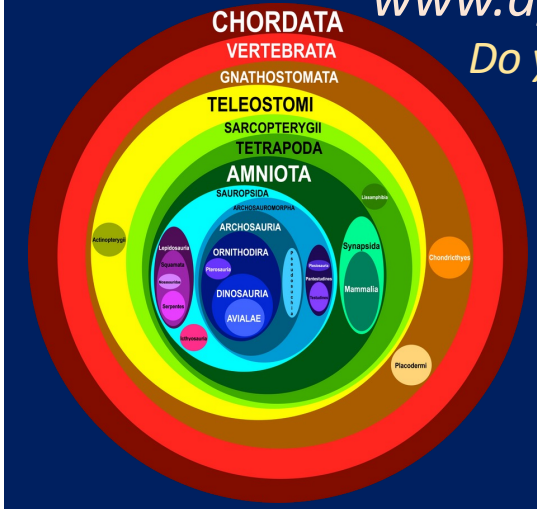
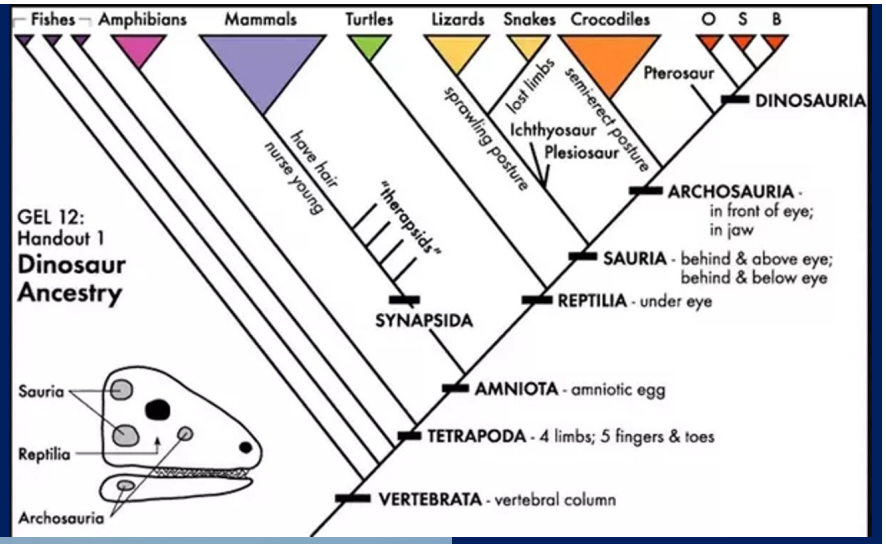
Skeletal Evolution & Earth History Lecture 5

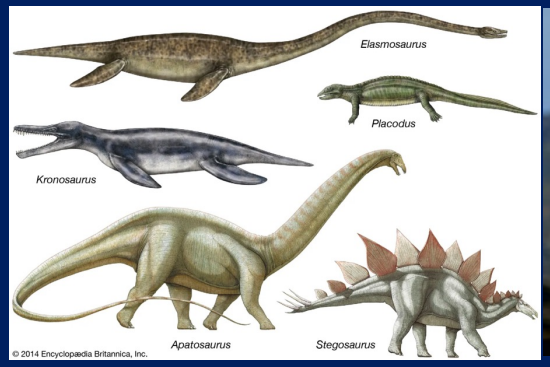
with Nicole Myers

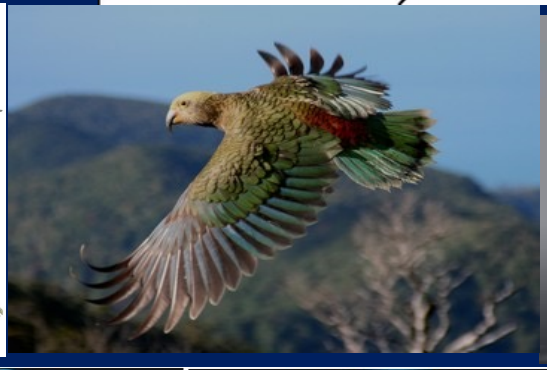
www.appreciatingearth.com/olli

Do you have a connection to Temelec House? If so, reach out to me!







