jaw
SAURIA - behind & above eye; behind & below eye
REPTILIA - under eye
SYNAPSIDA
GEL 12:
Handout 1
Dinosaur Ancestry
AMNIOTA - amniotic egg
TETRAPODA - 4 limbs; 5 fingers & toes
VERTEBRATA - vertebral column
Sauria
Reptilia
Archosauria

Dinosaurs

What do we know about them?

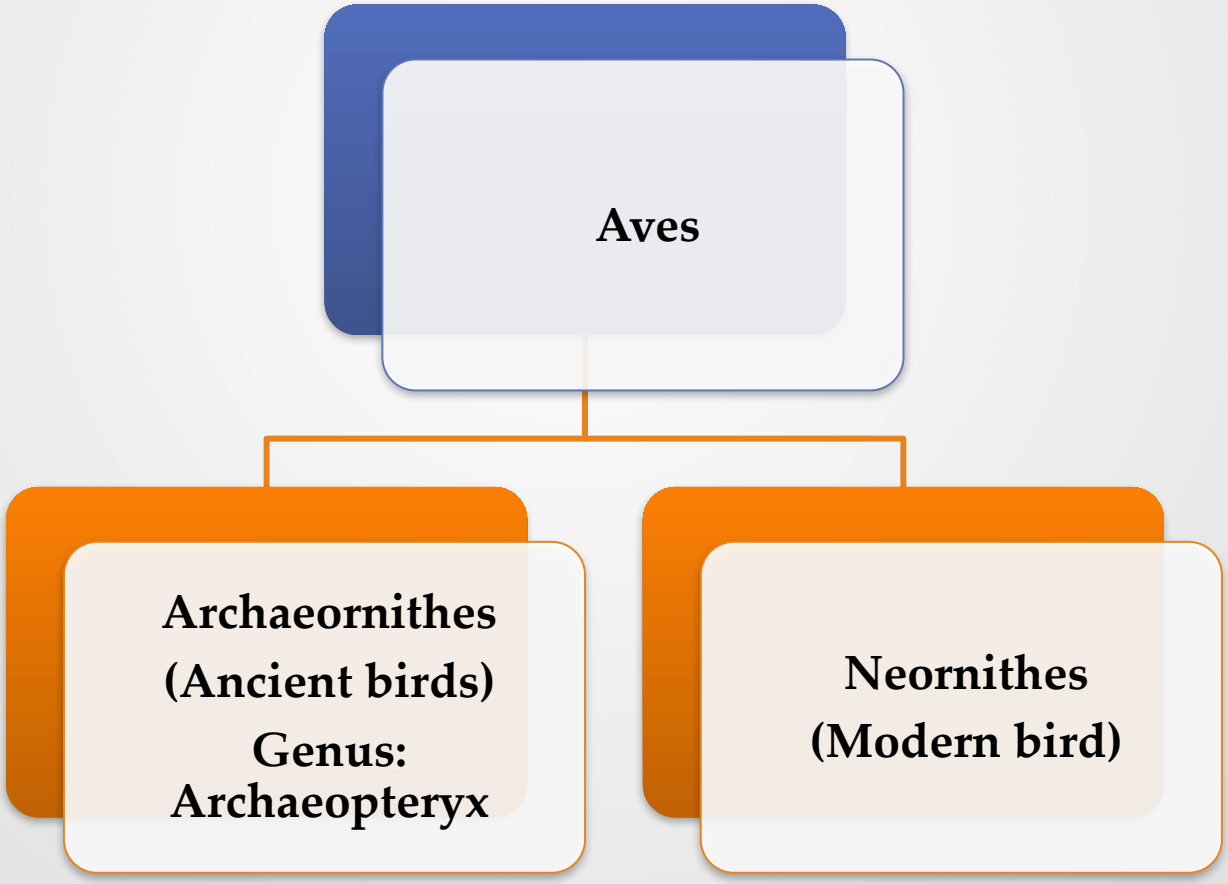
- Dinosaurs lived on earth more than 215 million years ago
- They lived in most parts of the world
- They ruled the earth for nearly 150 million years
- Dinosaurs have been extinct for 65 million years
- **<u>Extinct</u> – something that once alive but no longer exist anywhere on the earth**

AVES

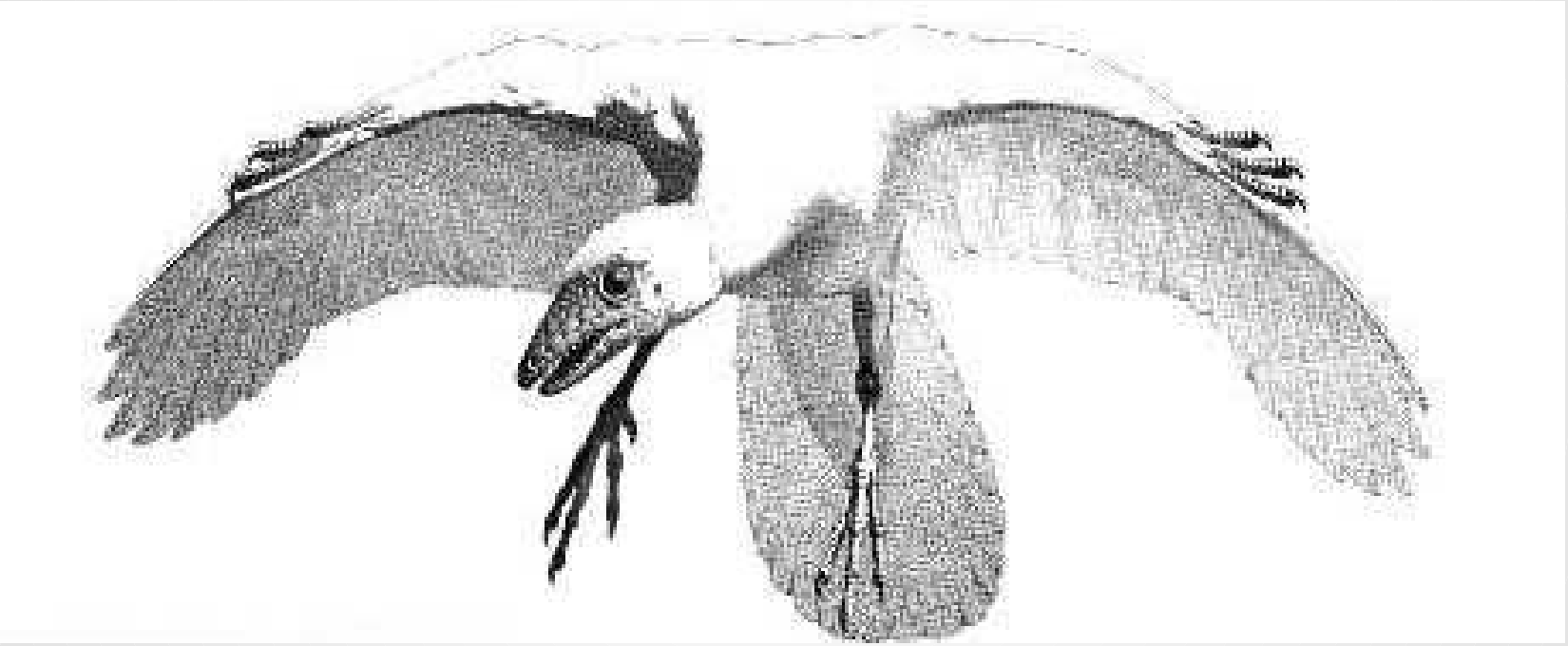
- Aves are warm blooded craniates in which every part of their body is modified in accordance with aerial life.
- Exoskeleton takes the form of feathers over the greater part of the body.
- Fore limbs are modified as wings.
- Except Jurassic Archaeopteryx, the teeth are absent in all tertiary and recent birds.
- Birds are oviparous. Eggs are large, shelled and cleidoic and have been derived from Mesozoic Archosaurian bipedal reptails.

AVES

- Aves are classified in to two subclasses



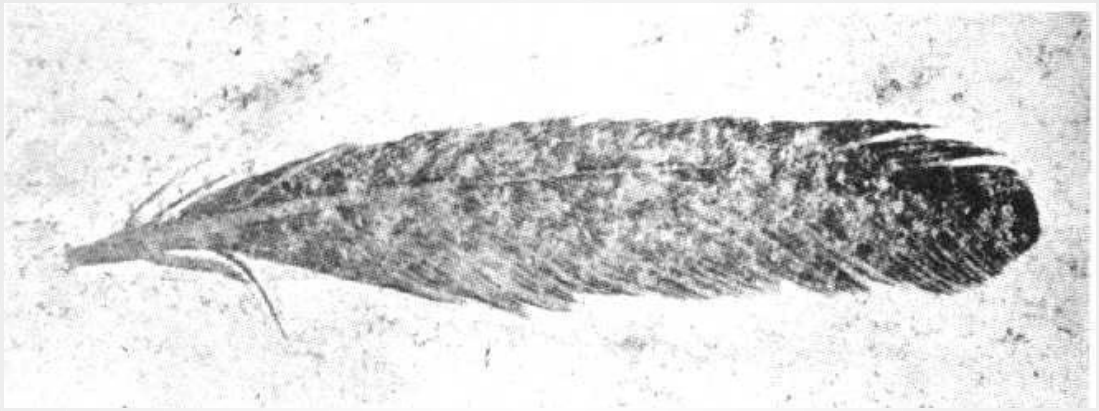
Archaeopteryx lithographica



Archaeopteryx

- Fossils known only from the Solnhofen lithographic limestone quarry in Bavaria
- First discovered in 1861
- The perfect ‘missing link’ between reptiles and birds
- the most important and valuable fossil known

A feather!



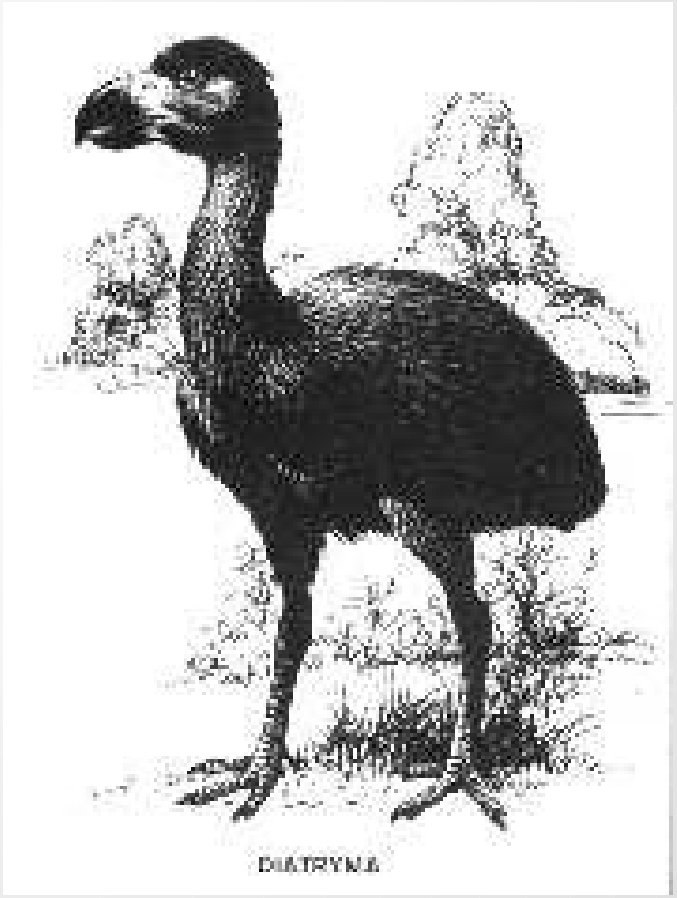
- probably for thermoregulation rather than flight

Archaeopteryx

- Dates to the **Jurassic**, ~160 mybp
- Slightly larger than a pigeon
- Did more gliding rather than flying
- Clawed 'fingers' for climbing
- Solid reptilian bones
- Had feathers and a furcula
- Probably not on the mainline of bird evolution

Diatryma

- ~60 mybp
- Large carnivore
- 7 ft. tall and flightless
- Probably ran down mammals and reptiles
- Found in New Jersey



Phororhacos

- ~30 mybp
- About as tall as a man
- Lived in South America, probably before the large predatory mammals lived there

Aepyornis

- Elephant bird
- weighed ~1000 pounds
- 2 gallon eggs

Evolution

WHAT IS EVOLUTION?

