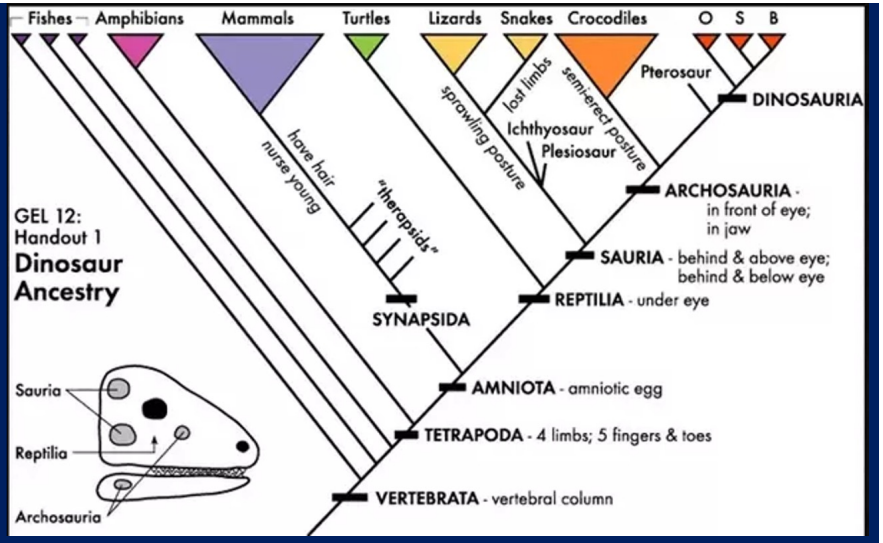
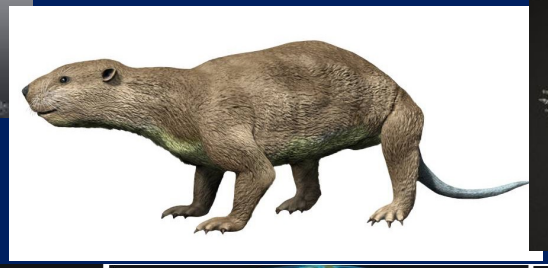
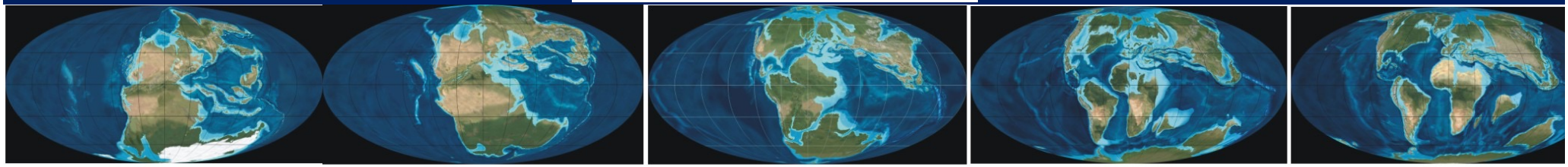
Skeletal Evolution & Earth History Lecture 6

with Nicole Myers

www.appreciatingearth.com/olli





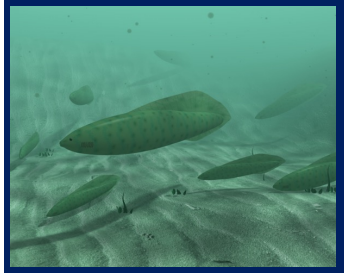


260 mya | 220 mya | 150 mya | 90 mya | 66 mya

Firsts of the

Cambrian - Ordovician - Silurian - Devonian - Carboniferous - Permian

chordates
vertebrates



538.8Ma

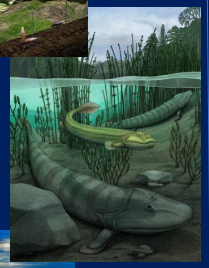
land plants
jawed fish

486.9Ma

cartilaginous
osteichthys

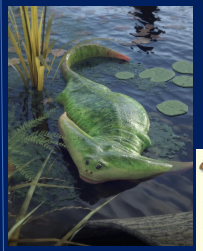
443.1Ma

tetrapods
amphibians



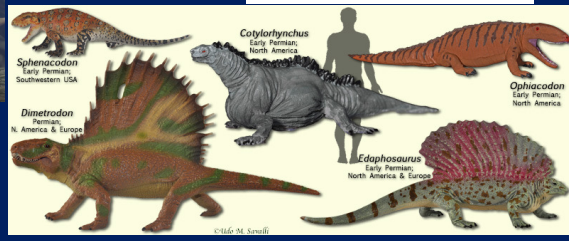
419Ma

Amphibians
Amniota
Synapsids
Sauropsids

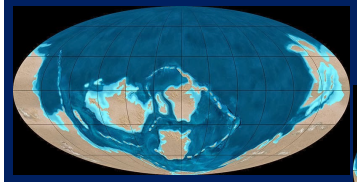


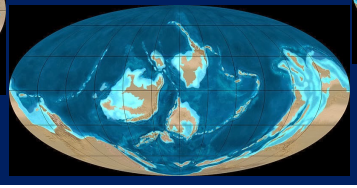
359.3Ma

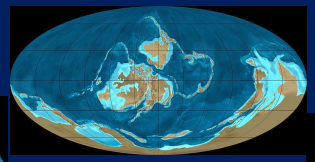
Seed plants

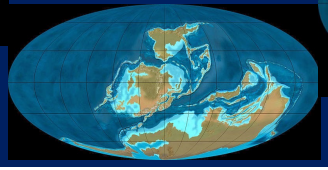


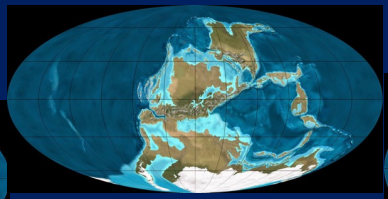
298.9Ma 252.2Ma

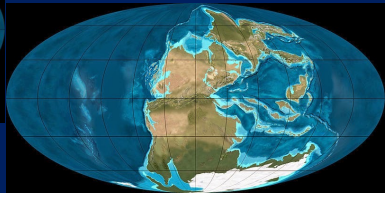






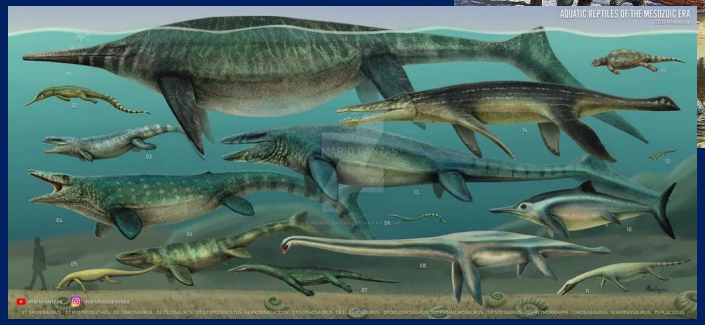


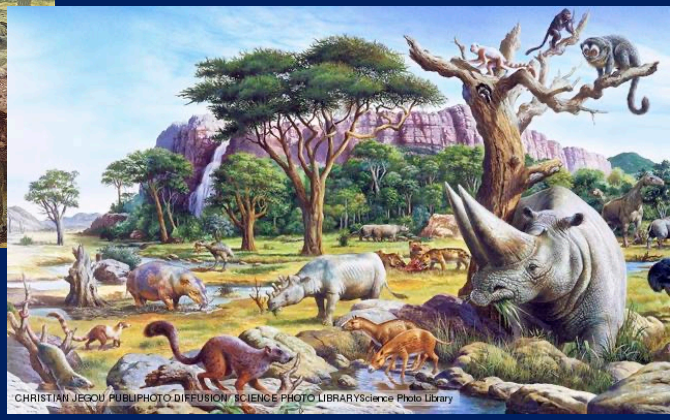




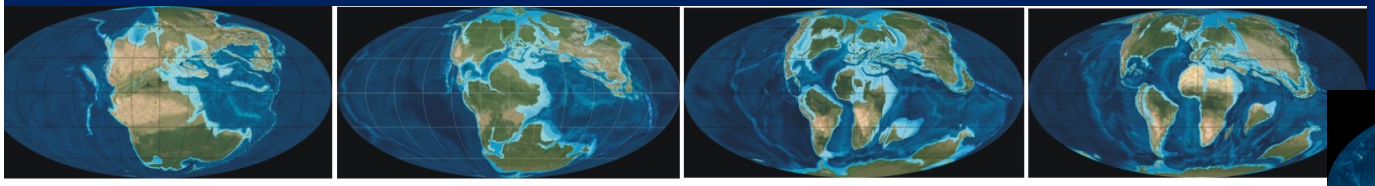
Firsts of the

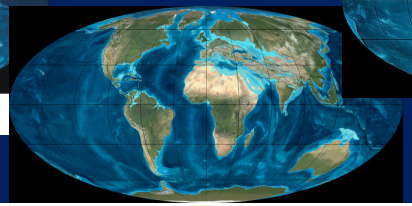
Triassic	Jurassic	Cretaceous	Paleogene	Neogene
Turtles	Aves	Dinosaur diversity	Rise of mammals	Ice Age
Crocodiles	Angiosperms			
Lepidosaurs				
Marine reptiles				
Dinosaurs				
Pterosaurs				
Mammals				

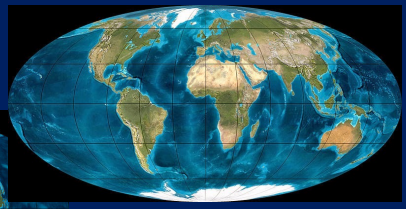




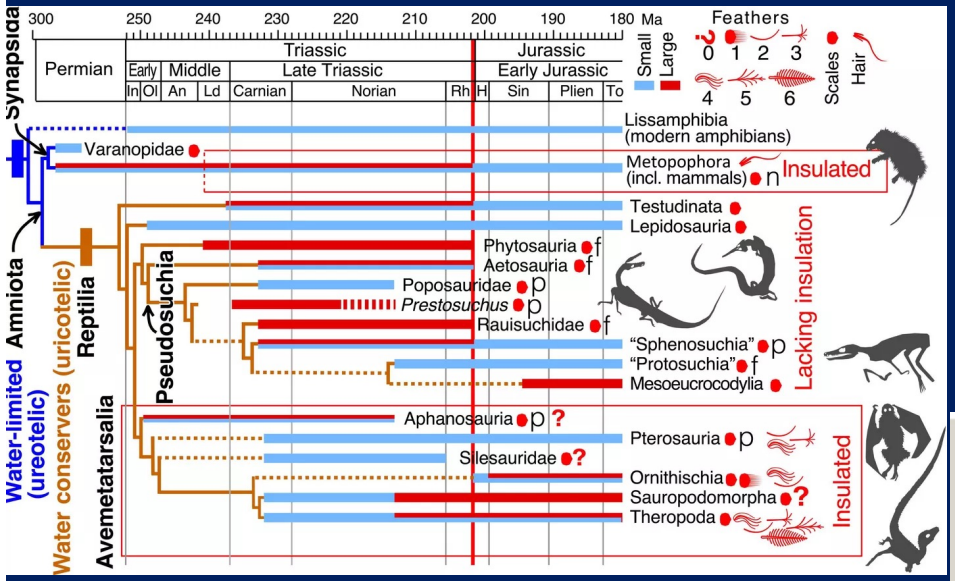
251.9Ma 201.4Ma 143.1Ma 66.0Ma. 23Ma 0Ma