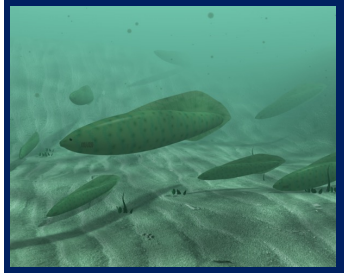


260 mya | 220 mya | 150 mya | 90 mya | 66 mya

Firsts of the

Cambrian - Ordovician - Silurian - Devonian - Carboniferous - Permian

chordates
vertebrates



538.8Ma

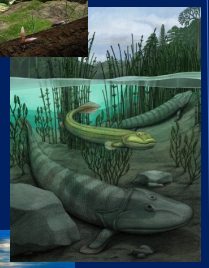
land plants
jawed fish

486.9Ma

cartilaginous
osteichthys

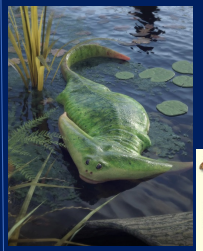
443.1Ma

tetrapods
amphibians



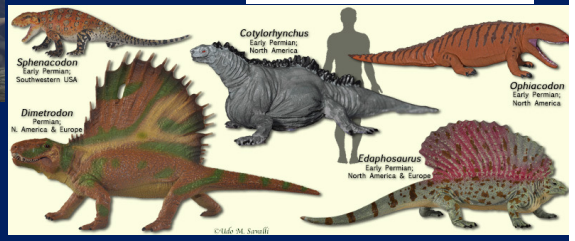
419Ma

Amphibians
Amniota
Synapsids
Sauropsids

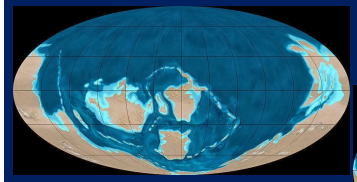


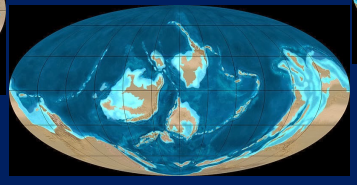
359.3Ma

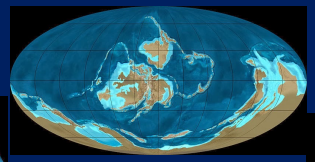
Seed plants

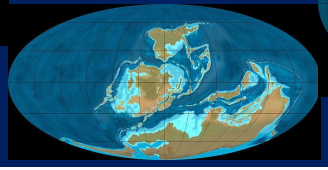


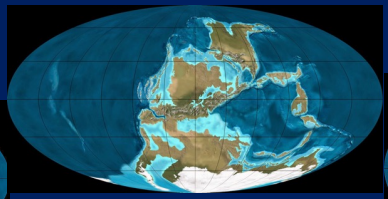
298.9Ma 252.2Ma

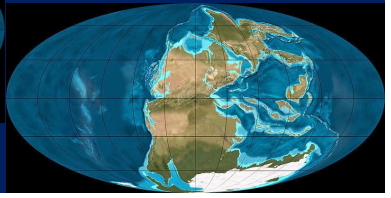












Firsts of the

Triassic - Jurassic - Cretaceous

Turtles

Crocodiles

Lepidosaurs

Marine reptiles

Dinosaurs

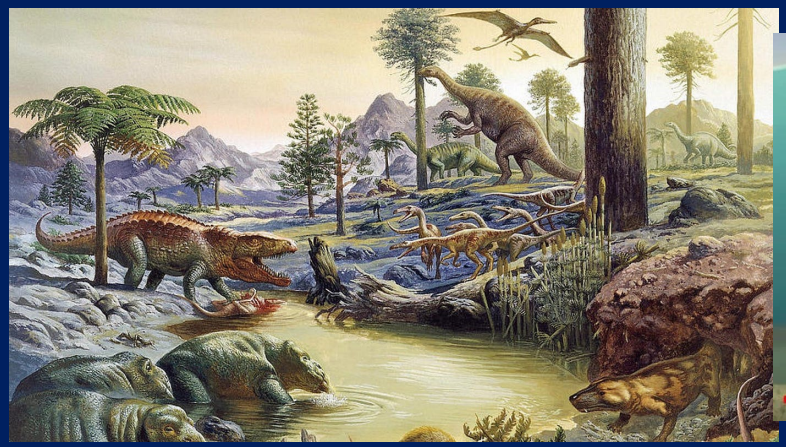
Pterosaurs

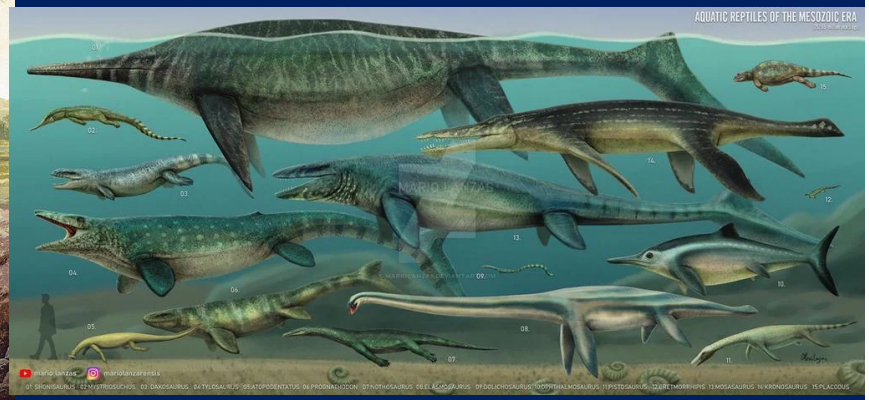
Mammals

Aves/birds

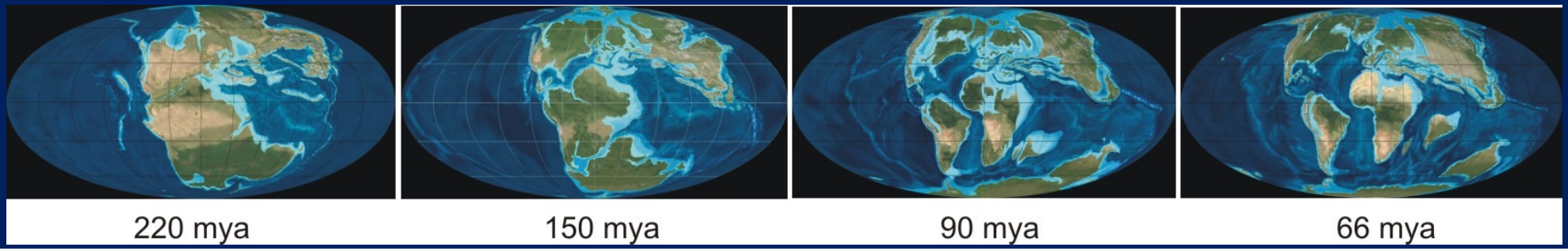
Angiosperms/flowers

"reptile diversification"





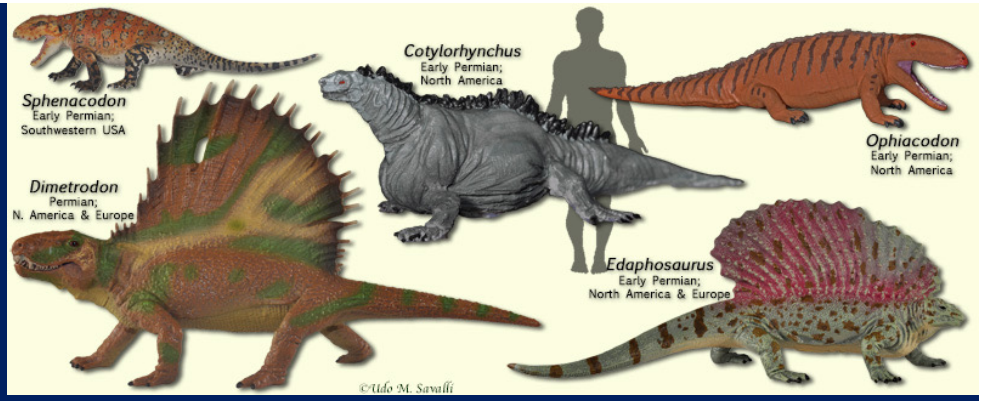
251.9Ma 201.4Ma 143.1Ma 66.0Ma

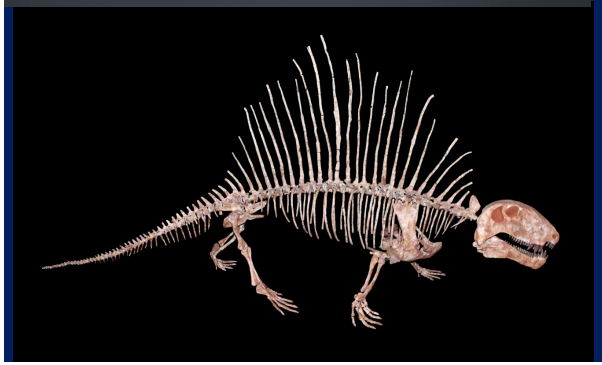


Permian Synapsida

Dimetrodon: 295-272Ma

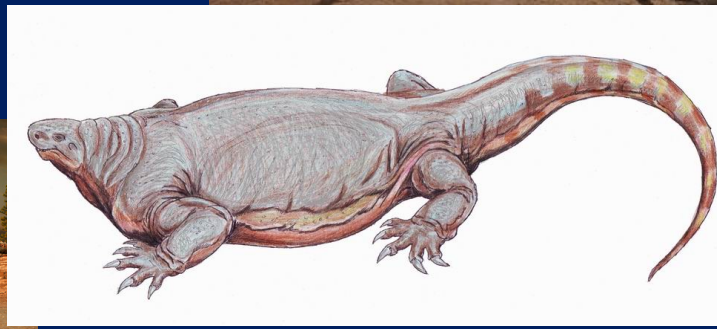
- Sailed semi-sprawling carnivore
- 1.7-4.6ft
- 60-550lbs