- Evolution is the process by which living things become adapted to their environment over many generations.

or

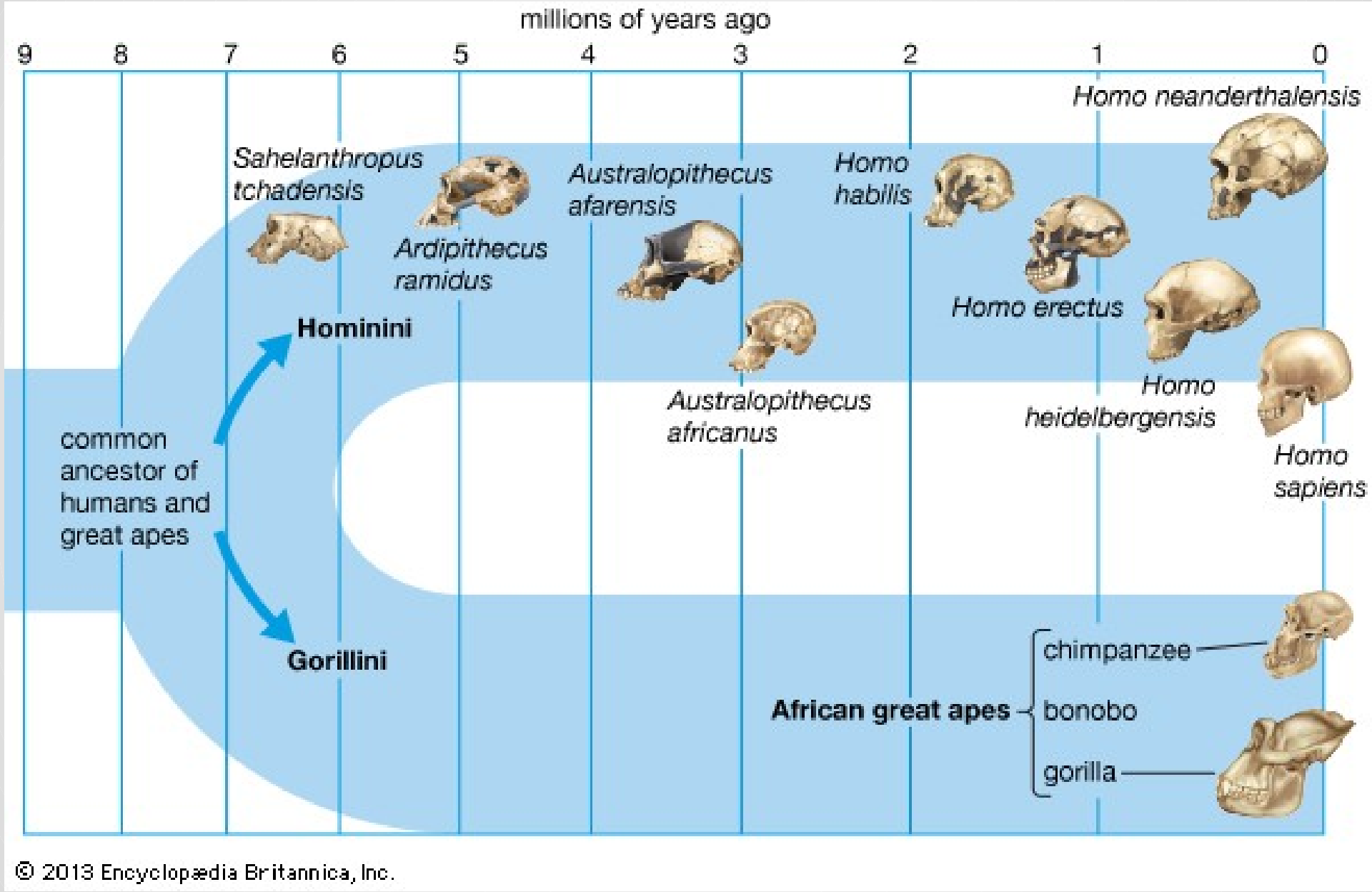
- Evolution is the process of gradual developmental modification so as to establish diversity and complexity in the living word.

Paleo-anthropology

- Paleoanthropology is the scientific study of human evolution.
- Paleoanthropology is a subfield of anthropology, the study of human culture, society, and biology.
- The field involves an understanding of the similarities and differences between humans and other species in their genes, body form, physiology, and behavior.
- Paleoanthropologists search for the roots of human physical traits and behavior.
- They seek to discover how evolution has shaped the potentials, tendencies, and limitations of all people.

- The earliest hominid fossils come from three African sites.
- Ar. kadabba is from Ethiopia; it is the earlier chronospecies of Ar. ramidus.
- Orrorin tugenensis is from Kenya, and
- Sahelanthropus tchadensis is from the Sahel of Chad.
- All these fossils are dated to the interval between 5 million and 7 million years ago.
- **Ardipithecus and Australopithecus** are the first two genera to evolve, were restricted to Africa.

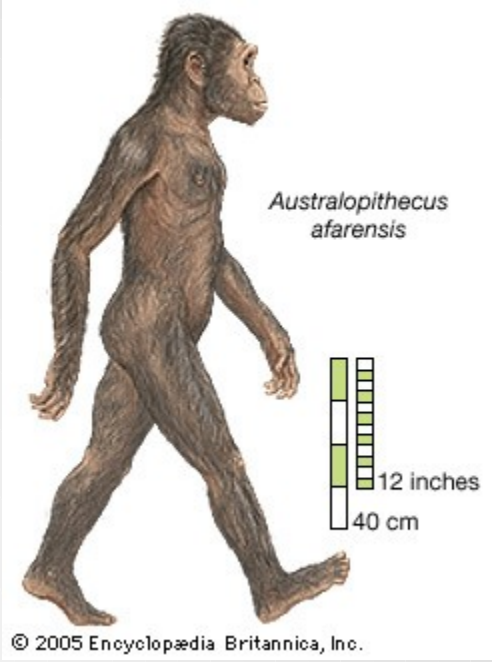
- Prior to the discovery of Ardipithecus, most people assumed that the last common ancestor of chimpanzees.
- The Ardipithecus fossils have no specifically chimpanzee-like features, and this indicates that the earliest hominids never passed through a chimpanzee-like stage.
- This finding surprised many scientists and much of the public, who had long envisioned that the ancestors of humans were early chimpanzees.
- Ardipithecus stands as the most likely ancestor of Australopithecus, and it provides the best insight into the biology of the earliest hominids and their immediate ancestors.



- Human evolution is the evolutionary process leading up to the appearance of **MODERN HUMAN** .
- The common ancestor of apes and man is a primate **DRYOPITHECUS** which was lived 15 million years ago .
- The next stage in the homidian evolution is the **RAMAPITHECUS** .
- Both **DRYOPITHECUS** and **RAMAPITHECUS** were hairy and walked like Gorillas and Chimpanzees, but **RAMAPIYHECUS** were more man like and is the forerunner of **HOMINID EVOLUTION** .

- **ARDIPITHECUS** *Ramidus* most closely resembled earlier hominids (such as *Sahelanthropus*) and also possessed some similarities to later skulls (such as those of *Australopithecus*).
- The cranial base and face were short, and the cranial capacity (the volume of the braincase) was similar to that of chimpanzees.
- The skull in ***Ar. Ramidus*** lacked the specializations for heavy chewing (that is, thickened enamel, larger and more robust jaws, and deeper faces) present in all later *Australopithecus*.
- In addition, it did not display the large incisors for frugivory (fruit eating) or the large canines associated with intermale aggression, as seen in living chimpanzees.

Australopithecus



- The various species of Australopithecus lived during the Pliocene (5.3 to 2.6 million years ago) and Pleistocene (2.6 million to 11,700 years ago) epochs.
- As characterized by the fossil evidence, they bore a combination of human- and apelike traits.
- Like humans, they were bipedal (that is, they walked on two legs), but, like apes, they had small brains.
- The most famous specimen of Australopithecus is "Lucy," a remarkably preserved fossilized skeleton from Ethiopia that has been dated to 3.2 mya.

- Australopiths shared several traits with modern apes and humans, and were widespread throughout Eastern and Northern Africa around 3.5 million years ago.
- The earliest evidence of fundamentally bipedal hominids can be observed at the site of Laetoli in Tanzania.
- This site contains hominid footprints that are remarkably similar to those of modern humans and have been dated to as old as 3.6 million years.
- The footprints have generally been classified as australopith because that is the only form of prehuman known to have existed in that region at that time.

- Most hominids are either the genus Australopithecus or Homo.
- Australopithecines were a successful genus.
- The Homo genus first evolved 2.4 million years ago.

RAMAPITHECUS

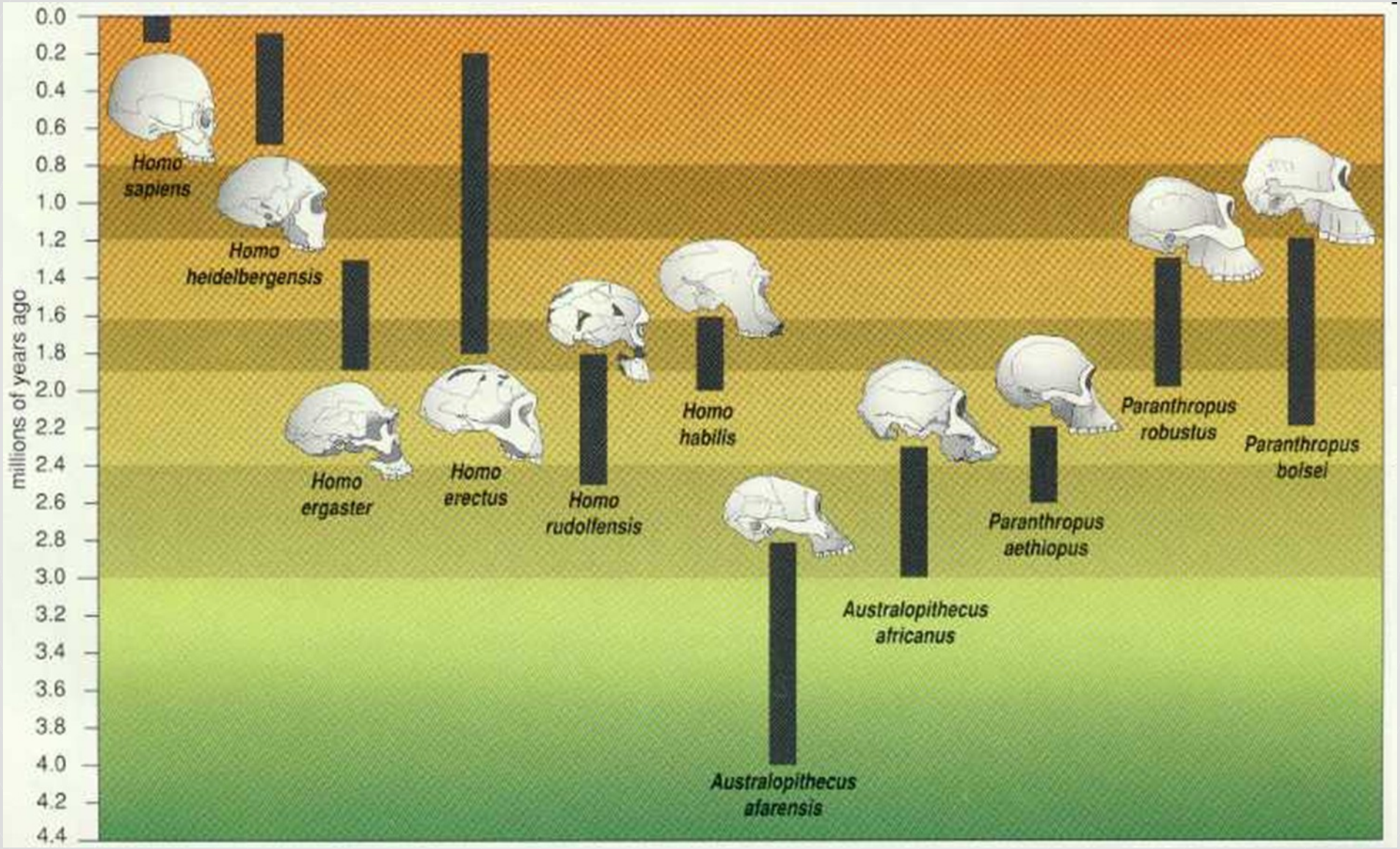
- APE-MAN.
- LIVED IN LATE MIOCENE AND EARLY PLIOCENE PERIOD.
- FOSSIL CONTAINS ONLY JAWS AND DENTITION.
- COLLECTED FROM INDIA AND AFRICA.
- DIRECT ANCESTOR

DRYOPITHECUS

- LIVED IN MIOCENE PERIOD.
- DESCENDED FROM PROPLIOPITHECUS.
- FORE LIMBS SHORTER THAN HIND LIMBS.
- DISTANT ANCESTOR OF MAN.