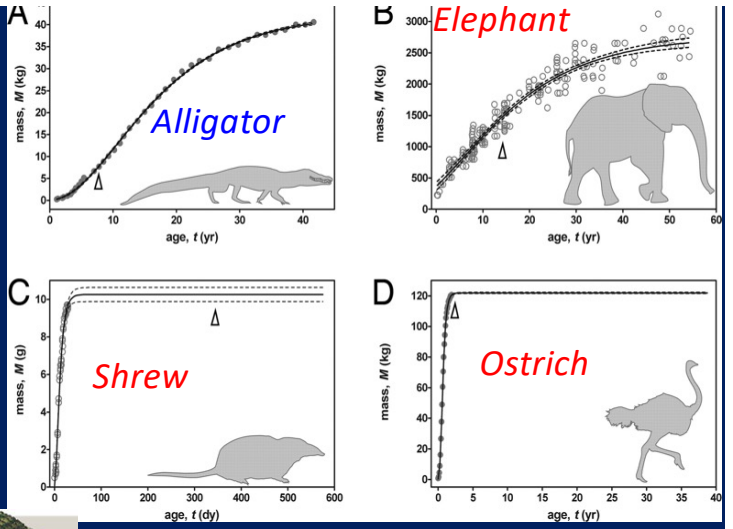


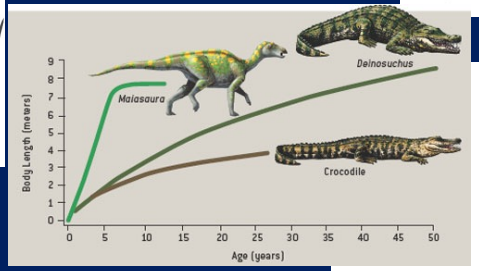


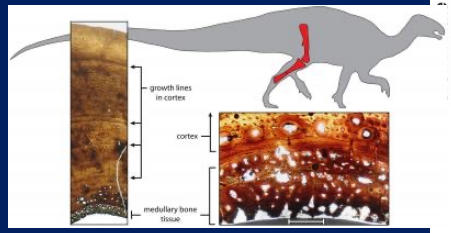


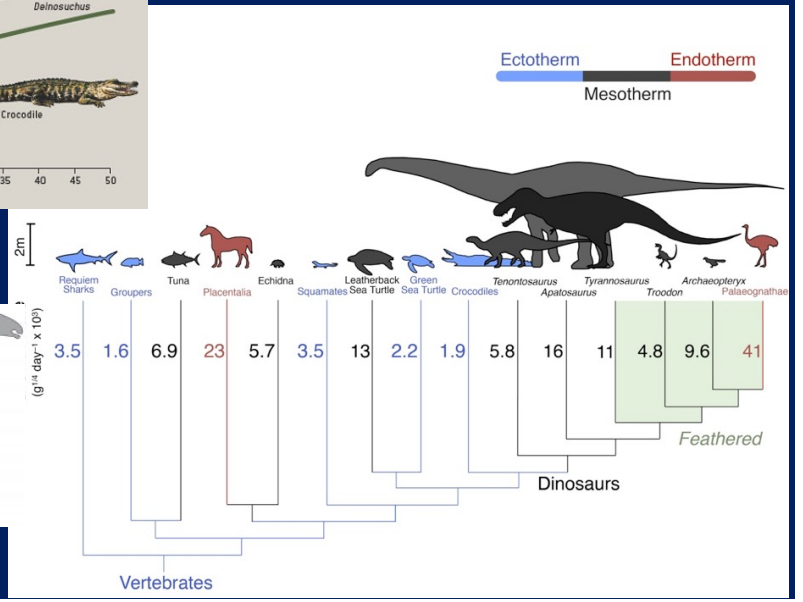
Metabolism: Growth Rate & Histology









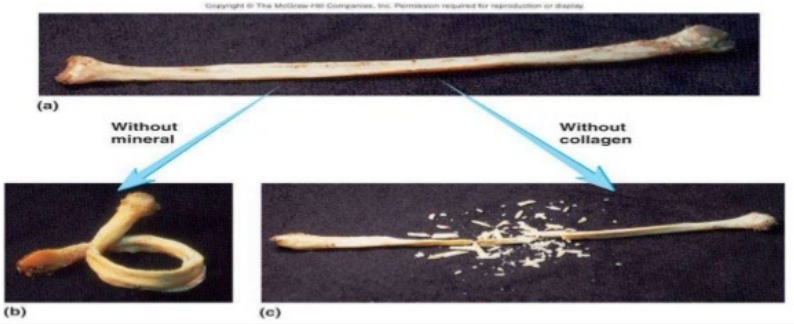


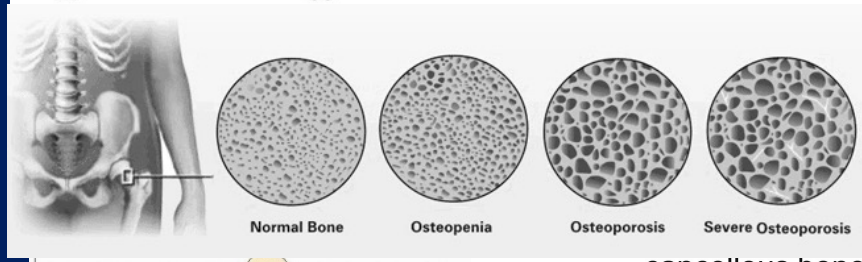
- Determinate vs. Indeterminate
- Microscopic bone growth rings
- Adult size dependent = environment + genetics
- Endotherms & fast growth rate
- Ectotherms & seasonal growth

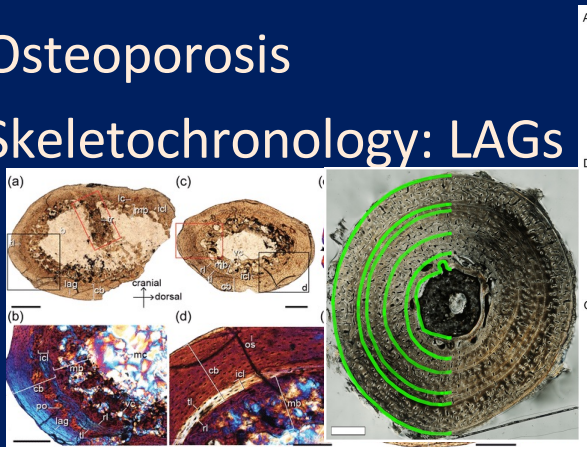
Bone Growth

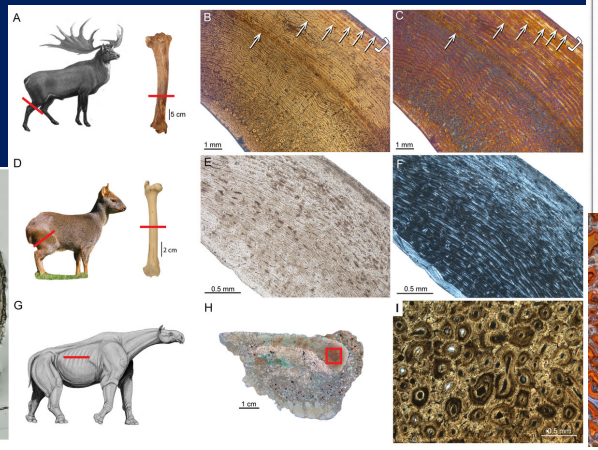
Tetrapod skeletons = hydroxyapatite & collagen

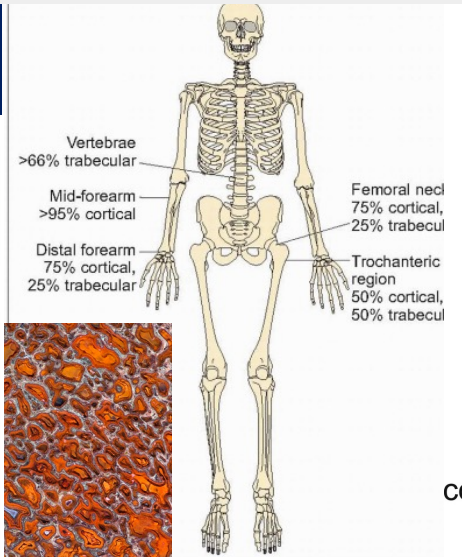
- Mineralized = Hydroxyapatite $Ca_5(PO_4)_6(OH)_2$
- Calcium & Phosphorous = 5th & 6th most abundant body elements (>90% in bone)
- Ca-phosphate skeletons = stable endoskeletons
- Bones: cortical vs. trabecular/cancellous
- Endocrine & metabolic processes + muscles & stress causes bone turnover (you: 100% in ~10yrs)
- Osteoporosis
- Skeletochronology: LAGs

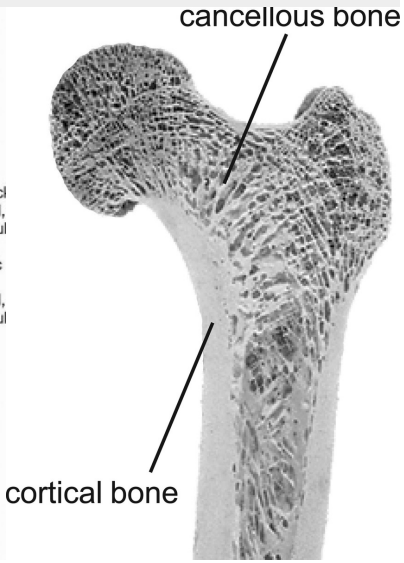






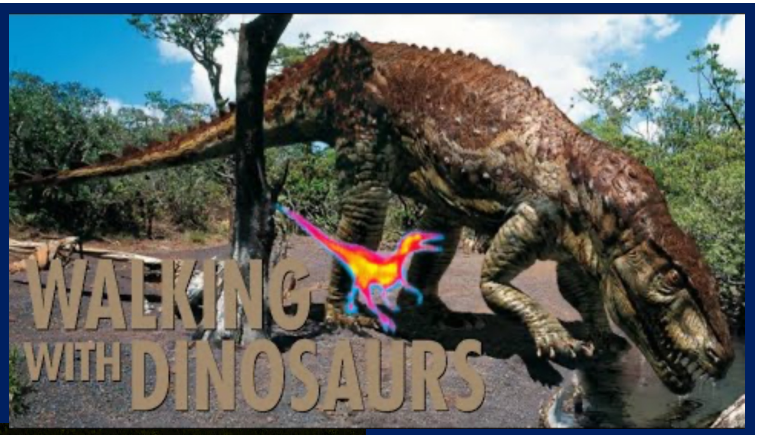






Pseudosuchia

- Low - medium metabolic rate, ectothermic
- Diapsida, Archosauria
- Oldest 260Ma - led to Crocodylia
- Postosuchus 237Ma