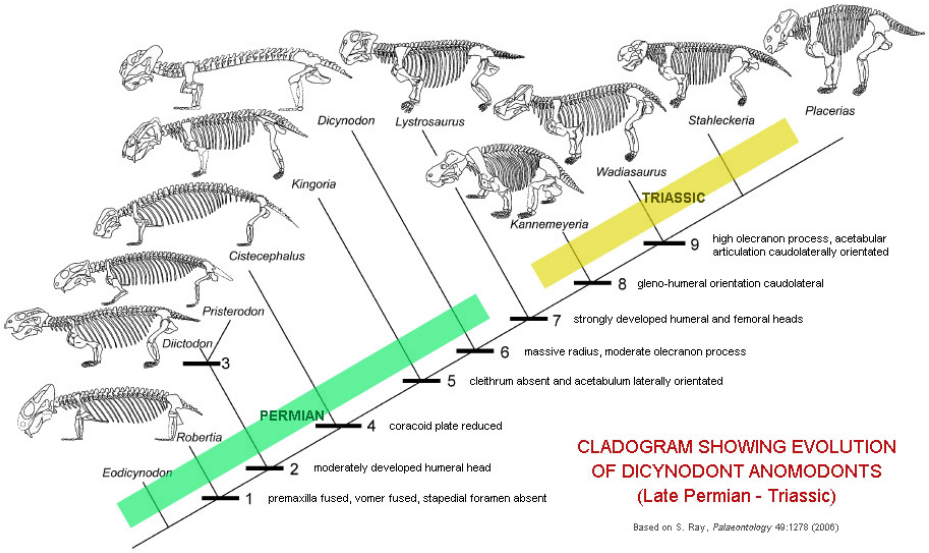
Cotylorhynuchus 279.5-270Ma

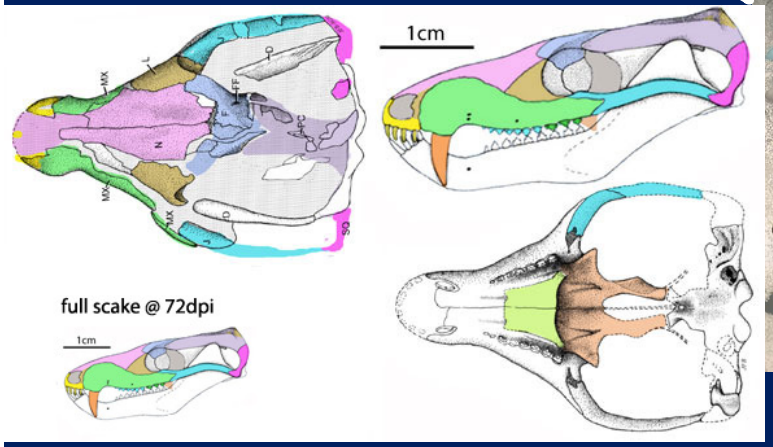
- semi-aquatic or terrestrial herbivore
- 3.6m
- 730lbs



Synapsida → Mammalia

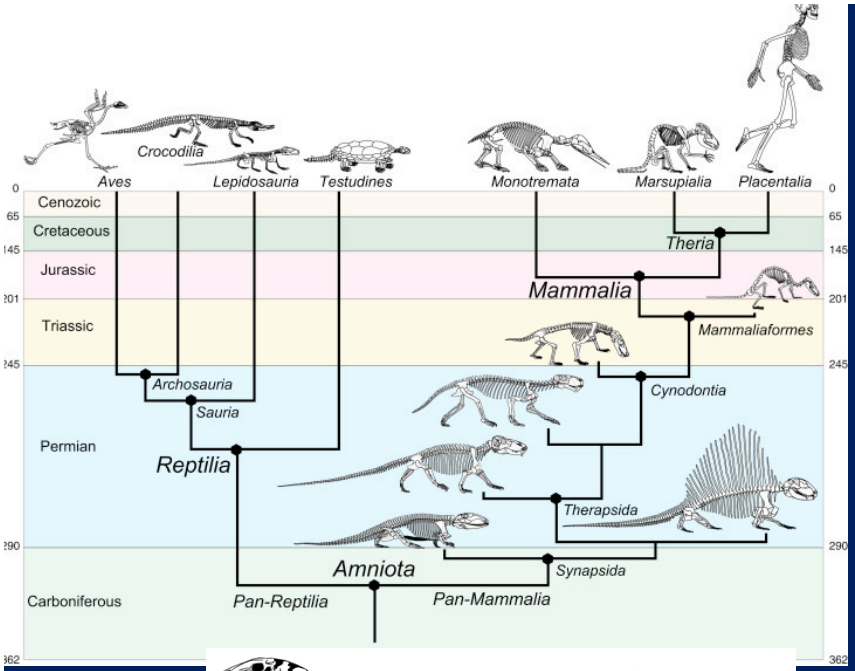
- ~315Ma earliest synapsid Asaphestera
- Permian-Triassic synapsid diversification
- ~225Ma earliest mammal = Brasilodon
- ~160Ma early Placental Mammal = Juramaia





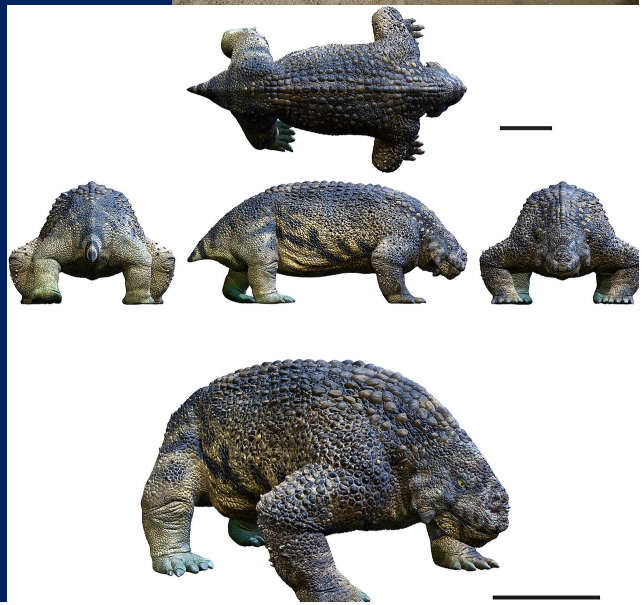
Permian Sauropsida/Reptilia

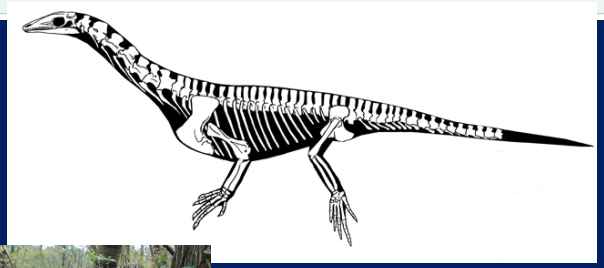
~330-315Ma divergence of Sauropsids & Synapsids (molecular clock date)