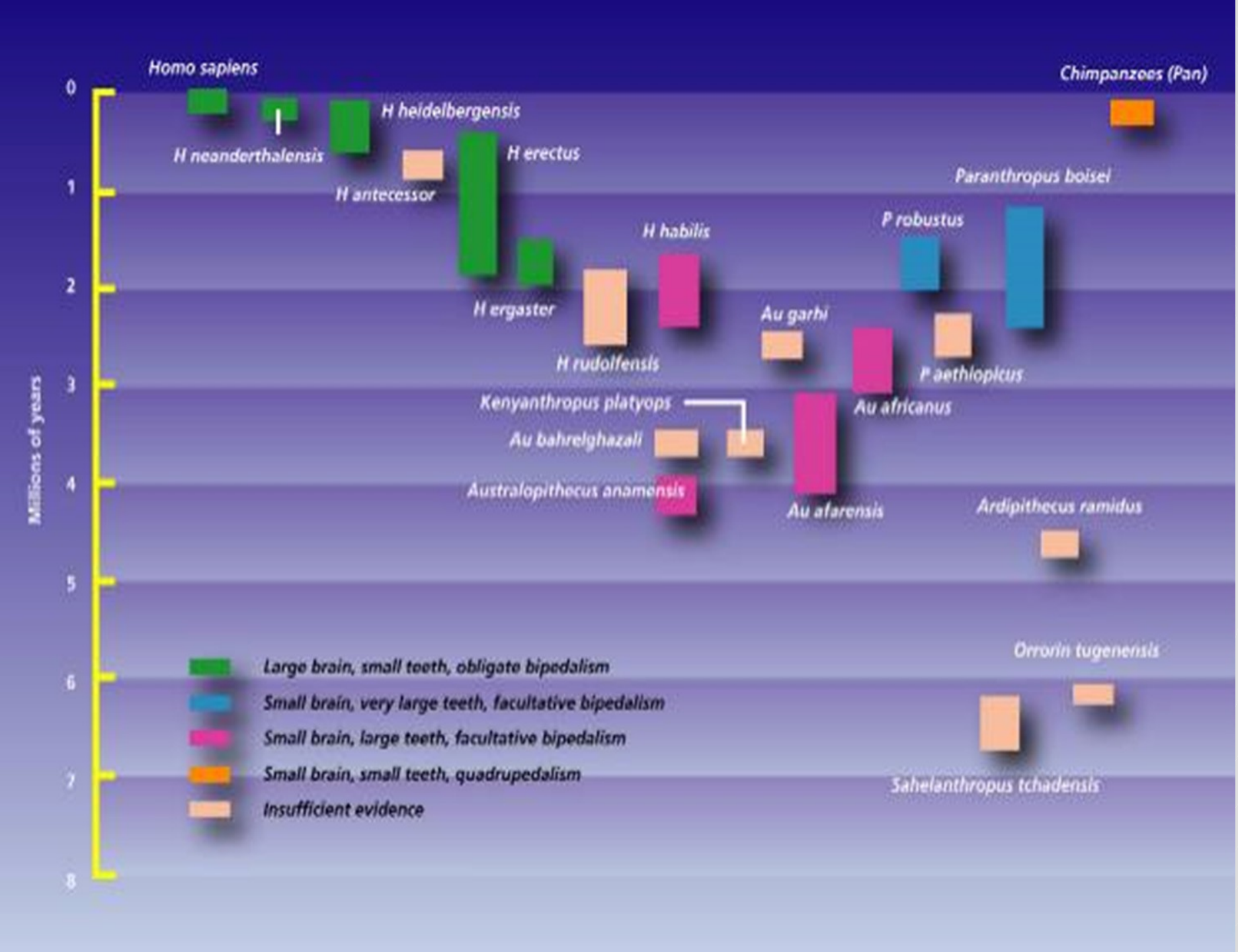
ANATOMICAL CHANGES

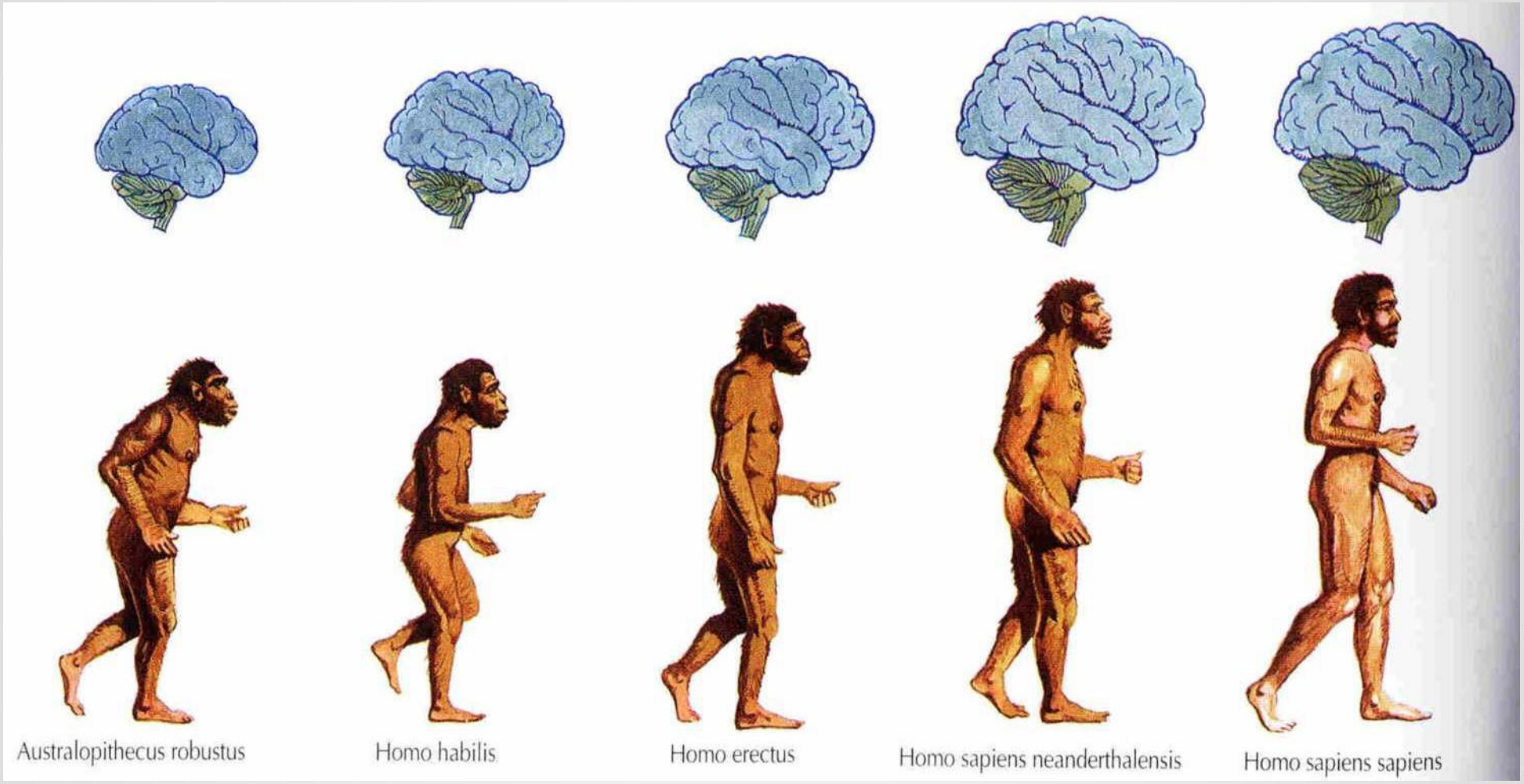
- Human evolution is characterized by a no. of MORPHOLOGICAL , DEVELOPMENT, PHYSIOLOGICAL and BEHAVIORAL changes that have taken place since the split between the last common ancestor of human and chimpanzees .
- The most significant of these adaptions are BIPEDALISM , INCREASED BRAIN SIZE , LENGTHENED ONTOGENY , and DECREASED SEXUAL DIMORPHISM .


millions of years ago
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
Homo sapiens
Homo heidelbergensis
Homo ergaster
Homo erectus
Homo rudolfensis
Homo habilis
Australopithecus afarensis
Australopithecus africanus
Paranthropus aethiopus
Paranthropus robustus
Paranthropus boisei

Important stages in human evolution

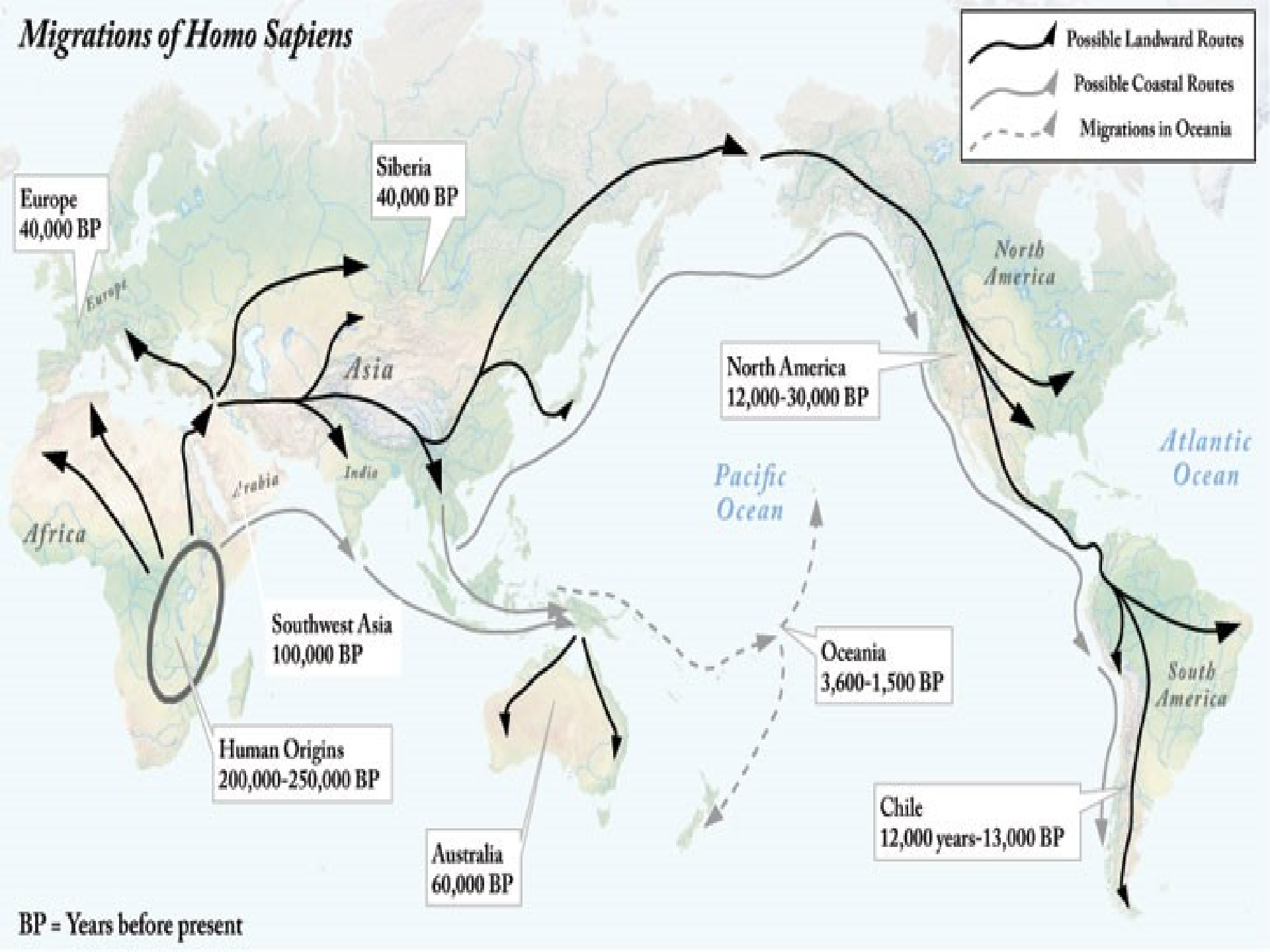
- 3.2 million years ago
- 3 million years ago
- 2 million years ago
- 1 million years ago