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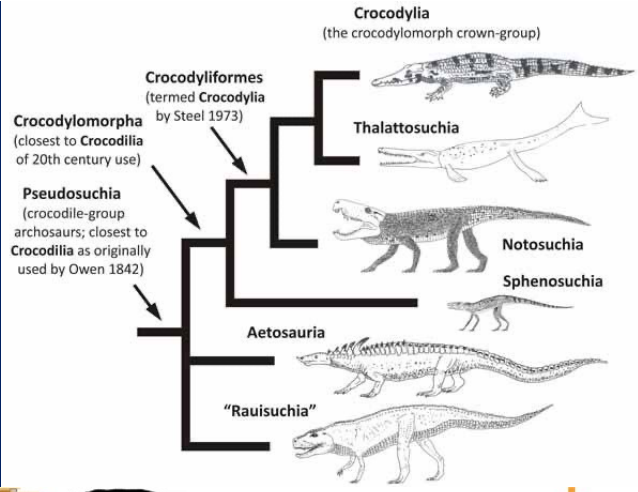
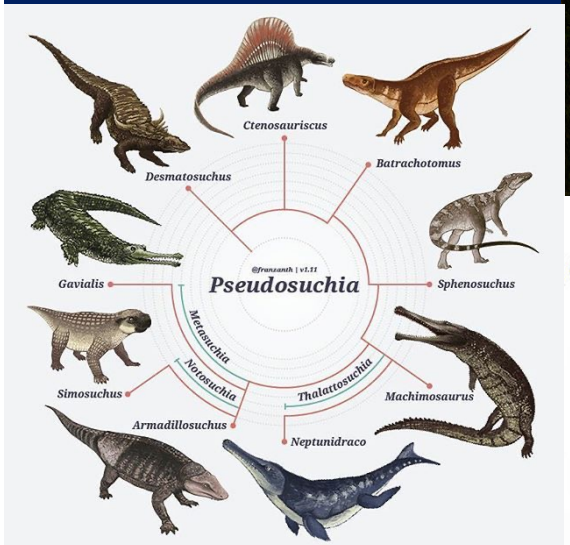
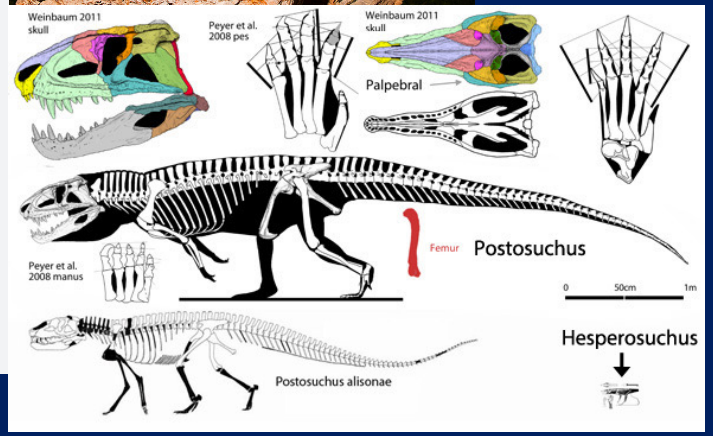
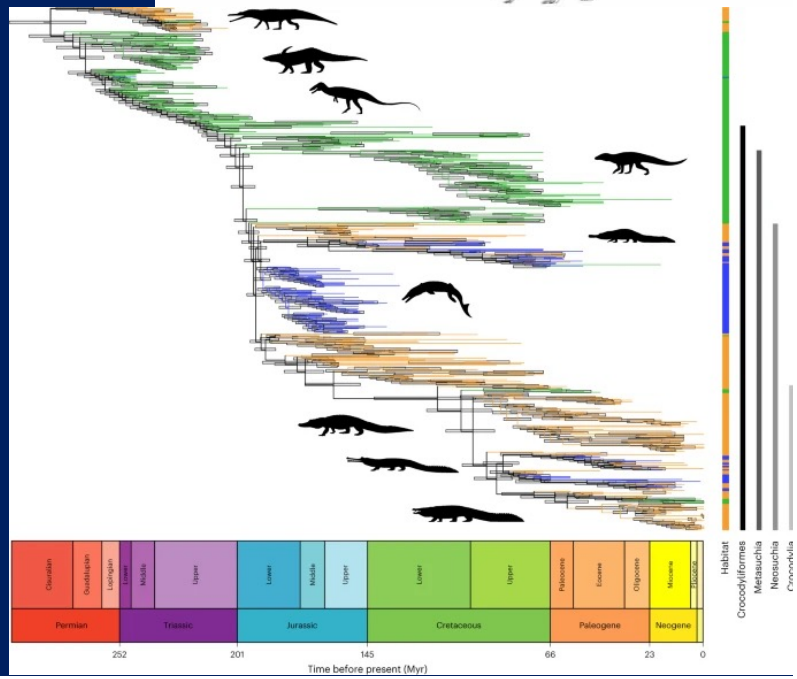


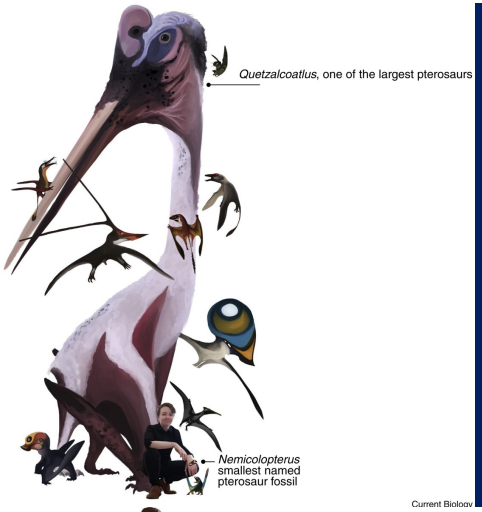






Pterosaurs

- Likely high metabolic rate, endotherms (filaments)
- Bones: pneumatic, air sacs
- Super long 4th finger
- Oldest 228Ma
- Quetzacoatalus 72Ma



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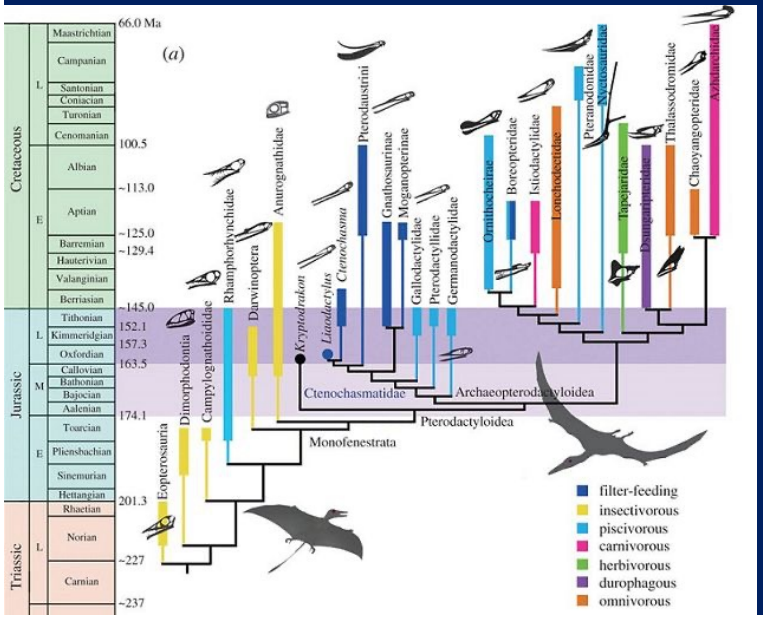
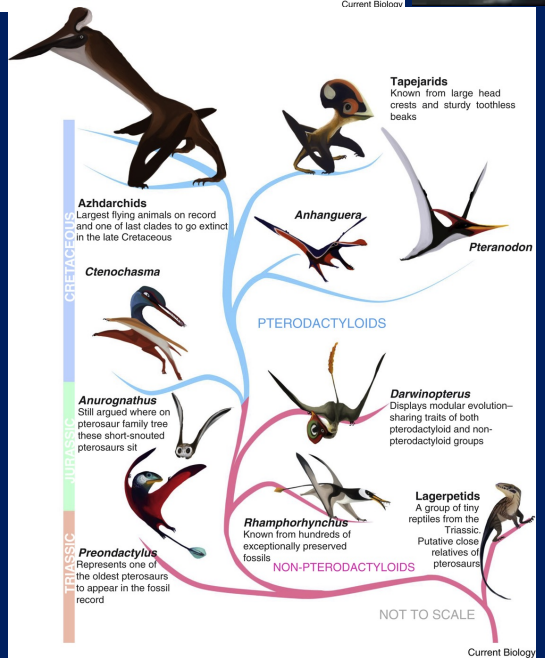
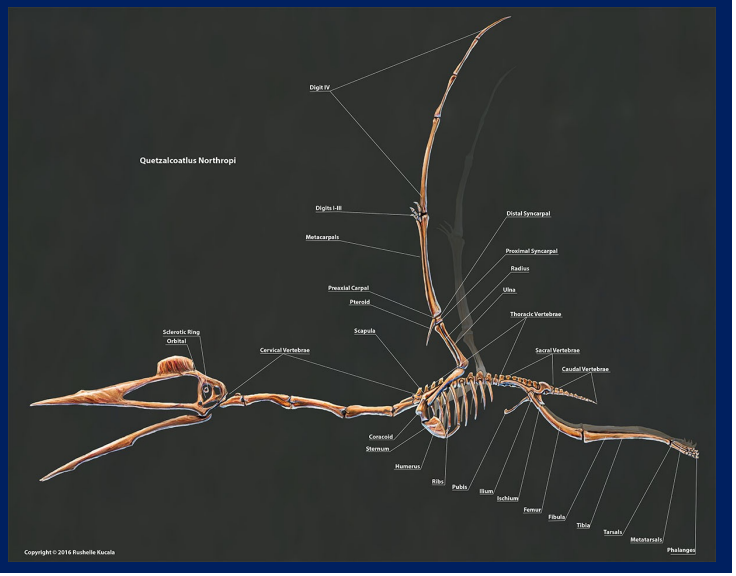
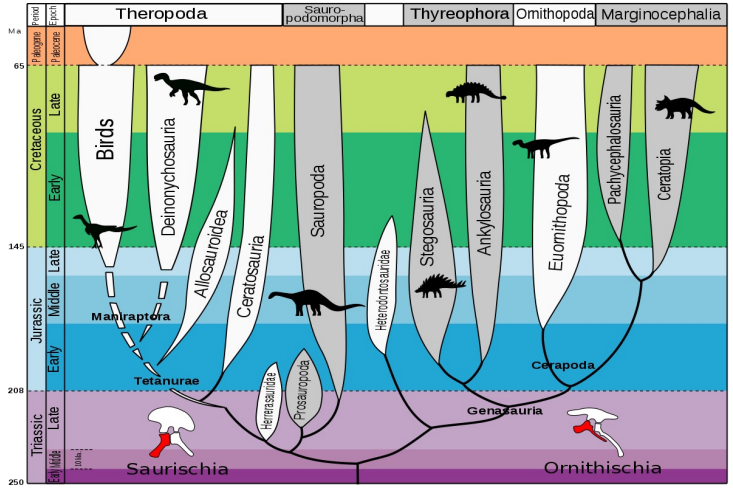