Scutosaurus 259-251Ma

- Anapsida
- Erect stance
- Osteoderms
- 2.5-3m
- 2,560lbs



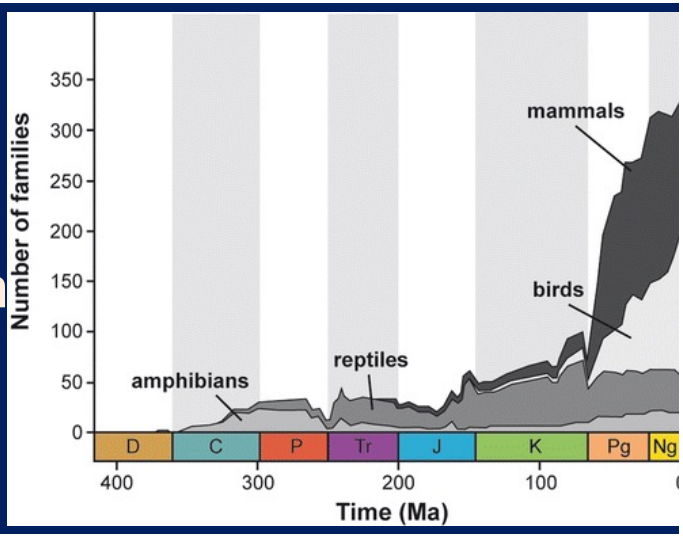


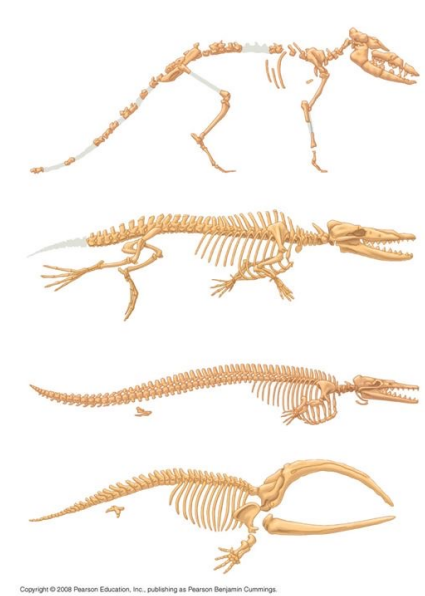
Protorosaurus ~257Ma

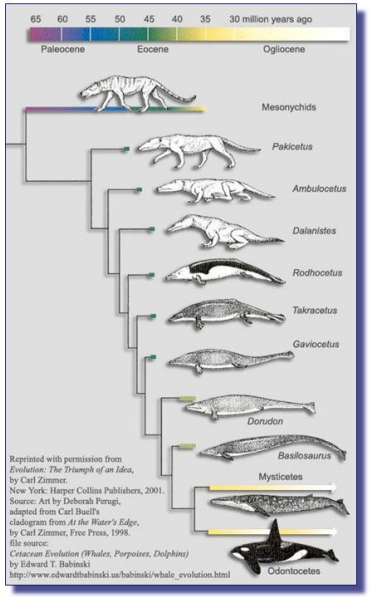
- Diapsid: semi-erect stance
- 1.5-2m

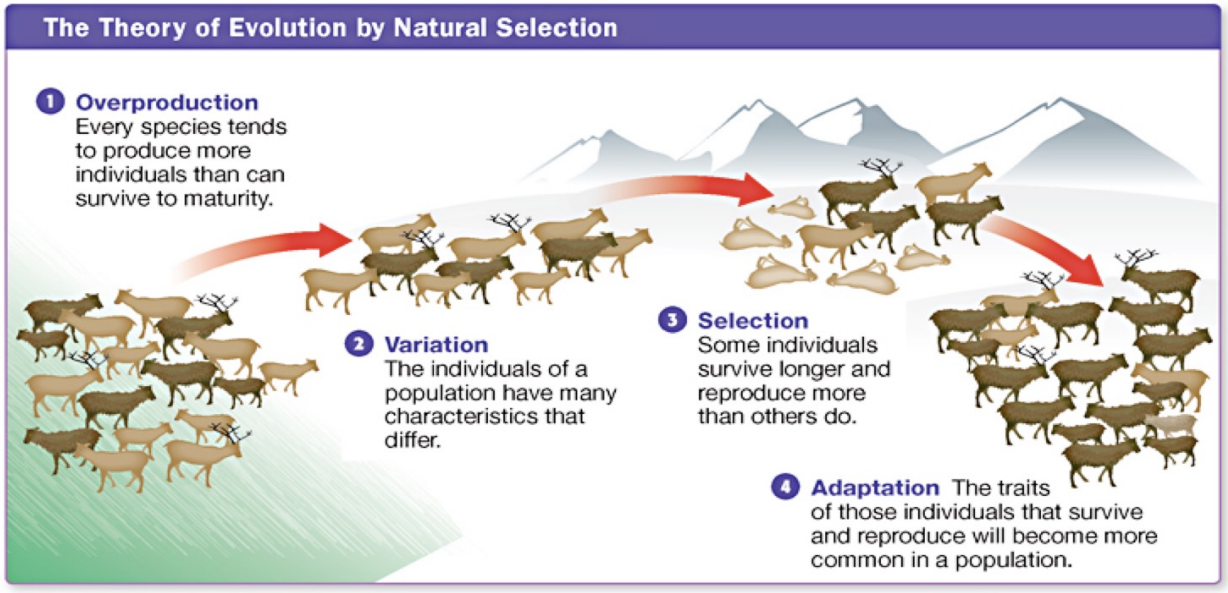
Evolution by Natural Selection

- **Inheritance:** **genetic** traits are inherited
- **Variation:** life forms vary **genetically** in a population
- **Selection:** survival depends on favorable **traits**
- **Time:** evolution in ongoing, speciation takes longer