Homo sapiens
Chimpanzees (Pan)
H heidelbergensis
H neanderthalensis
H erectus
H antecessor
Paranthropus boisei
P robustus
H habilis
H ergaster
Au garhi
H rudolfensis
P aethiopicus
Kenyanthropus platyops
Au africanus
Au bahrelghazali
Australopithecus anamensis
Au afarensis
Ardipithecus ramidus
Orrorin tugenensis
Sahelanthropus tchadensis
Millions of years
0
1
2
3
4
5
6
7
8
Large brain, small teeth, obligate bipedalism
Small brain, very large teeth, facultative bipedalism
Small brain, large teeth, facultative bipedalism
Small brain, small teeth, quadrupedalism
Insufficient evidence


Australopithecus robustus
Homo habilis
Homo erectus
Homo sapiens neanderthalensis
Homo sapiens sapiens

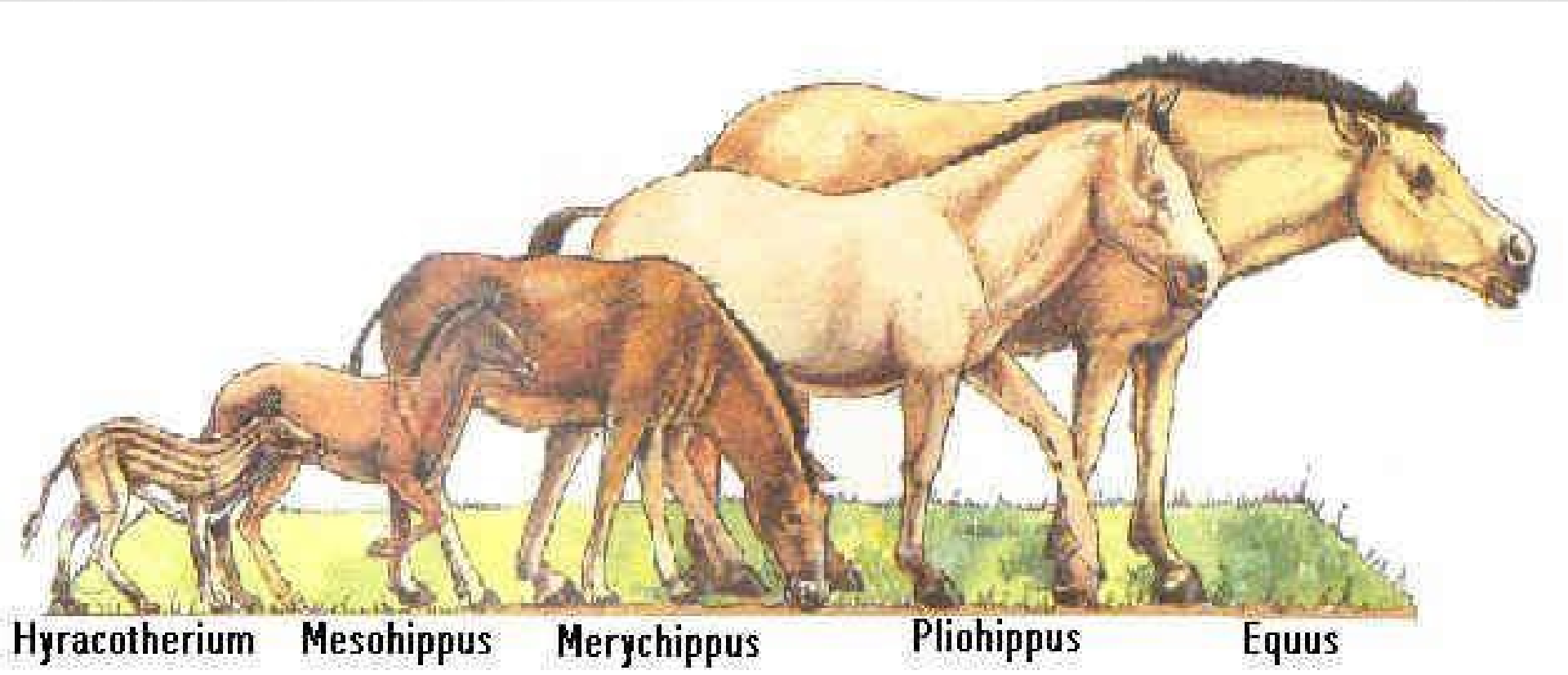
Early human migrations

- Humans left southeastern Africa and spread throughout the continent
- Humans traveled along the Indian Ocean to reach Australia
- By 10,000 years ago, modern human beings had spread all over the globe


Migrations of Homo Sapiens
Possible Landward Routes
Possible Coastal Routes
Migrations in Oceania
Europe
40,000 BP
Siberia
40,000 BP
North America
12,000-30,000 BP
Asia
Europe
Africa
Arabia
India
North America
Atlantic Ocean
Pacific Ocean
Southwest Asia
100,000 BP
Oceania
3,600-1,500 BP
South America
Human Origins
200,000-250,000 BP
Australia
60,000 BP
Chile
12,000 years-13,000 BP
BP = Years before present

Are we still evolving?

EVOLUTION OF HORSE

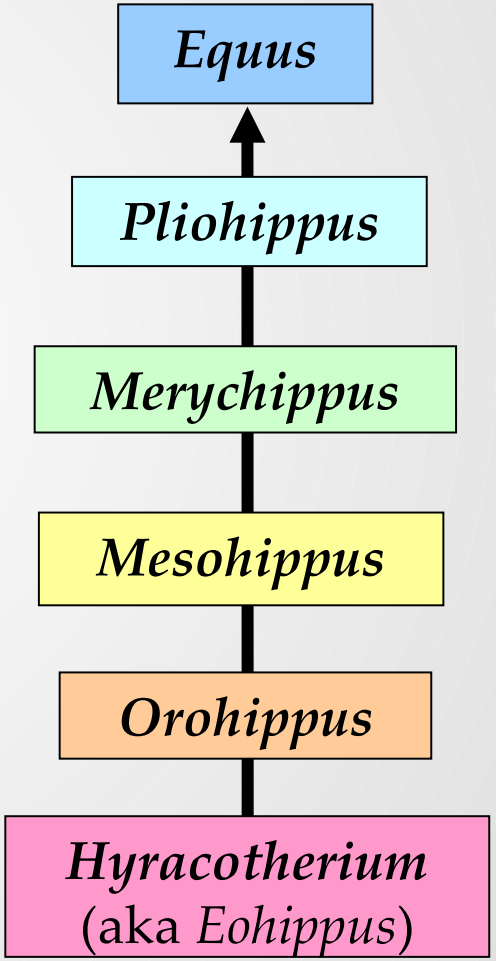


Scientific classification

- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Perissodactyla
- Family: Equidae
- Genus: *Equus*
- Species: *E. caballus*

Evolution

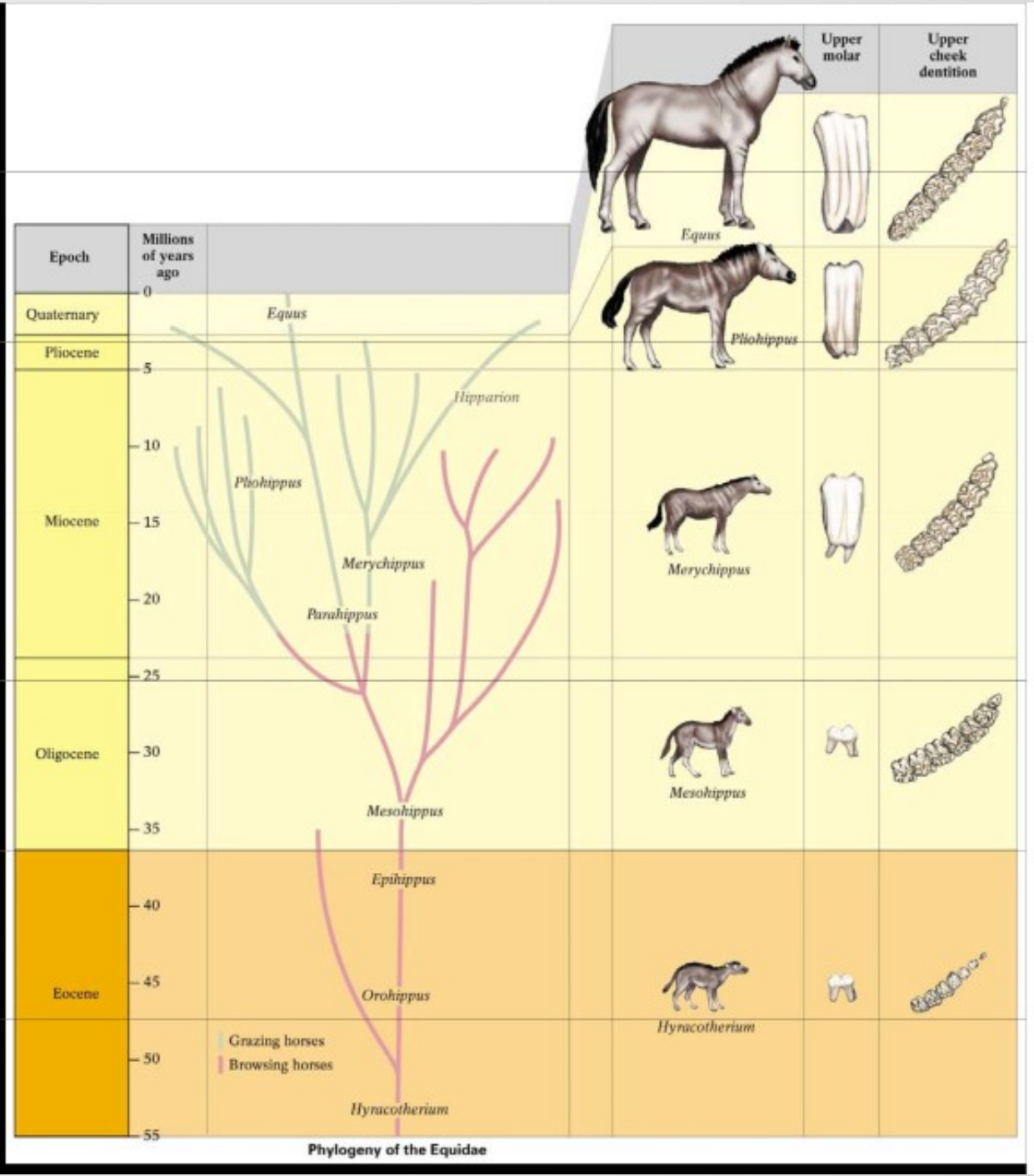
- The view of evolution in Darwin's day was that of **Gradualism**
- One species slowly transforming into another



The evolutionary history of horse are as follows:

Recent --- Equus
Pleistocene --- Equus
Pliocene --- Pliohippus
Miocene --- Merychippus
Oligocene --- Miohippus
Eocene --- Eohippus or Hyracotherium

“Family tree” of the horses

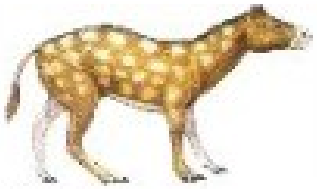


Equus

- The genus *Equus* includes horses, zebra and asses
- The last remaining branch of a diverse group of equids
- Similar to the status of *Homo sapiens,* the last remaining species of a once diverse group of Hominids
- The evolution of the horse is much better documented than ours
- The fossil record is very complete

Hyracotherium or *Eohippus* from the Eocene, a forest browser

- Horses are one of the oldest forms of mammals.
- In the early evolution periods, the did not look at all like they look today.