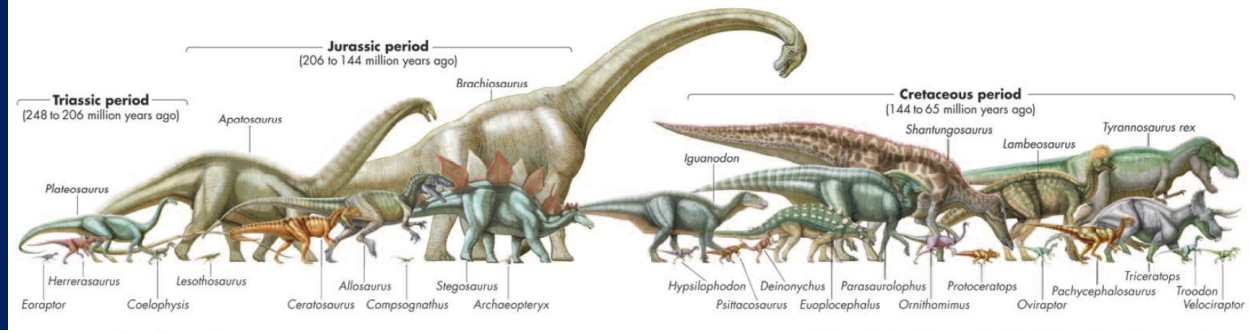


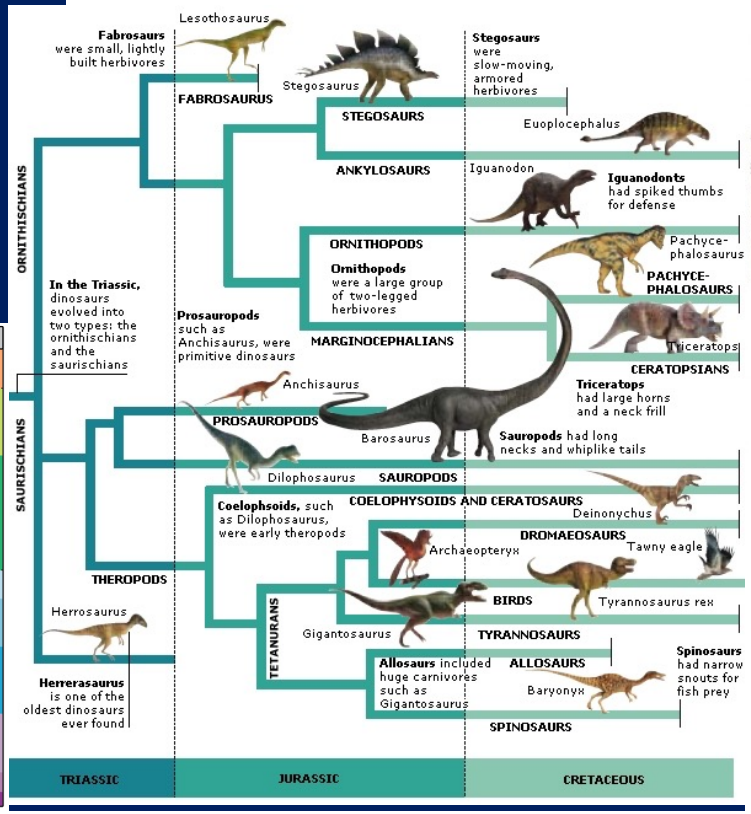


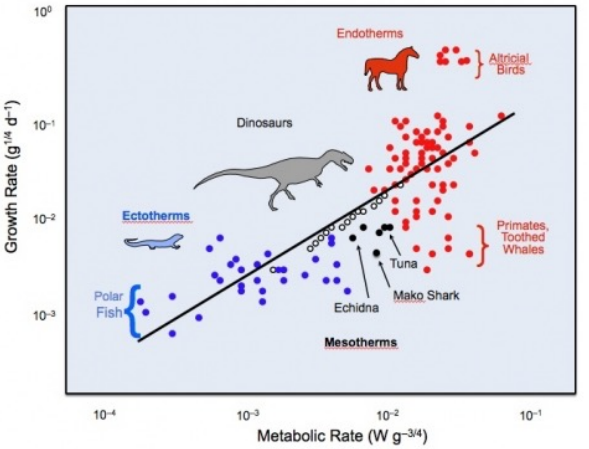
Dinosauria

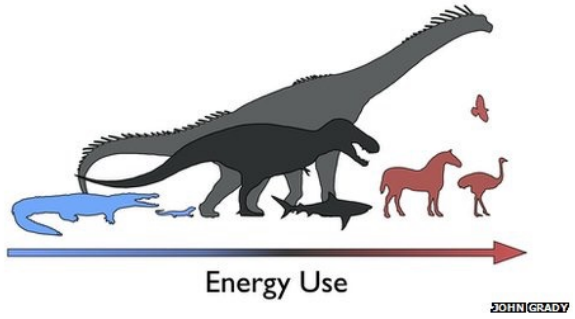
- Medium-high metabolic rate = higher caloric intake
- Mesotherms to Endotherms?
- Sauropsida, Diapsida, Archosauria, Ornithodira, Dinosauria
- Ornithischians & Saurischians
- Pneumatic bones + air sacs
- Display features