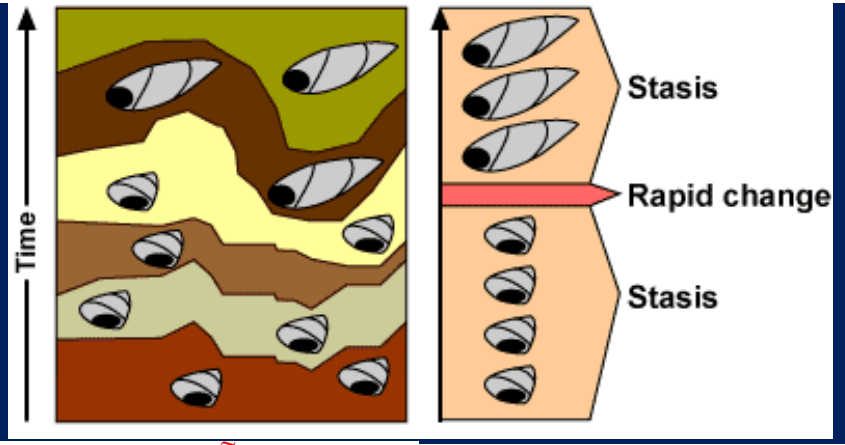


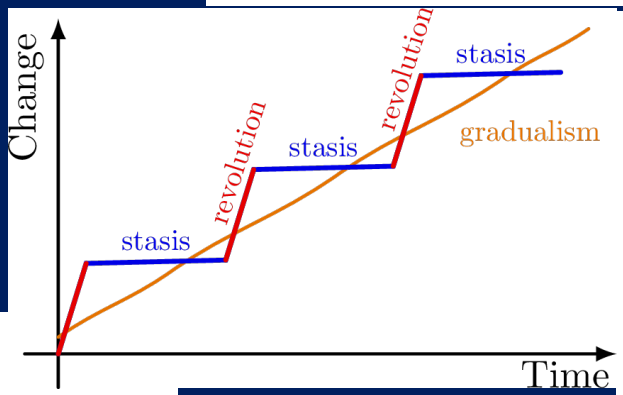


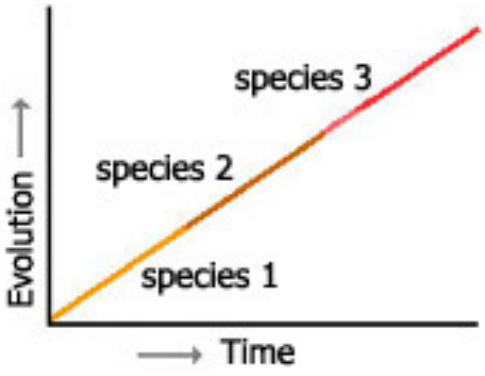
Speciation

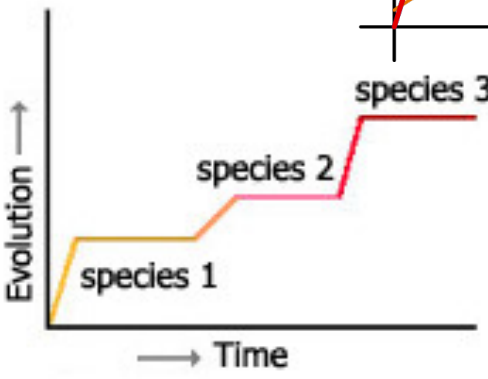
Speciation: populations evolve to become new & distinct species

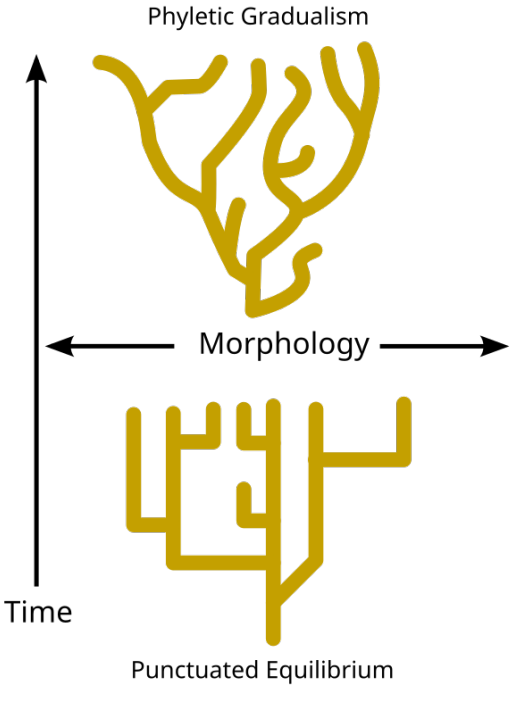
- **Phyletic Gradualism** = slow & steady evolution due to interbreeding population
- **Punctuated Equilibrium** = long term stasis followed by rapid differentiation due to rare geologically rapid events











Molecular Evolution

Mutagenesis:

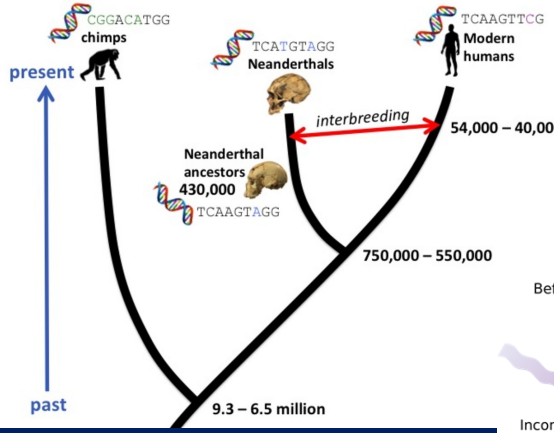
- Spontaneous DNA error OR environmental exposure (radiation/chemical/infectious agent) changes an organism's genetic material = increased genetic variation

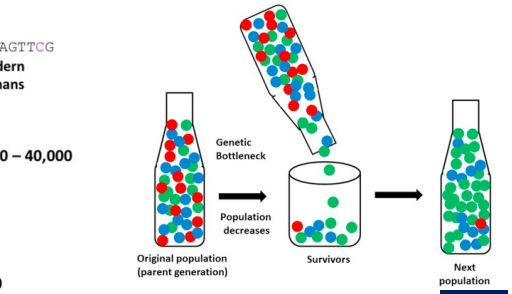
Genetic Drift:

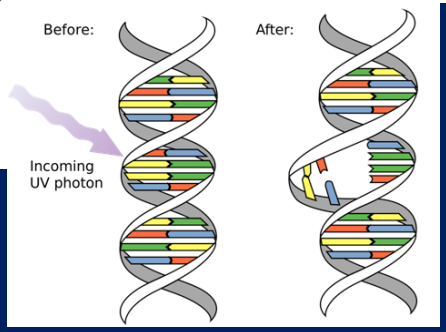
- "Change in frequency of an existing gene variant in the population due to random chance" (NHGRI)

Molecular Clocks:

- Some genes have more constant rates of change (mutations) than others
- Neutral mutations do not influence survival