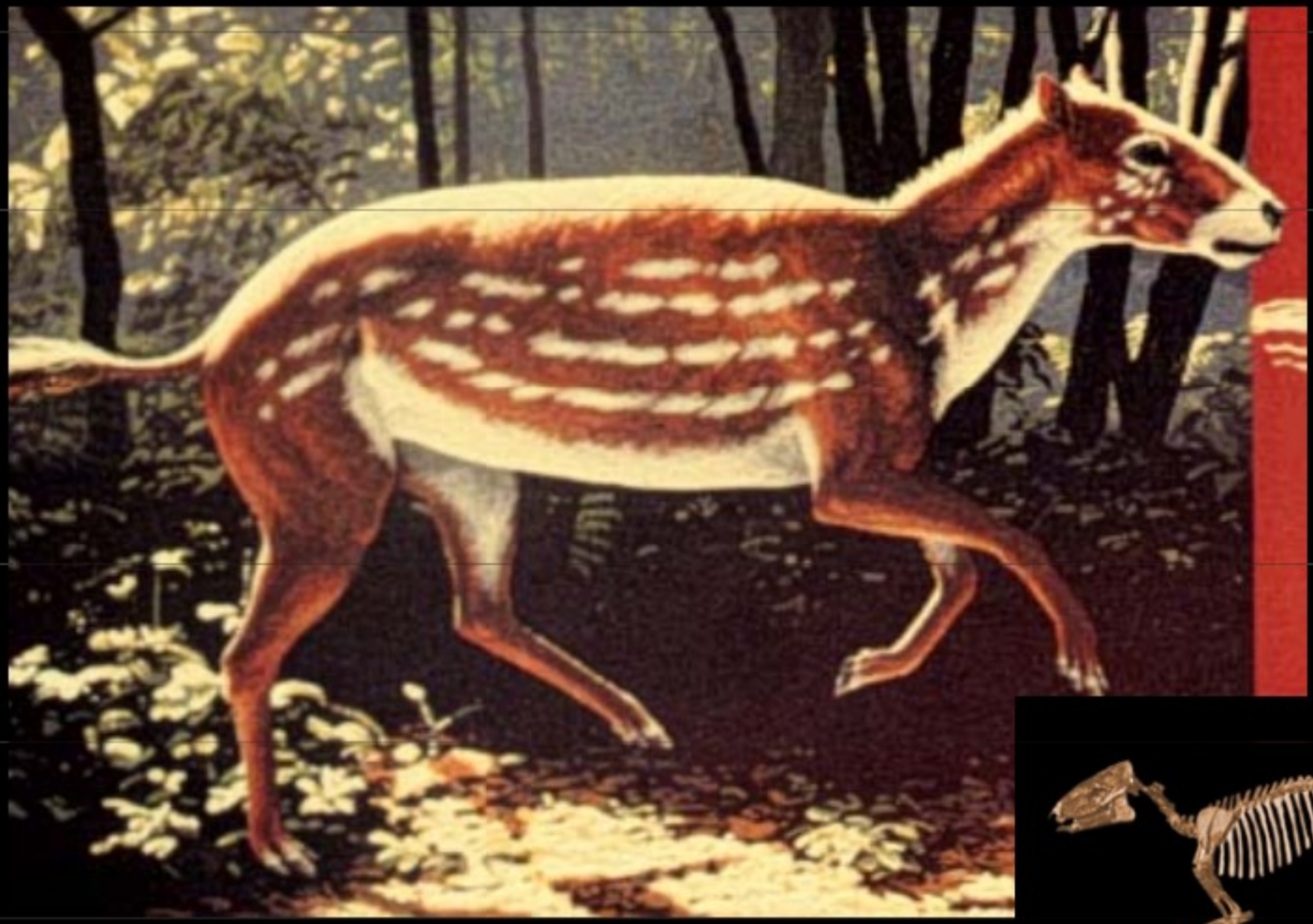


60 Million years ago

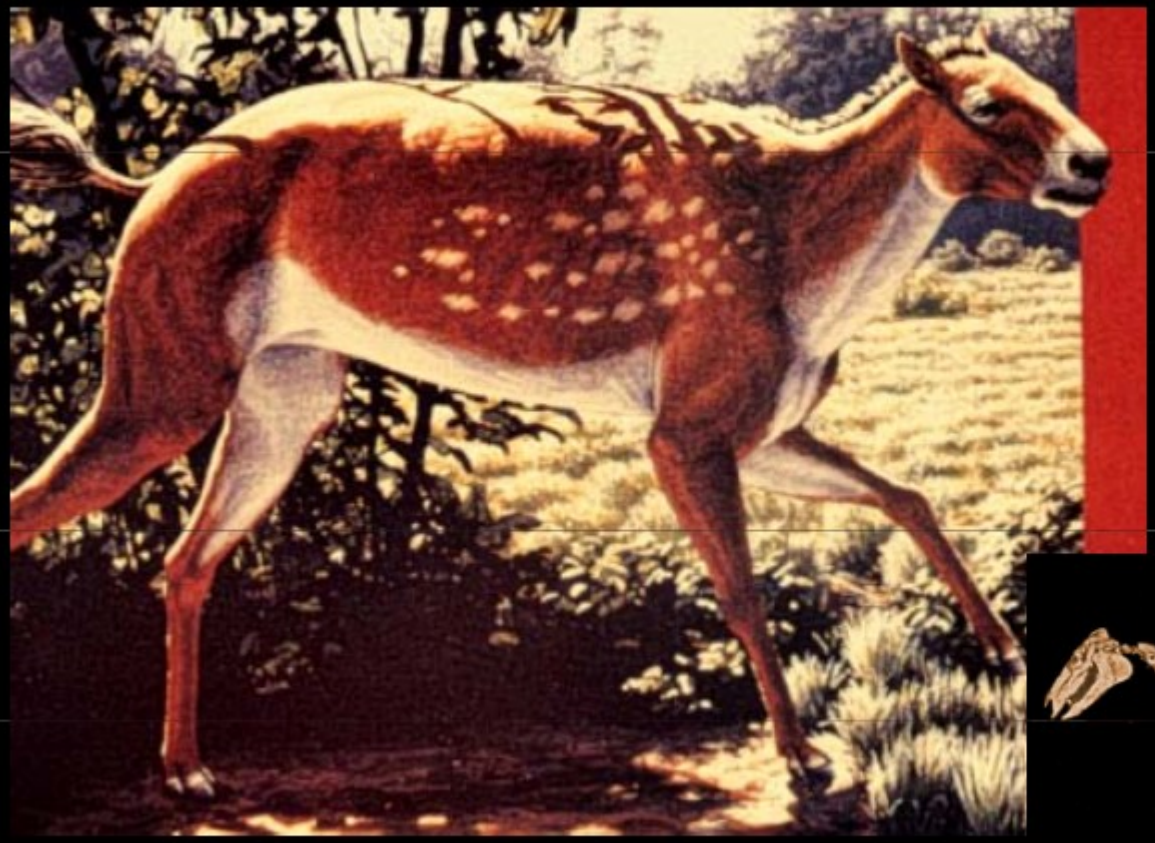
Eohippus

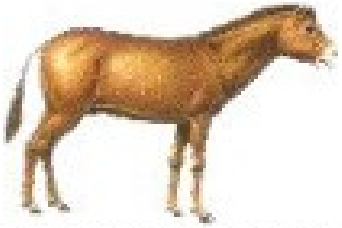
- About the size of a fox, or a medium sized dog.
- Nicknamed “Dawn Horse”.
- Looked like a deer in skin, most likely for camouflage.
- Had 5 toes on frontal feet, and three on hind feet.
- Toes ended in a strong, thick, horny type nail and their tips.
- had little or no lateral vision.
- teeth were similar to a pig, short and crowned for eating plants.
- stood about 14 inches high at his shoulder and weighed around 12 lbs

Orohippus from the late Eocene, also a forest browser



Miohippus from the Oligocene. Forests were shrinking, grasslands were expanding.



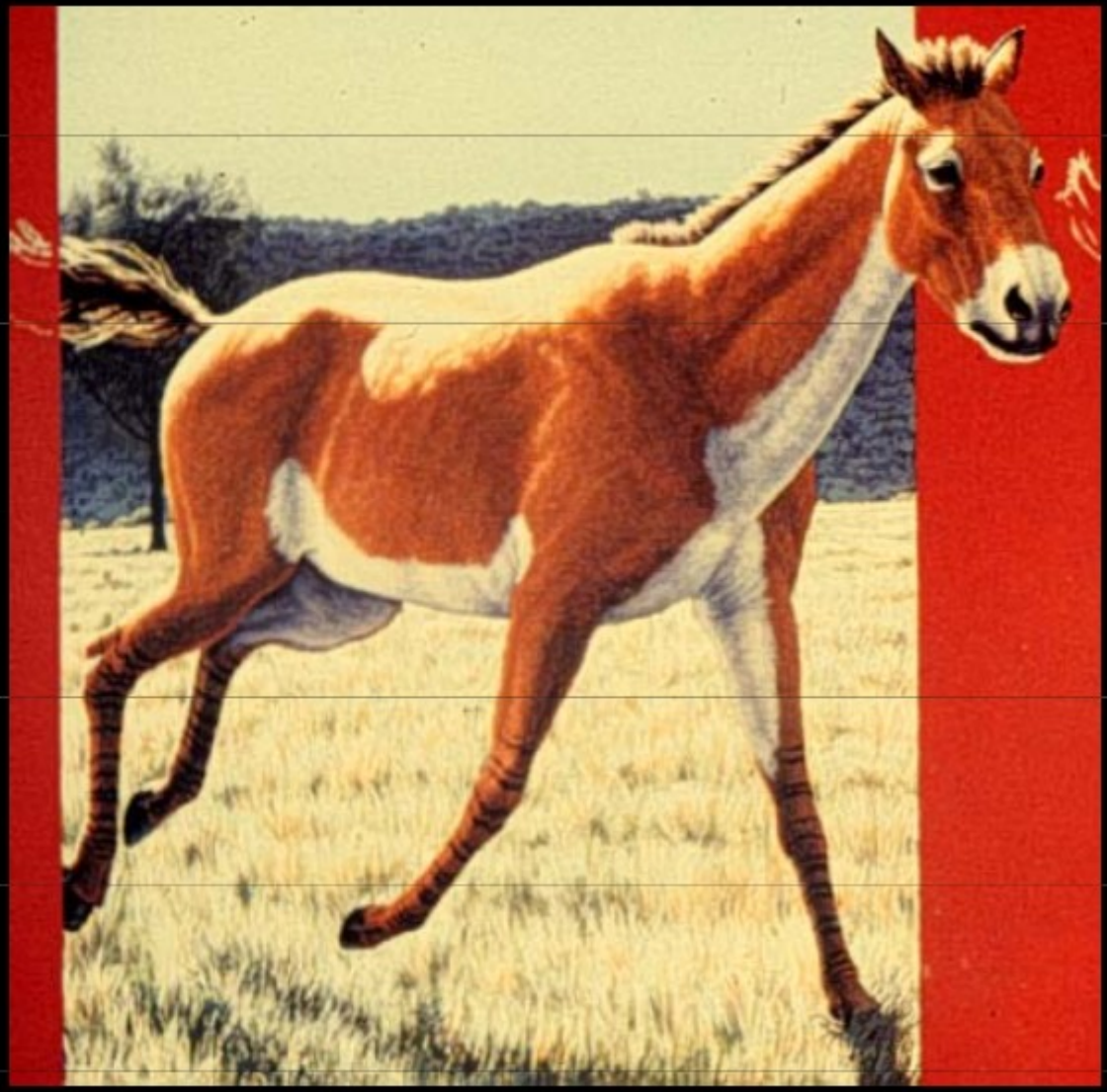


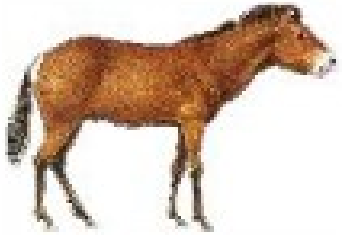
30 million years ago

Miohippus

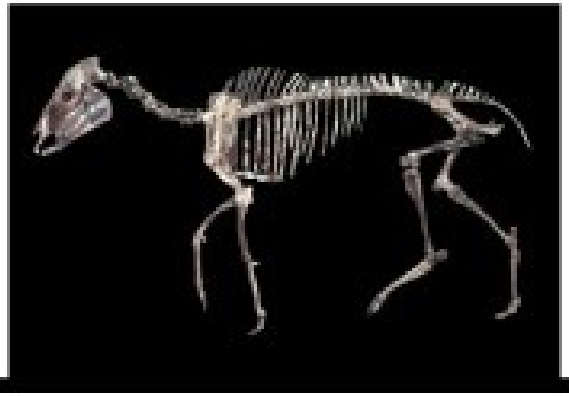
- Ankle joint changed.
- Slight dish, concave, to it's face.
- Stood at a minimum of 24 inches at the shoulder.
- Weighed much more then the Mesohippus.
- Head longer.
- Incisor teeth form.
- Mesohippus and the Miohippus species overlapped for more then 4 million years.
- 5 million years until another change occurs…