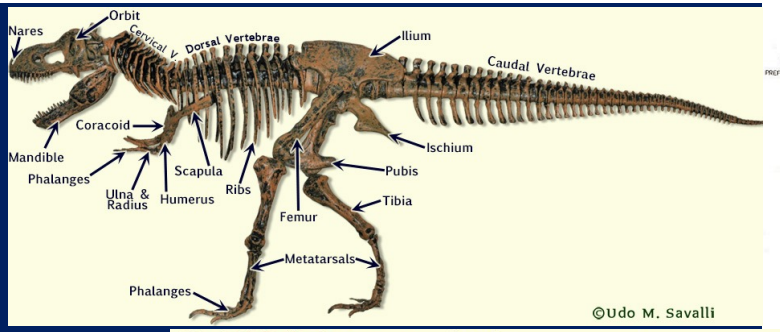


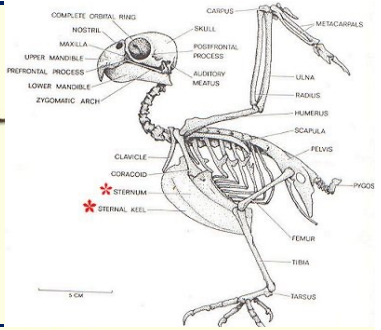


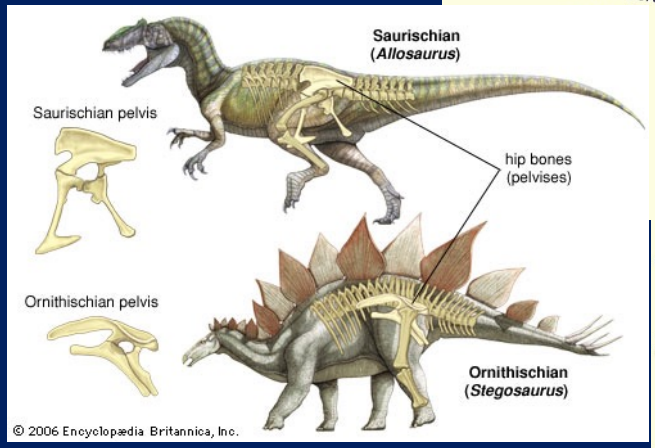


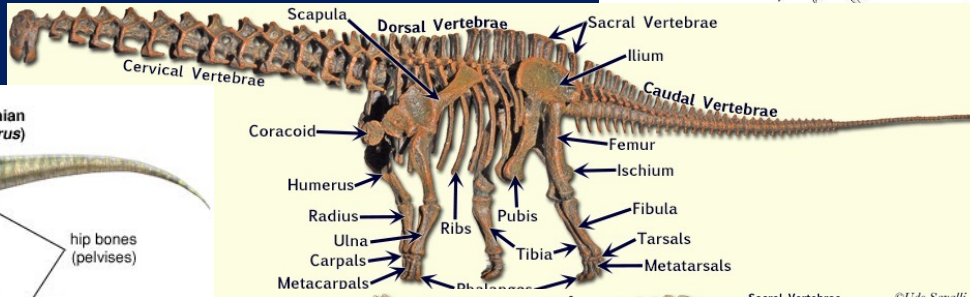


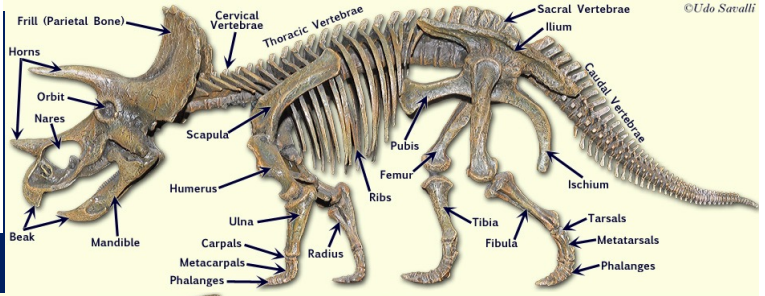
Dinosaur Diversification











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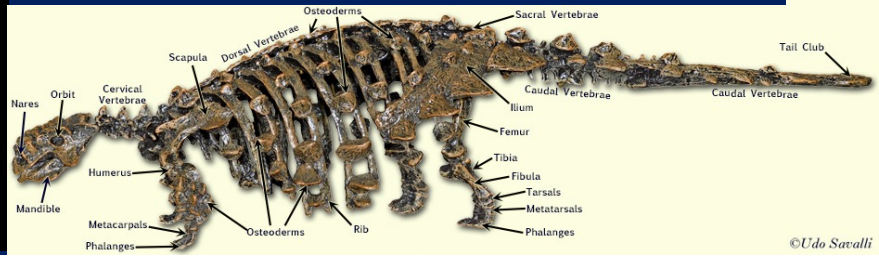
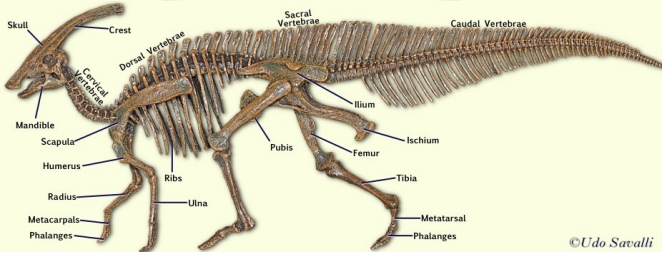
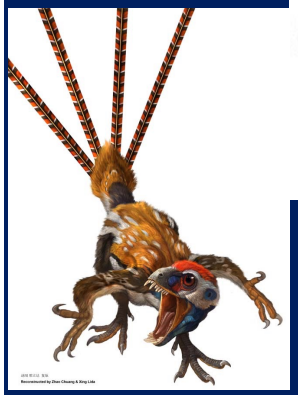
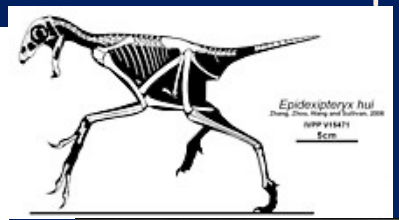


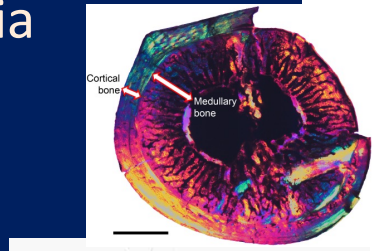


Avian Dinosaurs = Aves = Birds

- Highest metabolic rate, endotherms, bipeds
- Dinosauria, Theropoda, Coelurosauria (feathers), Maniraptora, Pygostylia
- Medullary bone
- Oldest: ~164Ma Epidexipteryx hui
- First flier: ~150Ma Archeopteryx







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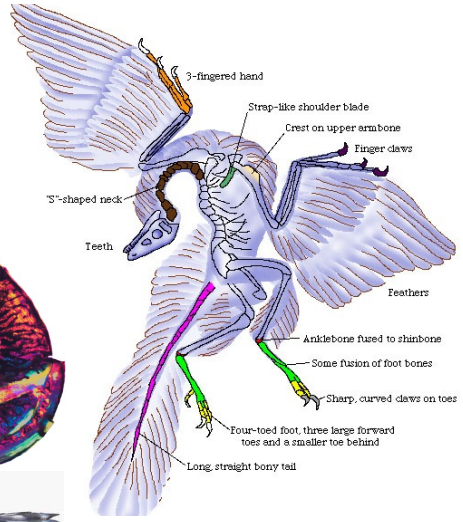
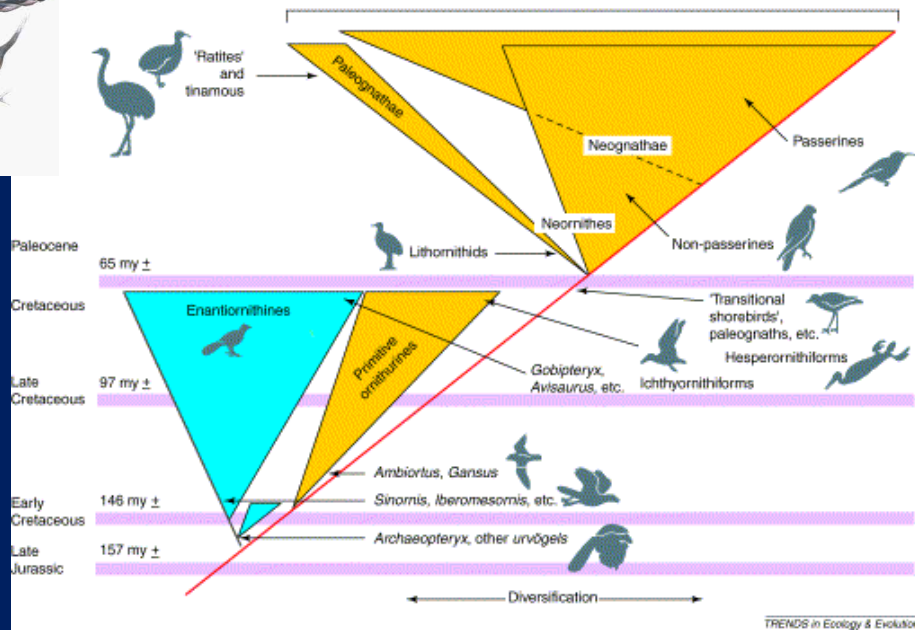
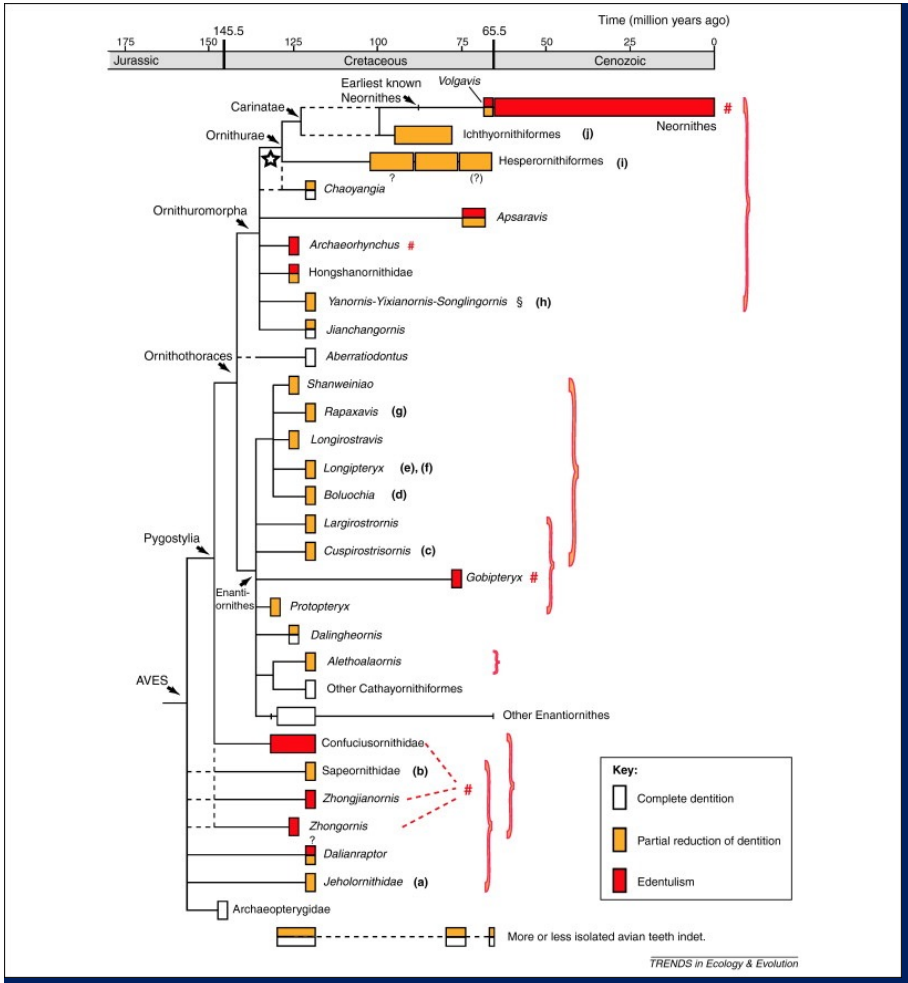
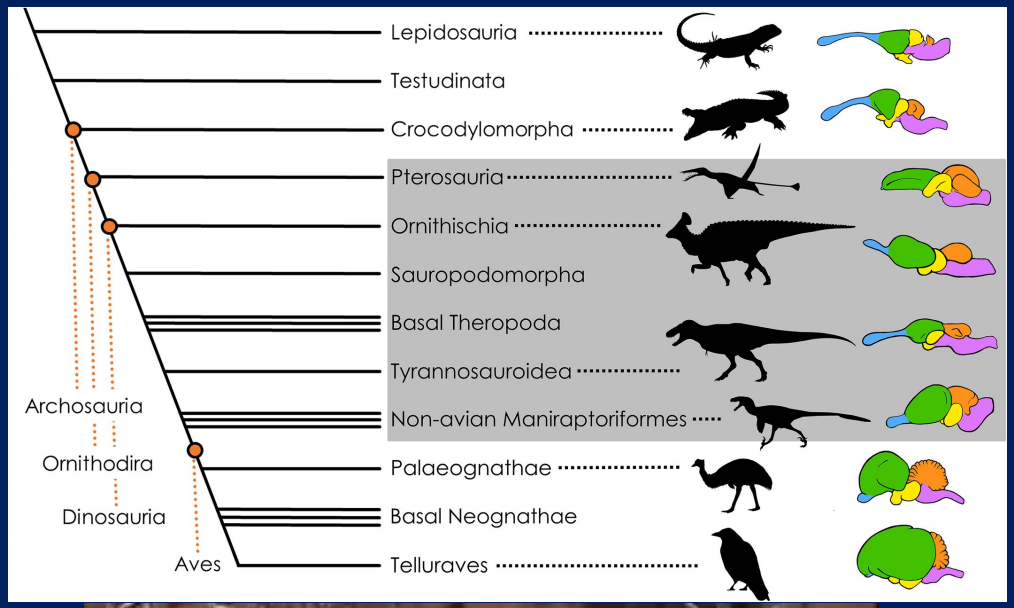






Avian Dominance



http://www.youtube.com/watch?v=KrKoHGMoXrE

- Loss of teeth & surviving the extinction
- Endocasts & big brains

10min. Break!