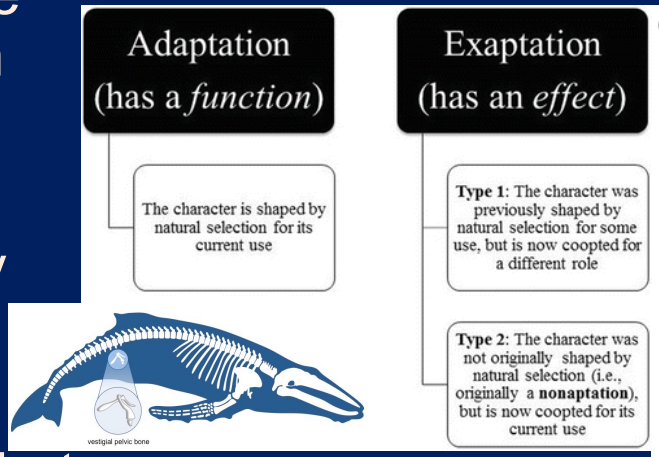


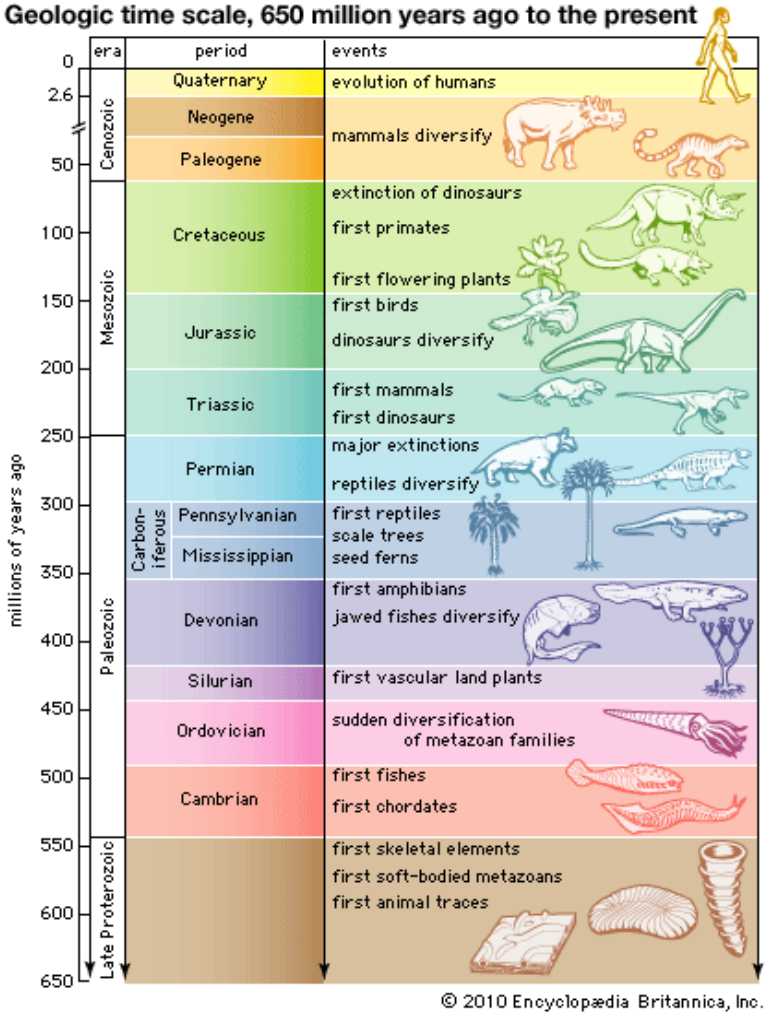
https://youtu.be/rMSVwWYXIjg

Adaptation & Exaptation

All genetic features arise as a result of a mutation

- **Adaptation**: features/behaviors that arose & was favored by natural selection for its current function
- **Exaptation**: a feature that performs a function that was not produced by natural selection for its current use - shift in function
- **Vestigial Structure**: adaptive for ancestor but now non-functional

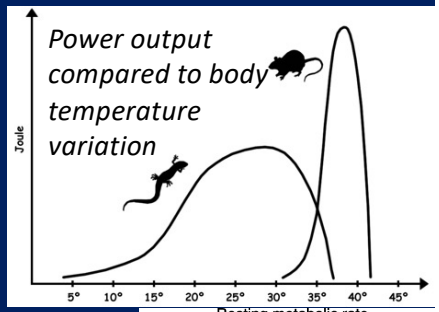


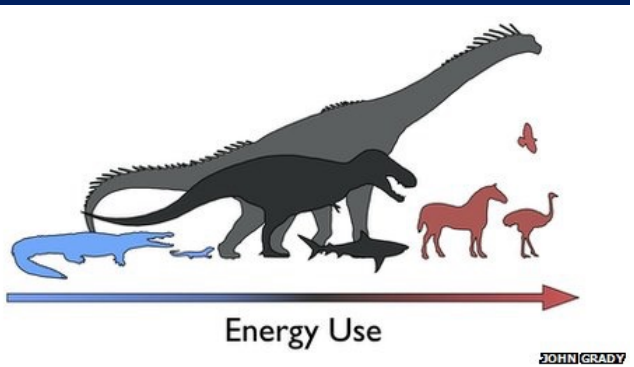


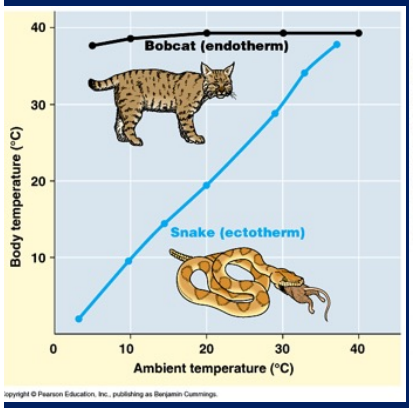
Metabolism Hyper-Simplified

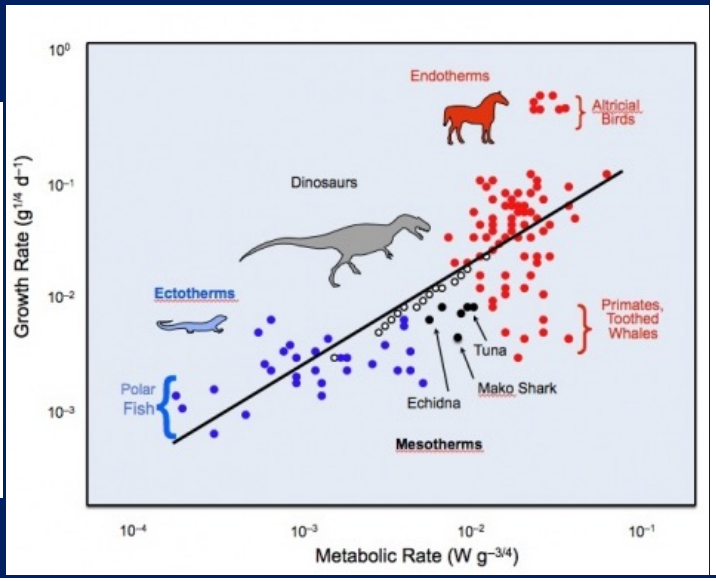
Histology: microanatomy of bones reveals temp. control & growth patterns