Merychippus from the Miocene, a plains grazer



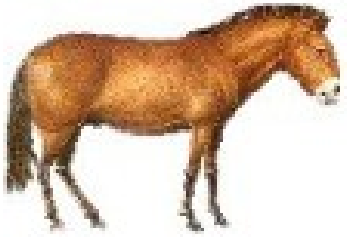


20-25 million years ago

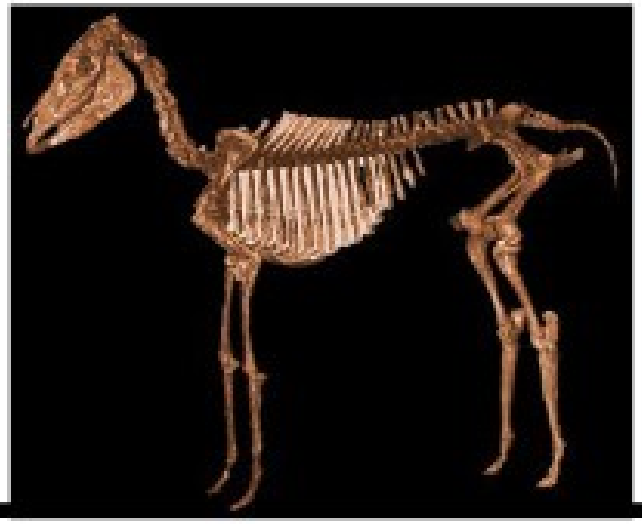


Merychippus

- Looked very similar to today's horses.
- Stood over 36 inches tall at shoulder.
- Still had three toes, outside toe became weaker.
- Head changed, the eye moved, allowing better vision.
- Longer neck, for easier grazing.
- Developed defenses.
- Developed a better sense of smell.
- Toes started turning into hooves.
- Teeth developed into the teeth we know today.



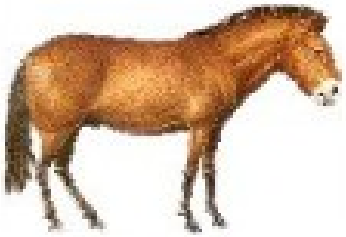
12-6 million years ago



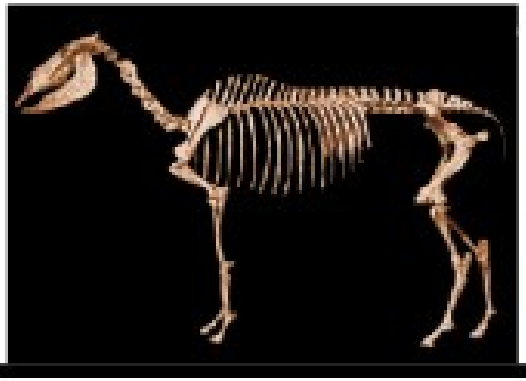
Pilohippus

- Considered direct link to the Equus, which is, in short, the horse we know today.
- First single toed, or hooved horse.
- Strong leg ligaments, to increase speed and power.
- Had a dished face.
- Resembled a pony in many factors.

The modern horse *Equus* from the Pleistocene and Recent



5 million years ago



Equus

- This is the horse we know today!
- Does not have a dished face.
- Many strands of horses arose after the Pilohippus, the Equus was the only to survive.
- About 3,000 years ago, the modern day horse was used for migration, farming, warfare, sport, communication, and travel.
- Horses are now used for many of the same reasons, and more.

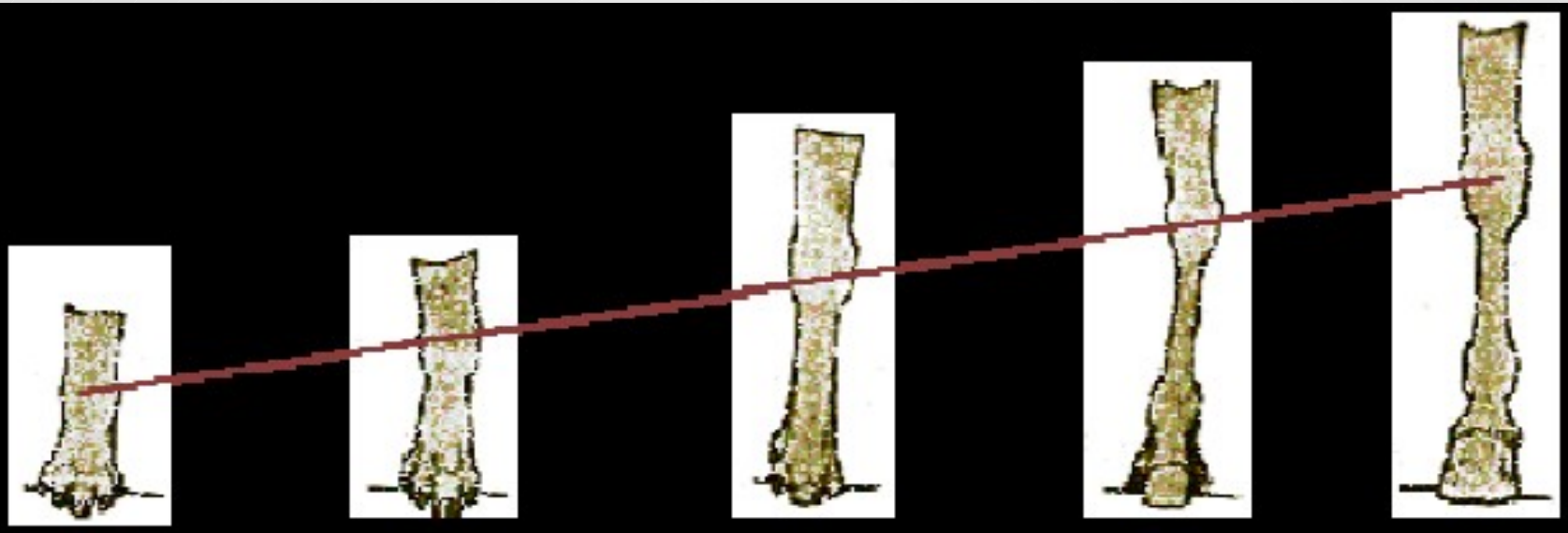
- Reduction in toes
- Elongation of legs by standing on the toes
- Increased body size
- Elongation of the muzzle
- High crowned, specialized teeth

Trends in the evolution of the horses

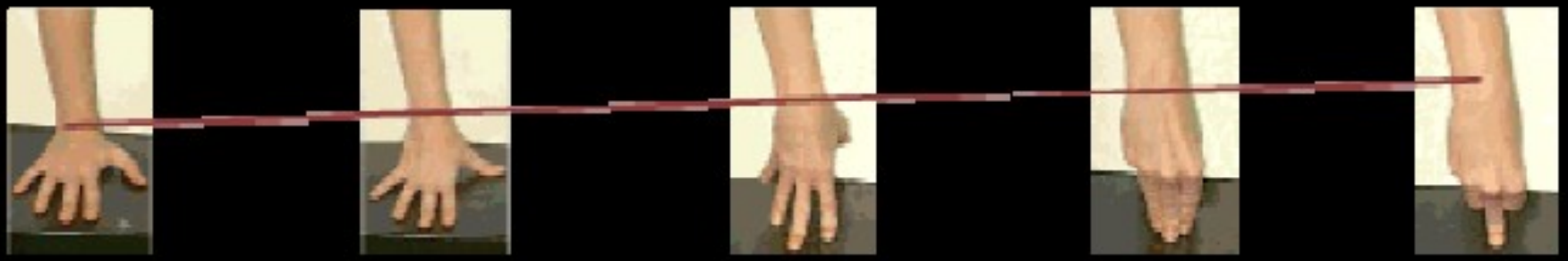
- Increased size
- Reduced number of toes and longer legs
- A stiffer back

Merychippus
20Ma

Equus



Horses reduced their toes from five to one, while also lengthening the bones, during their evolution.



Teeth for grazing

- Larger teeth and a larger skull to hold them

Trends in the evolution of the horses

- The trends correspond to changes in the climate and vegetation of the Earth over the past 55 million years,
- combined with the arms race between predators and prey.

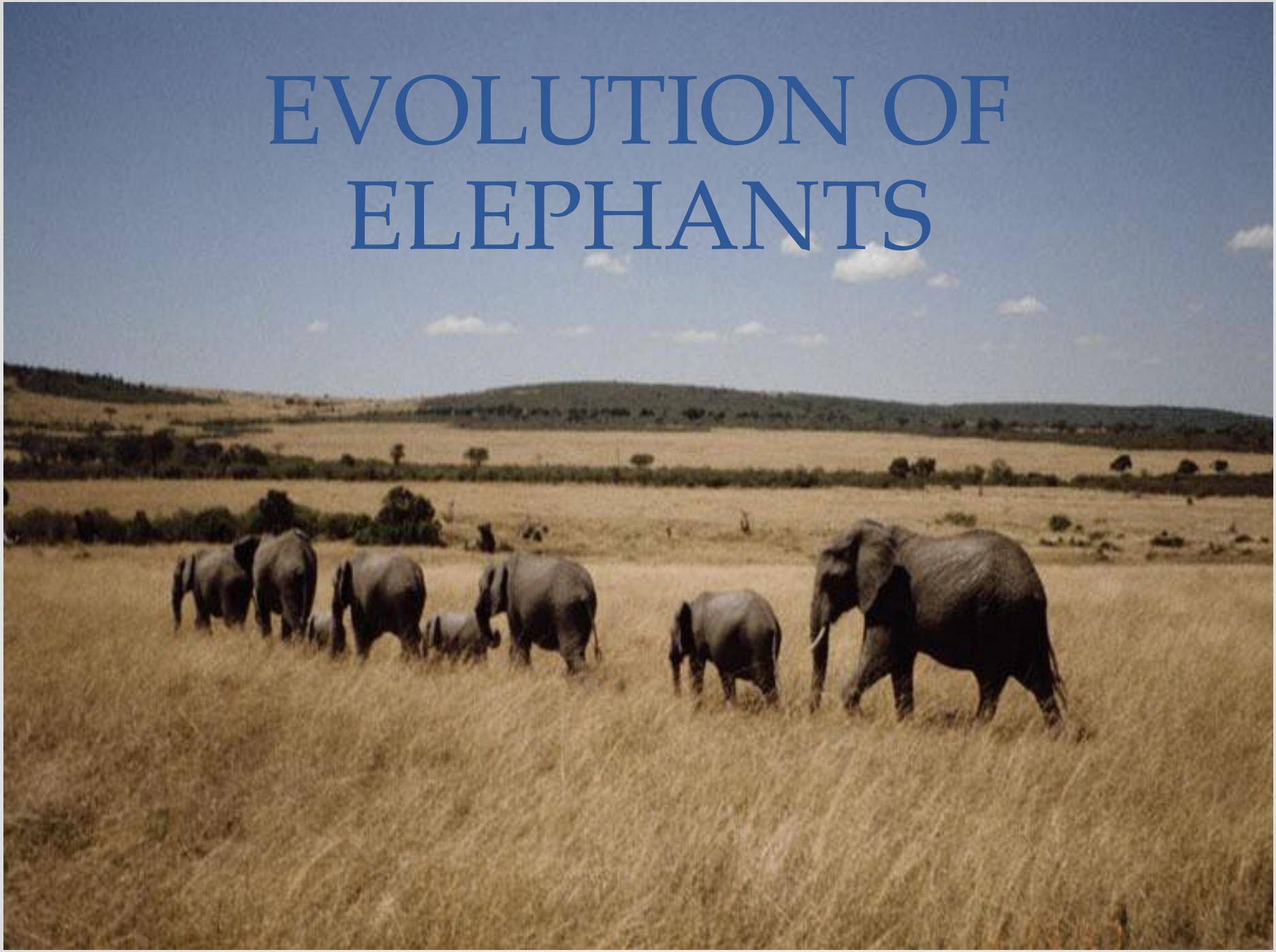
From…….. rich rainforest which covered most of the Earth in which the horses ancestors browsed on leaves and hid from predators.