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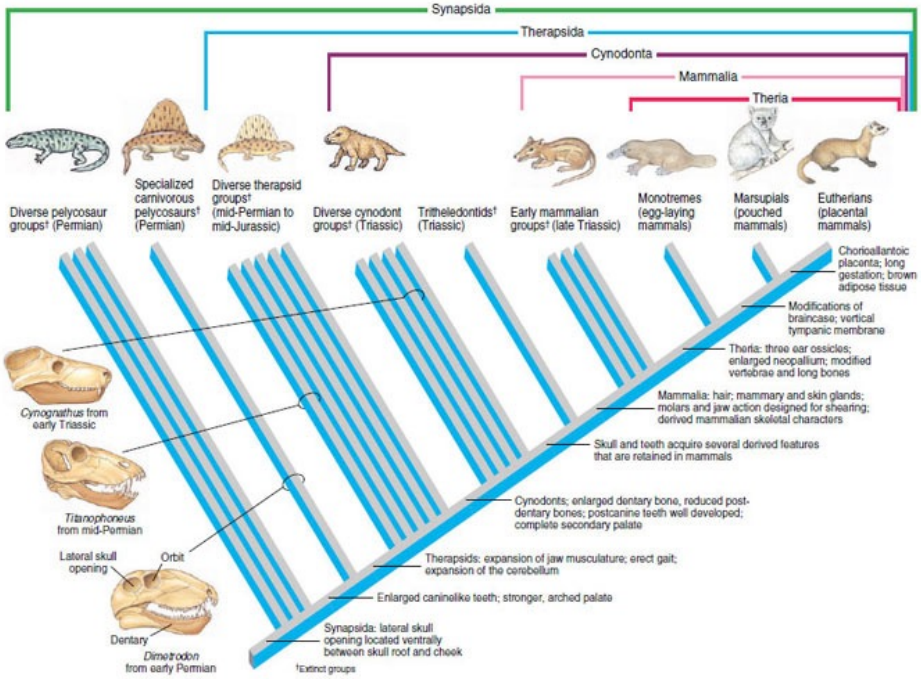
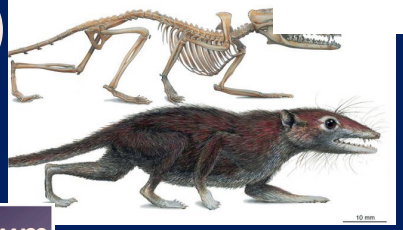
Synapsida → Mammalia

- ~315Ma earliest synapsid Asaphestera
- ~255Ma Diictodon (cynodont “dog teeth”)
- ~195Ma Hadrocodium (Mammaliaformes)
- ~160Ma placentals & marsupials diverge (jaws, teeth, & skulls)
- ~160Ma Juramaia (earliest placental)
- ~66Ma Didelphodon (marsupial)



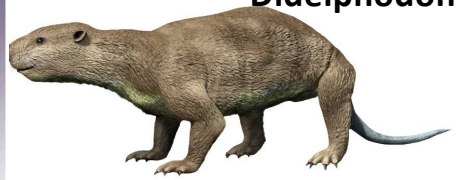
https://www.youtube.com/watch?v=T-TlDyvm3Bo&ab_channel=WildDestinations

Juramaia



Hadrocodium

Didelphodon



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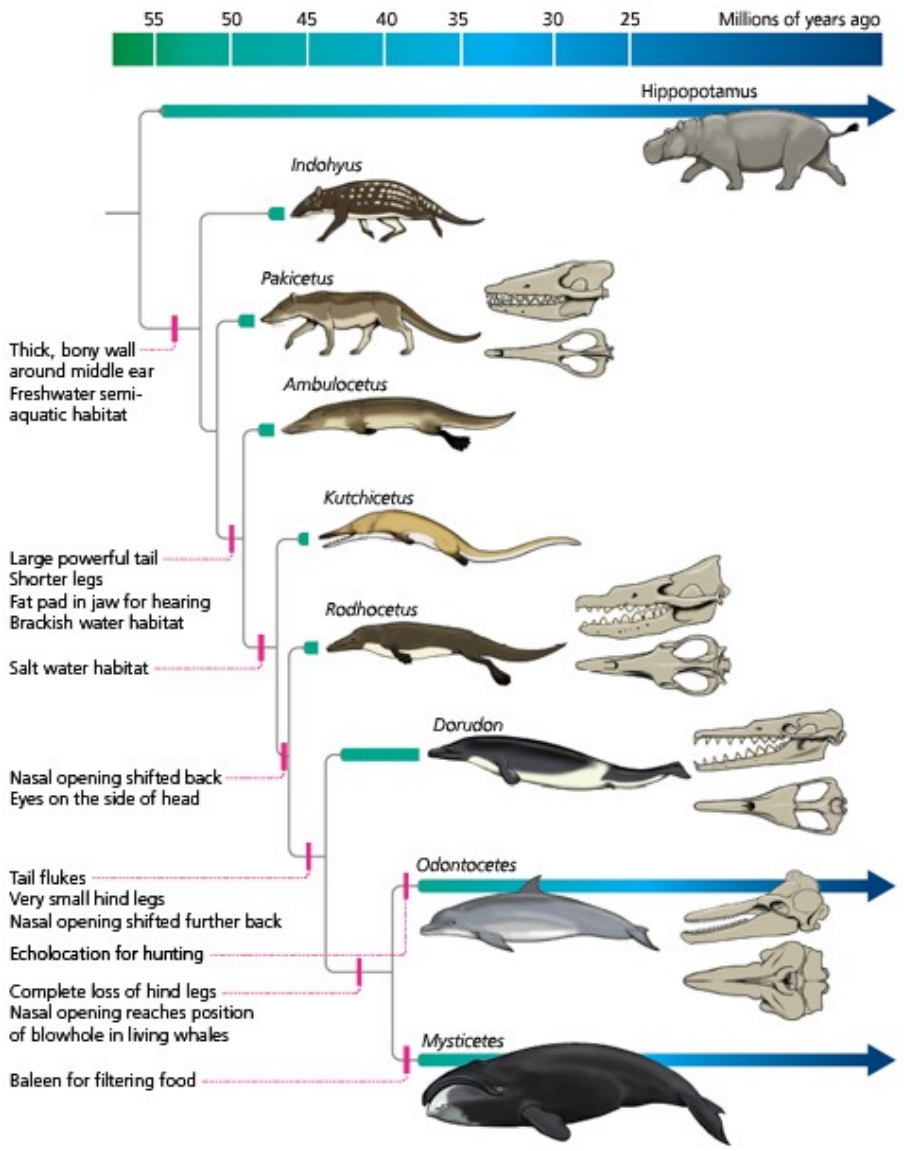
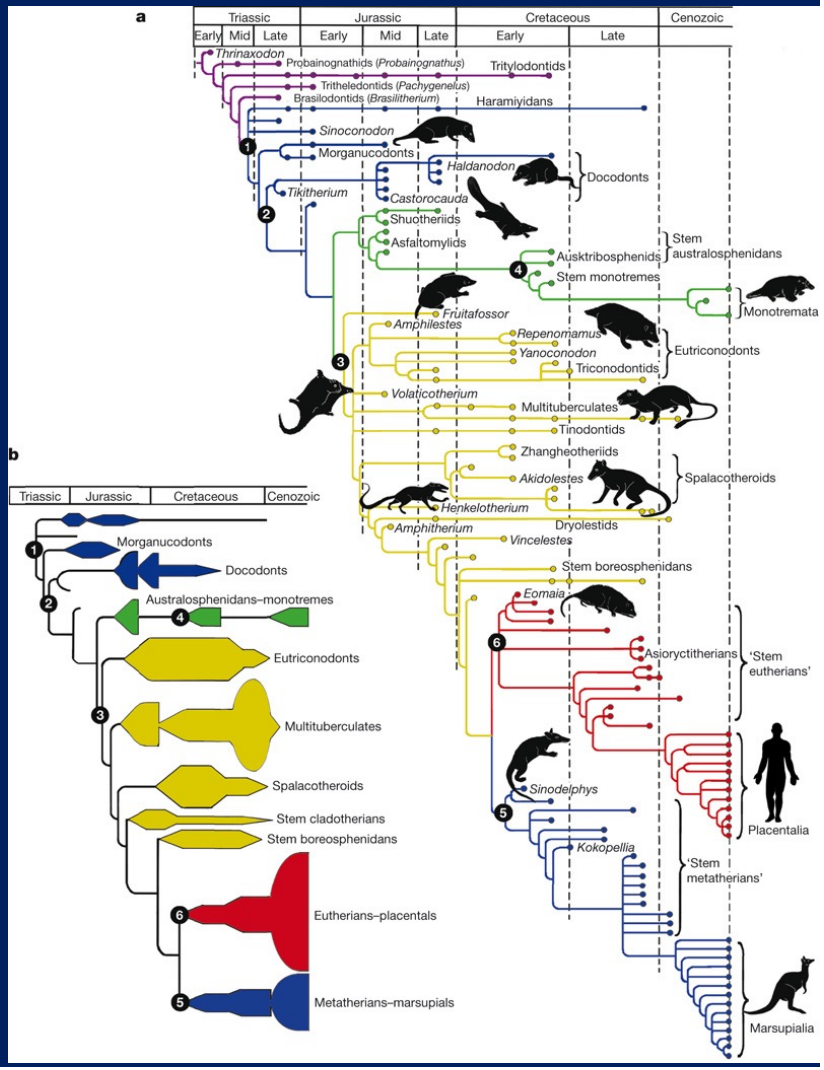
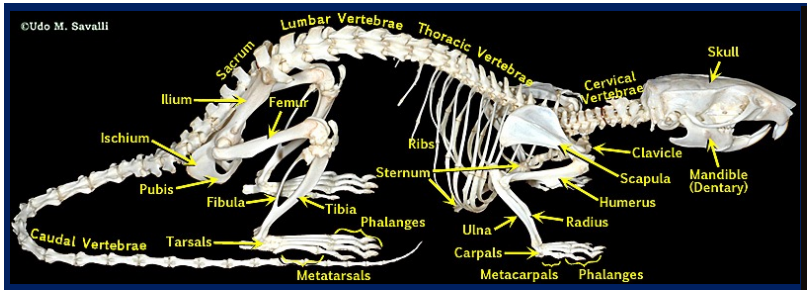