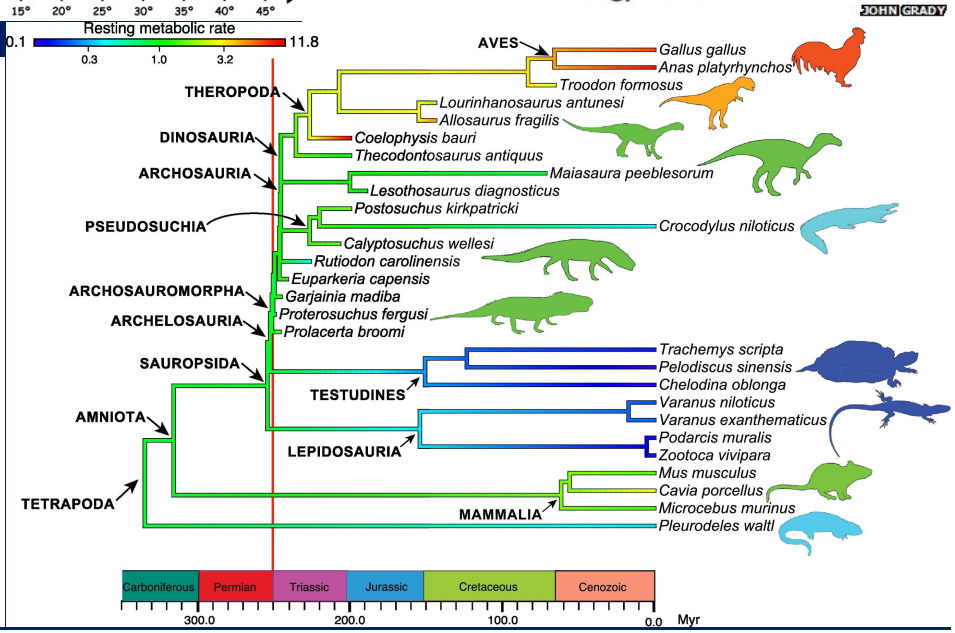
- Higher metabolic rate correlates with faster growth rate
- Max size = genetics + environment
- Ectotherms
- Mesotherm
- Endotherm [includes all living bipeds]
- Gigantotherm





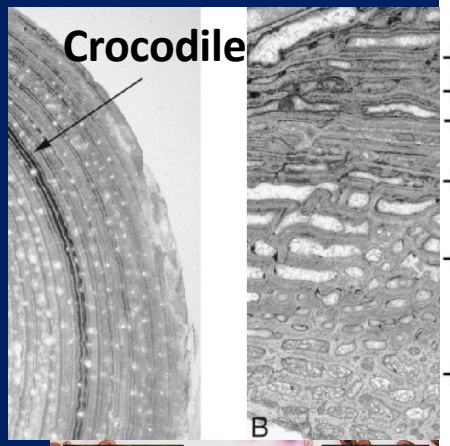


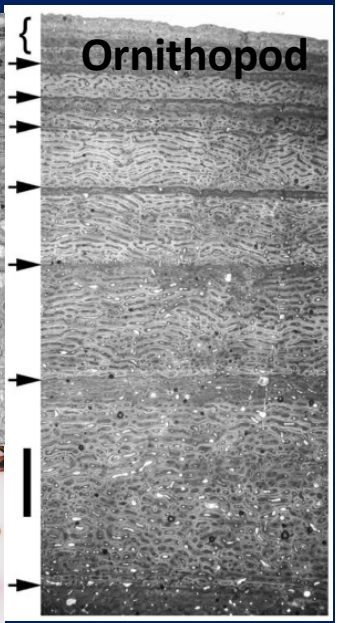


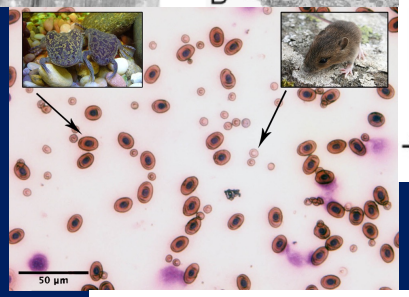


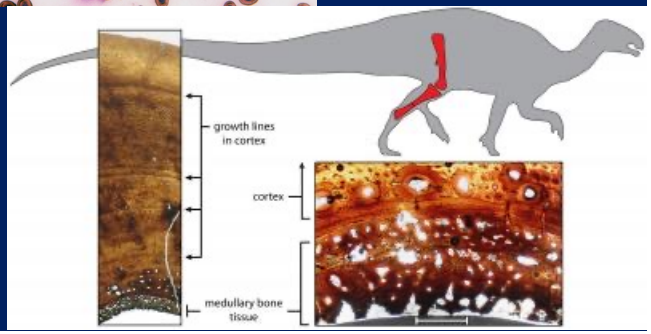
Fossil Evidence of Metabolism: Histology & Skeletal Articulation

- Living ectotherms (amphibians/reptiles) = less agile, bursts of speed, poor lungs, primitive hearts
  - Skeletal evidence: trackways, weight distribution, bones with low density of large blood capillaries, seasonal bone growth rings, poikilothermic oxygen isotopes
- Living endotherms (mammals/birds) = sustained activity, fast, & agile, large lungs, efficient hearts
  - Skeletal evidence: track ways, habitual bipedalism (balance), long rigid tails, elongate slender limbs & limb joints, short femur relative to shin, larger & more complex brain, bones with high density of small blood capillaries, decreasing growth ring thickness, rapid growth rate, homeotherm oxygen isotopes









10min. Break!