To ……. open savannah grassland where the modern horses grazed grass and had to run from predators.

Environmental Causes of Evolutionary trends in horses and many other ungulates

- Need for greater speed and body size to escape predators.
- Cooling climate during the Cenozoic replaced forests with grasslands. Simple hooves and elongated legs are adaptive for running in the open. Elongated muzzle to reach grass.
- Grasses are high in silica. High crowned teeth are adaptive.

EVOLUTION OF ELEPHANTS



Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Proboscidea

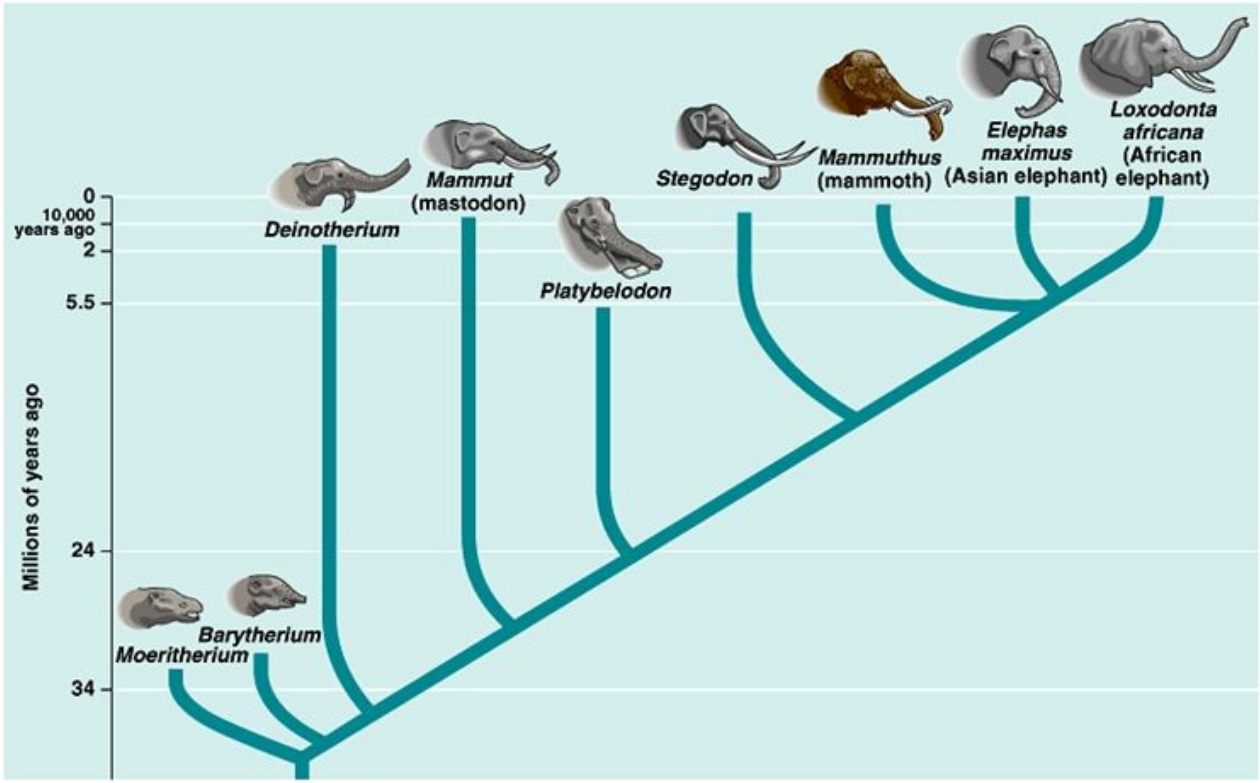
Ancestry & Evolution of Elephants

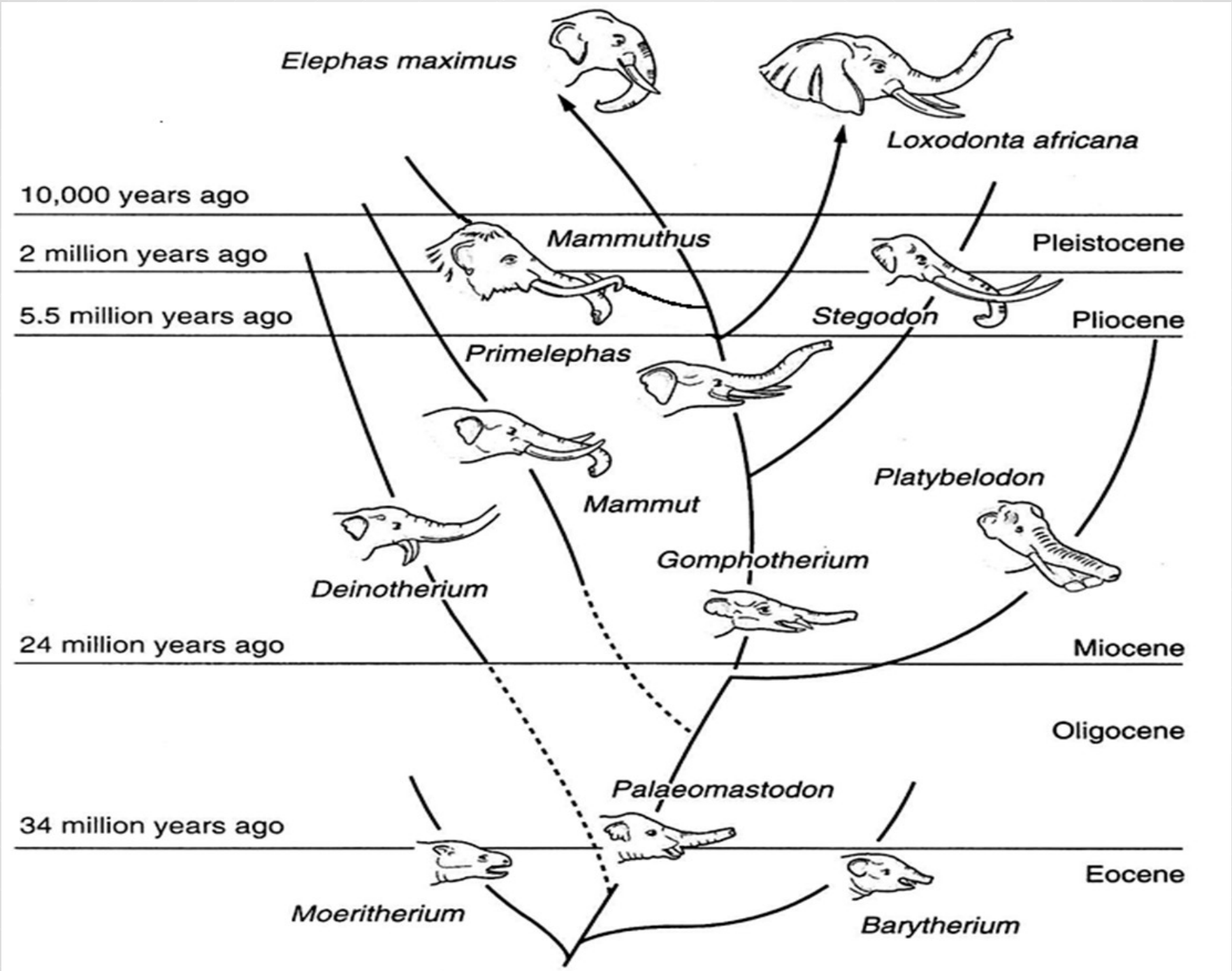
	Eocene - 55 MM	Oligocene - 36 MM	Miocene - 24 MM	Pliocene - 5 MM	Pleistocene - 2 MM	Holocene - 10 M
Ancestral Proboscideans						
Moeritherium **	■					
Barytherium **	■	■				
Numidotherium **	■	■				
Deinotherium **			■	■	■	
Platybelodon **			■	■		
Paleomastodons						
Mammutidae [Mastodon]				■	■	■
Ancestral Gomphotheres			■	■		
Advanced Gomphotheres						
Anancus				■	■	
Cuvieronius				■	■	■
Elephantidae						
Primelephas						
Stegotetrabelodon			■	■	■	■
Mammuthus				■	■	■
Loxodonta [African Elephant - sub species: africana, cyclotis]				■	■	■ →
Elephas [Asian Elephant - sub species: maximus, indicus, sumatranus]				■	■	■ →

Chart by Wayne Hepburn is a synthesis of selected orders and species from numerous sources.

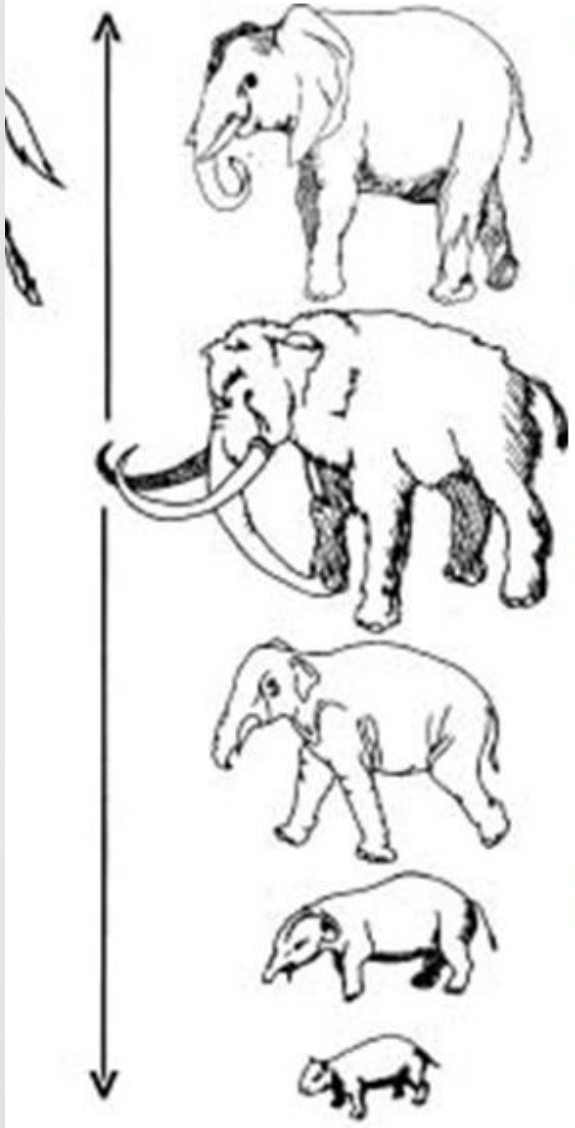
Fossil record

- Today's organisms descended from common ancestor's




Elephas maximus
Loxodonta africana
10,000 years ago
2 million years ago
Mammuthus
Pleistocene
5.5 million years ago
Stegodon
Pliocene
Primelephas
Mammut
Platybelodon
Deinotherium
Gomphotherium
24 million years ago
Miocene
Oligocene
Palaeomastodon
34 million years ago
Eocene
Moeritherium
Barytherium