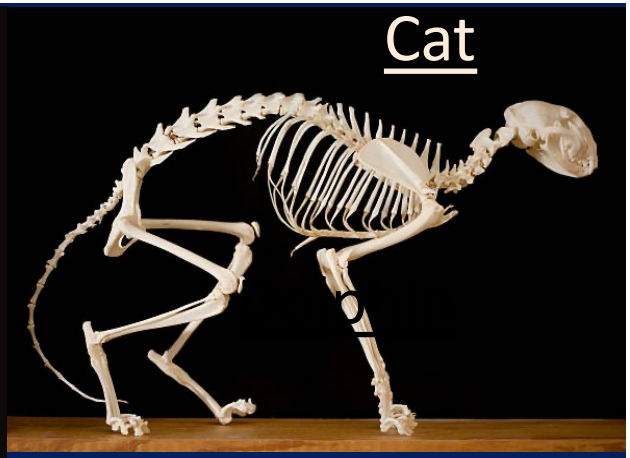
Mammal Ancestral Traits

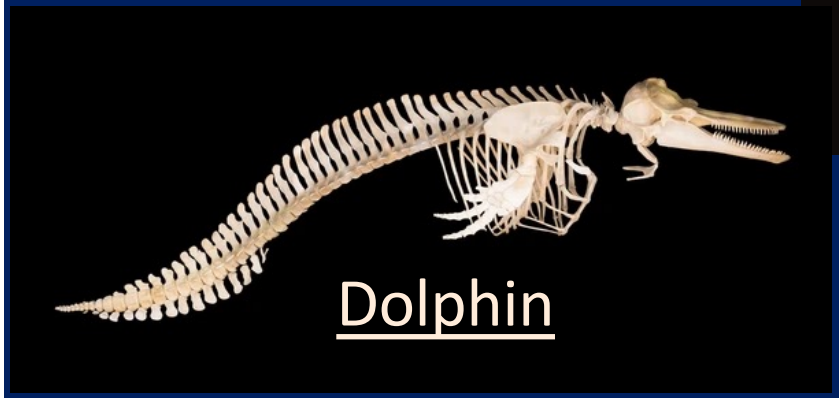
- **Skin**: water barrier + thermoregulation + teeth + hair + fingernail
- **Better hearing bones**: reptiles have 1 & mammals have 3
- **Burrowing & climbing**: spine undulates in sagittal plane + flexibility

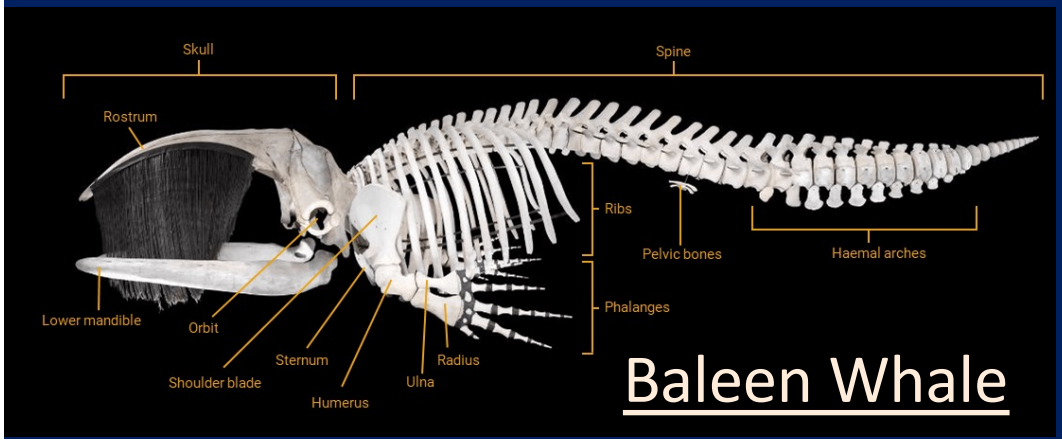


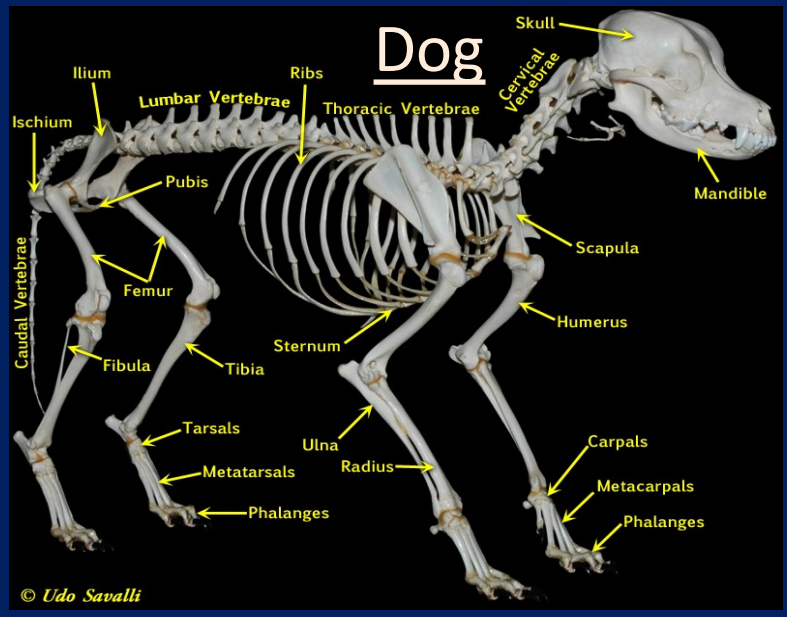
Cenozoic Mammal Skeletons









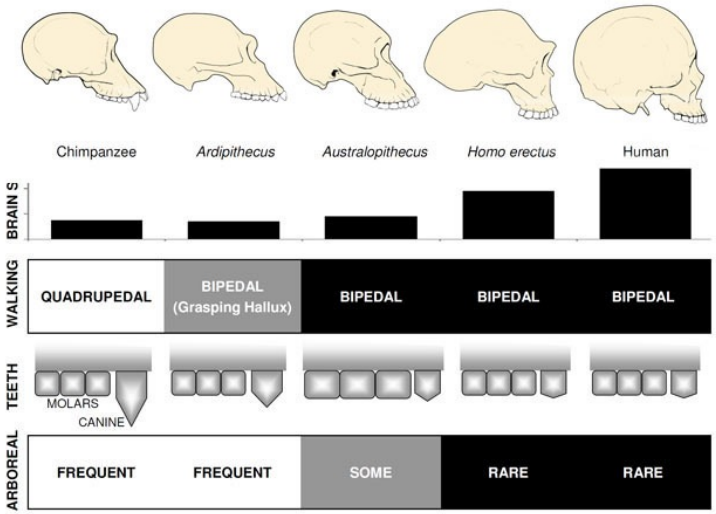


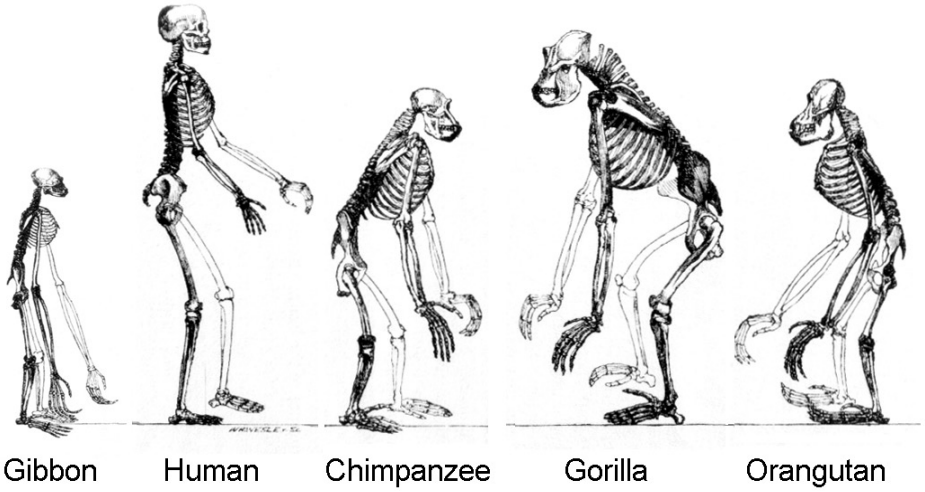
Primate Ancestral Traits

~50Ma Notharctus = earliest primate, nails instead of claws, hand like ours, divergent thumb

- Grip with hands
- Eyes face forward
- Bipedalism = back problems, freed hands

Rhesus monkey

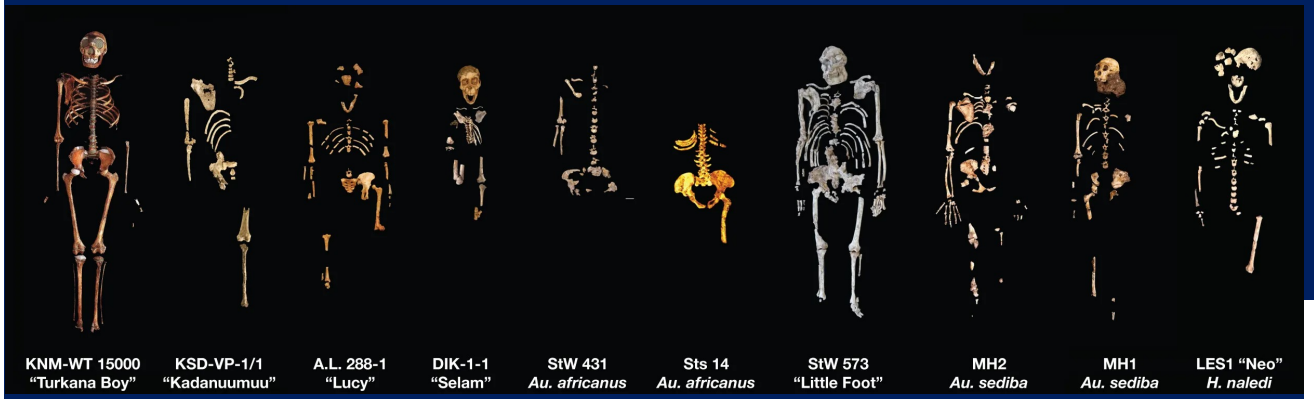


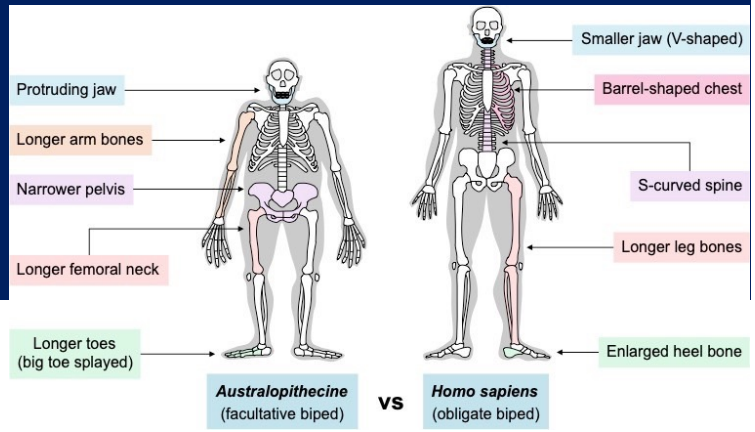


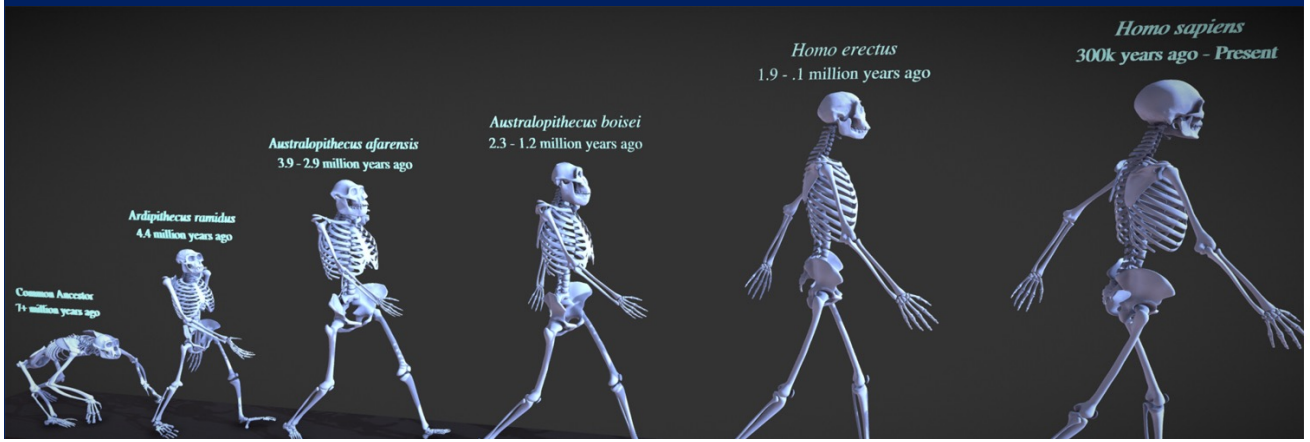
Hominids: Hominins + Great Apes (Human & Gorilla)

Hominins

- Homo (humans) & Pan (chimps & bonobos)
- Bipedal locomotion (lumbar curve), broad ilium, larger brain case, smaller teeth
- ~4.4Ma Ardi climbed in the trees: grasping foot that could walk + grasping hands



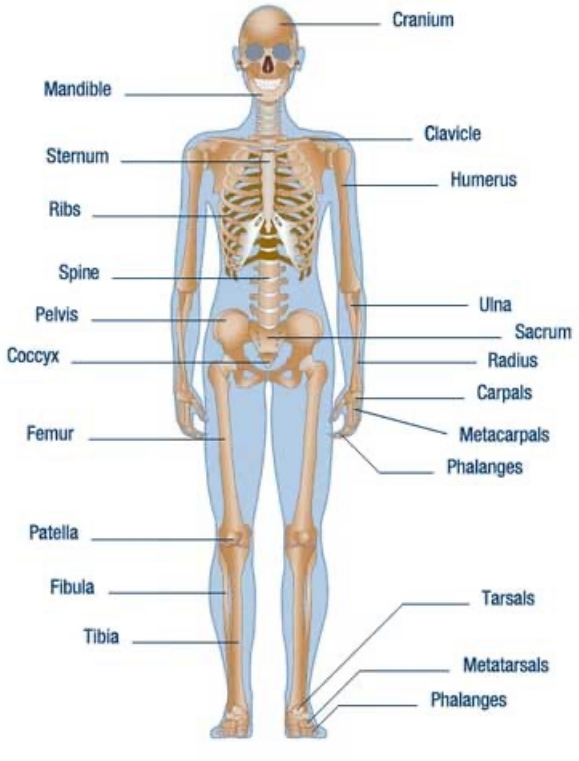




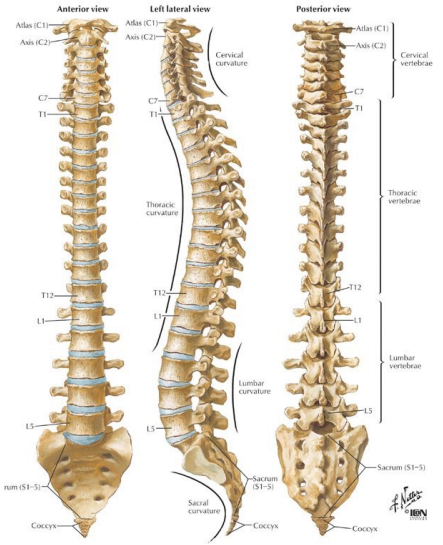
Homo Sapiens Range of Motion

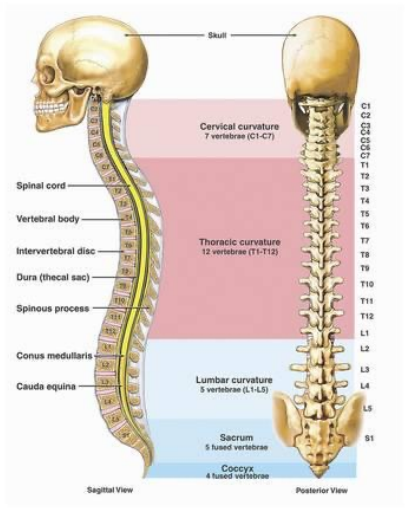
- Human Range of Motion (ROM) →
- Every vertebrate has a unique range of motion
- Human skeletal issues: lordosis & kyphosis
- Barrel shaped rib cage
- SI Joint
- Posture
- Sitting
- Text neck
- Osteoporosis

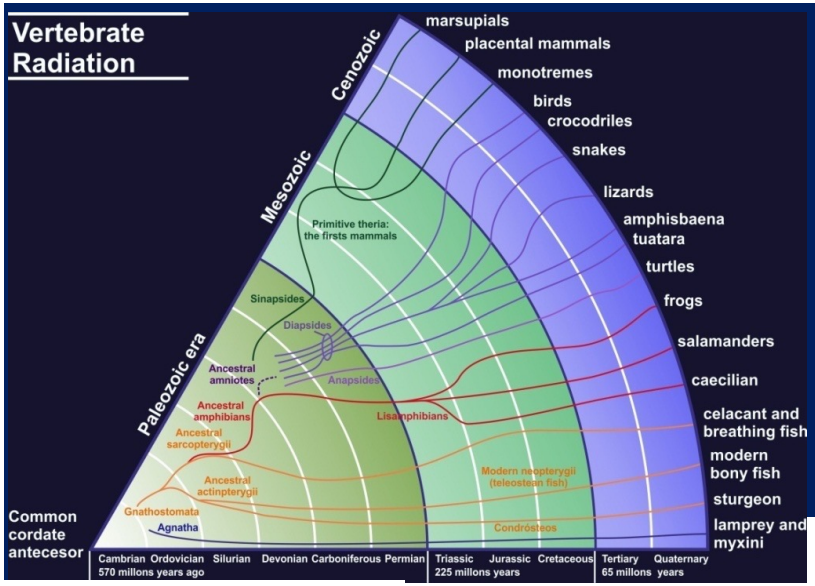
Gravity is rude but your skeleton helps you defy gravity every day



Spinal Section	# Vertebrae	Curvature	Extension	Flexion	Axial Rotation	Lateral Flexion
Cervical	7	Lordotic	75°	40°	50°	35°
Thoracic	12	Kyphotic	25°	45°	35°	20°
Lumbar	5	Lordotic	35°	60°	5°	20°
Sacral	5 fused	Kyphotic	x	x	~3-5°	x
Coccyx	4	Usually kyphotic - "does not move"				
TOTAL	**33**	**X**	**135°**	**145°**	**~90°**	**75°**



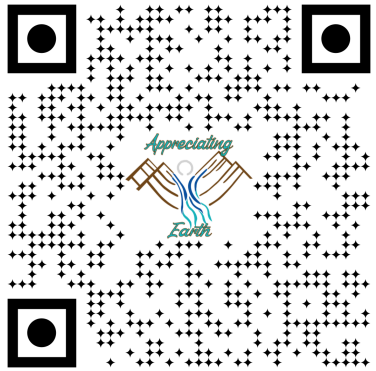


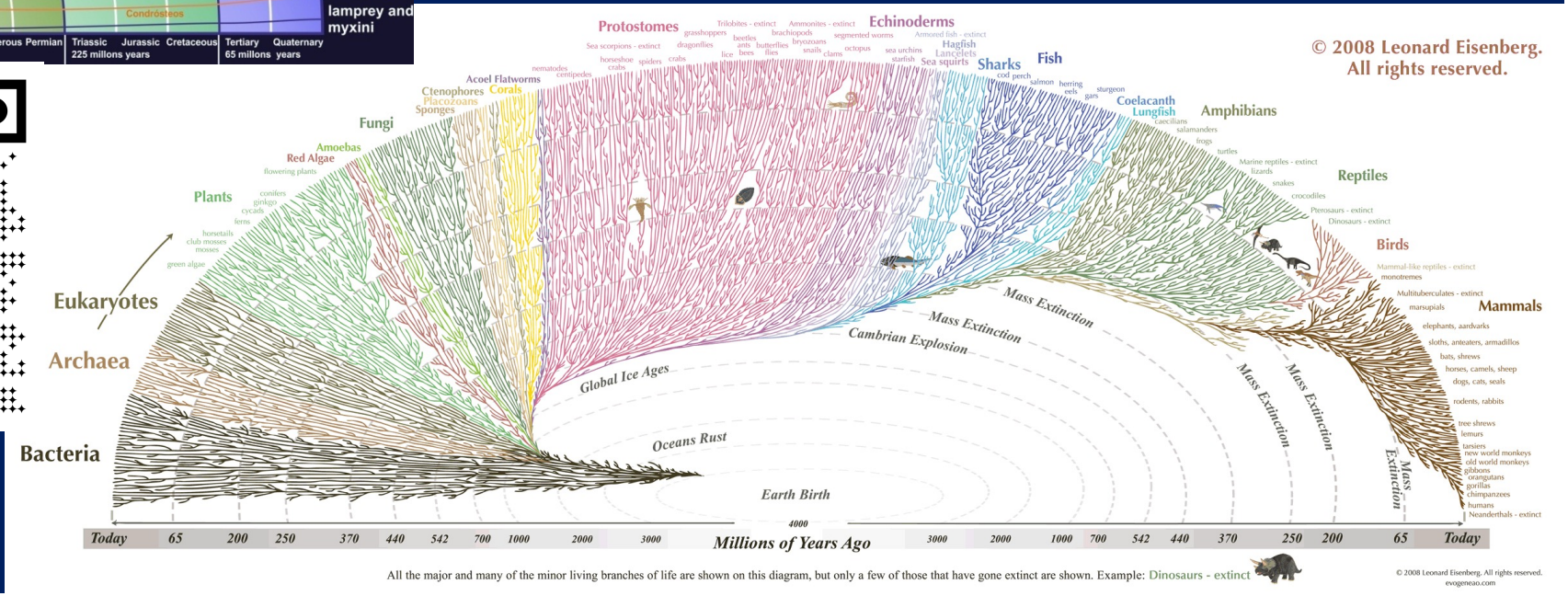


Life on Earth

Our skeletons are alive, they evolve with us individually and as a species, genus, family, order, etc. Your skeleton is a reflection of your ancestors, your posture, your diet, & your endocrine system.

Sign up for the Appreciating Earth newsletter!





All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs - extinct