Examples of Evolution



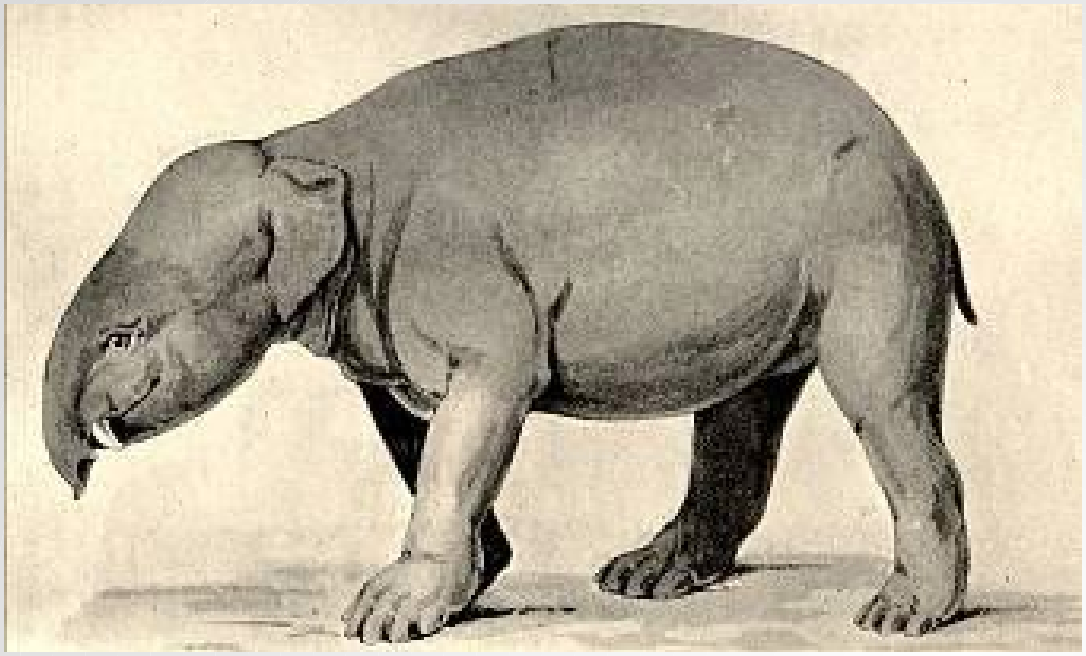
- The ancestor of the present elephant was the size of a pig and had no tusks.
- Over time, the size of the elephant's body and head increased tremendously.
- The two upper incisor teeth increased in size and length and gradually developed into tusks.
- The early trunk was much shorter than the trunk of today's elephant.

The evolutionary history of elephants are as follows:

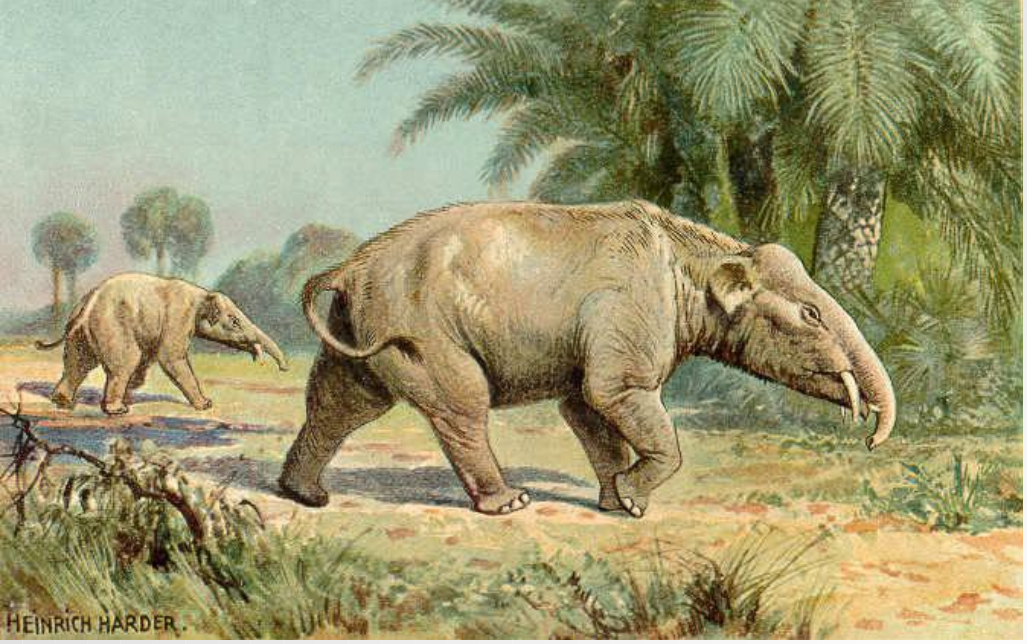
- ♣Recent : Elephas, Loxodonta
- ♣Pleistocene : Mastodon
- ♣Pliocene : Stegodon
- ♣Miocene : Trilophodon
- ♣Oligocene : Palaeomastodon
- ♣Eocene : Moeritherium

- The evolution of elephants begins in the late **Eocene** with **Moeritherium (upper Eocene)** within long, narrow elevated head and have molar teeth with cross rows of Cusps.
- **Palaeomastodon** of the **Oligocene** age was larger in size with strong teeth in elevated Skull.
- **Trilophodon** and **Tetrabelodon** of **Miocene** age had a long lower jaw and only two molars in each jaw, bigger in size with more transverse rows of cups.
- **Gomphotherium** of **Miocene** and **Pliocene** are abundant and may have been a direct ancestors of elephants and mastodon.

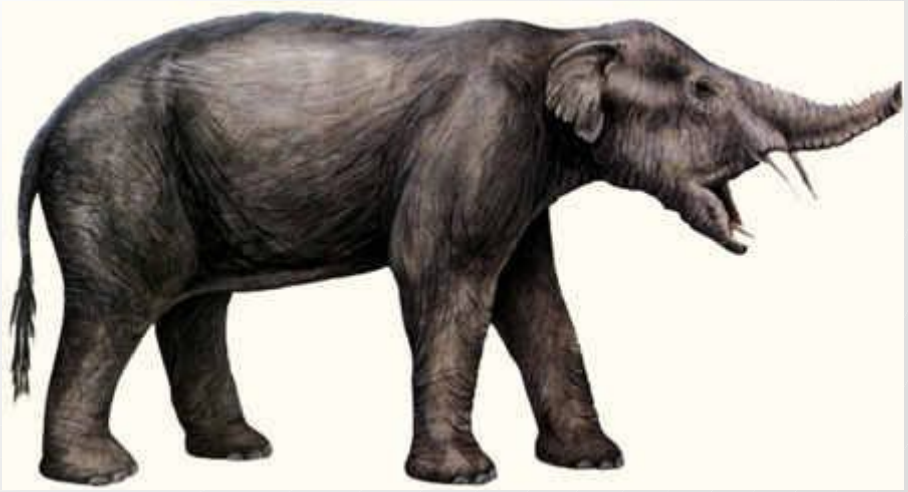
- **Mastodon** was larger in size, growths of pillar-like legs, with specialization of the teeth and have molars with transverse ridges.
- **Stegodon** of Pliocene age have molars consist of a series of low, roof-shaped ridges. Furthermore, stegodon skeletons are more robust and compact than those of elephants.
- **Elephas** of recent age with one molar functional in each jaw at a time and have many transverse ridges of enamel.
- The genus **Elephas** includes the living elephants of India and **Loxodonta** of Africa.
- The problem that lies in the study of Proboscidean evolution is the existence of parallel evolutionary lines whose interconnecting relationships have still to be completely worked out.



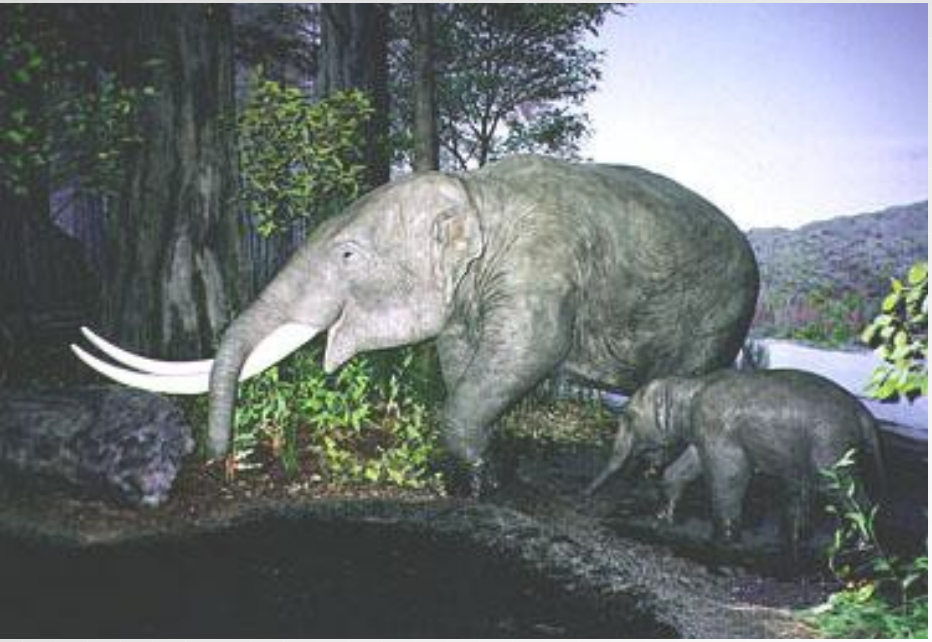
Eocene : Moeritherium



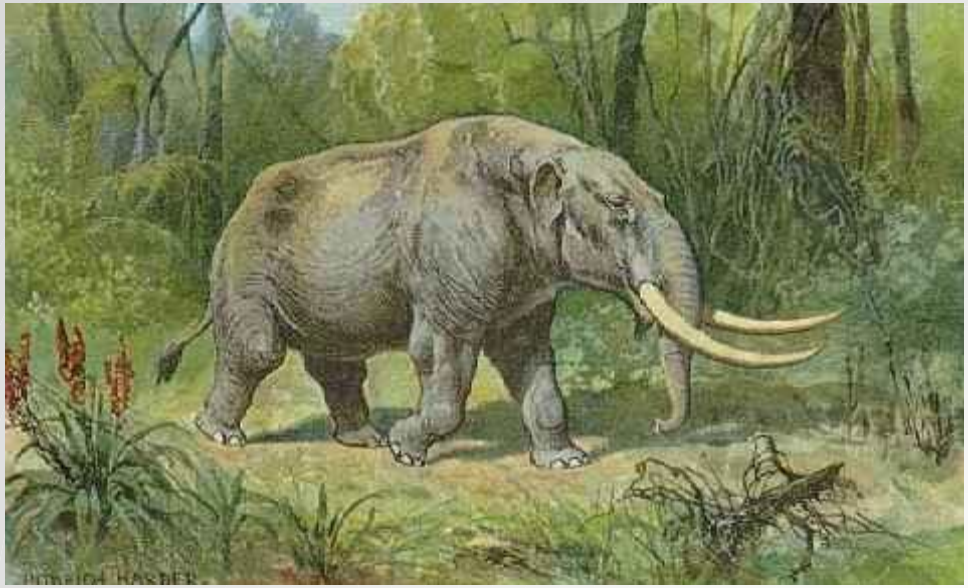
♣Oligocene : Palaeomastodon



♣Miocene : Trilophodon



Pliocene : Stegodon



Pleistocene: Mastodon

Recent : Loxodonta

Recent : Elephas