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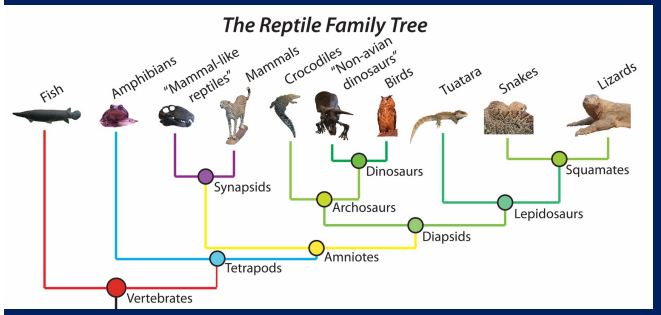
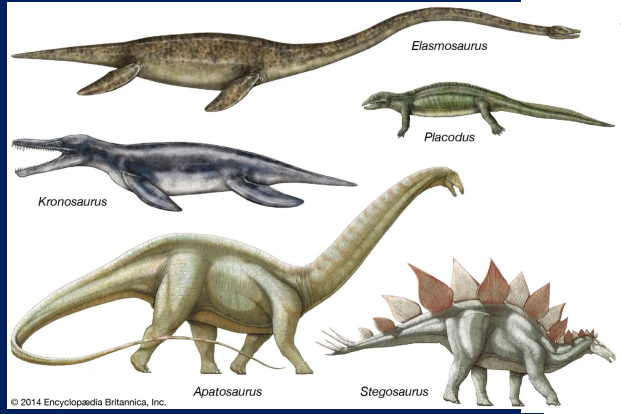
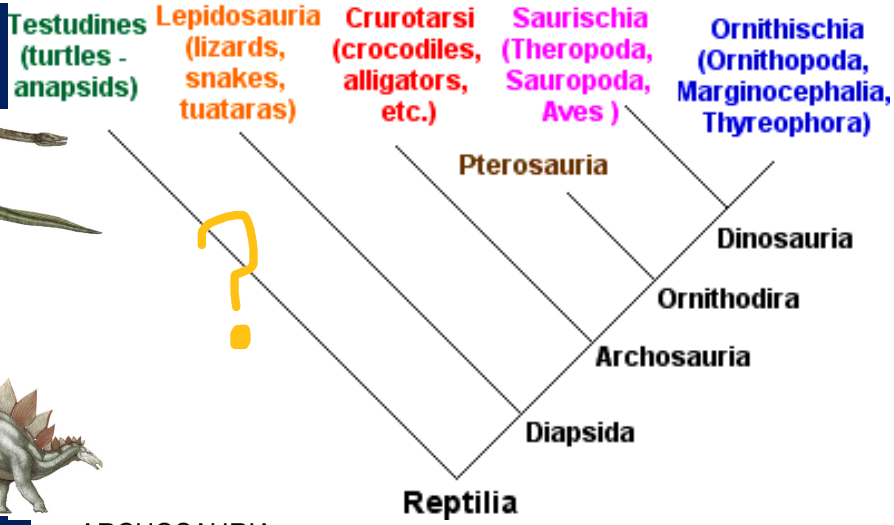
https://www.youtube.com/watch?v=TaMTLJUa-b4

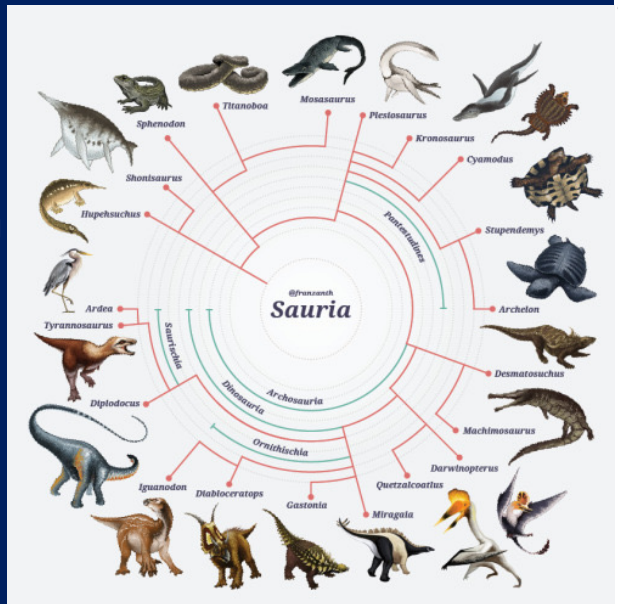
Sauria

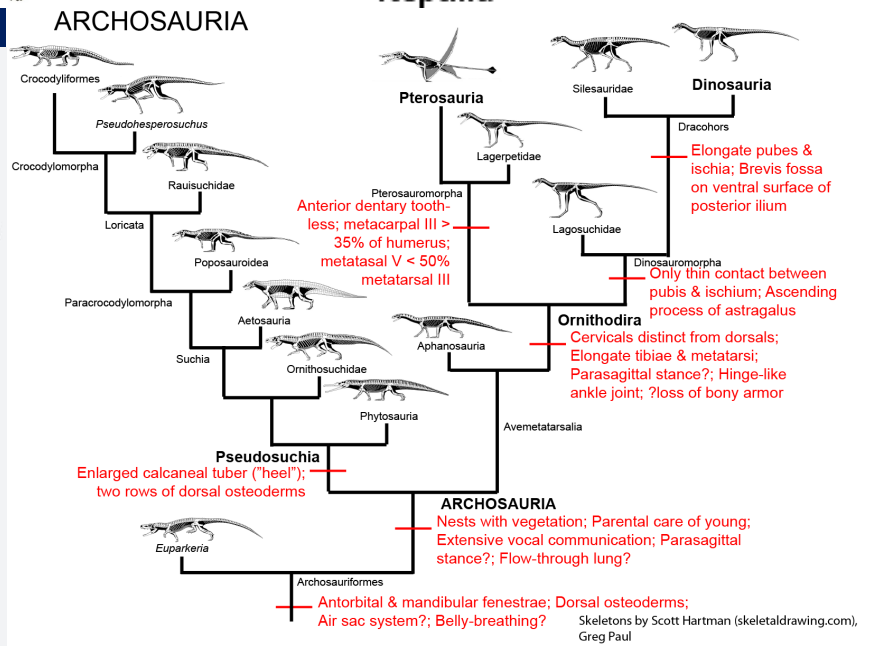






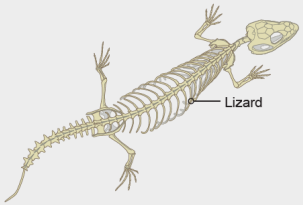
- ~302Ma Diapsida
- ~246Ma Marine reptiles
- ~245Ma Archosaurs
- ~240Ma Lepidosaurs
- ~237Ma Pseudosuchia
- ~225Ma Testundines
- ~230Ma Dinosaurs
- ~210Ma Pterosaur



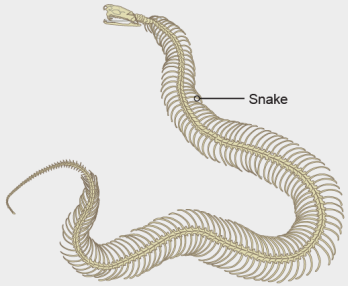


Shape Shifters

The evolution of snakes from their lizard ancestors is one of the most dramatic transformations in the history of vertebrates. Recent discoveries have allowed researchers to start to reconstruct how the distinctive snake body plan, with its extremely long trunk and lack of limbs, emerged.



The typical lizard, represented here by a Chinese skink, has 65 vertebrae and four well-developed limbs that splay out to the side of the body, supported by the pelvis and other bones of the pelvic girdle.

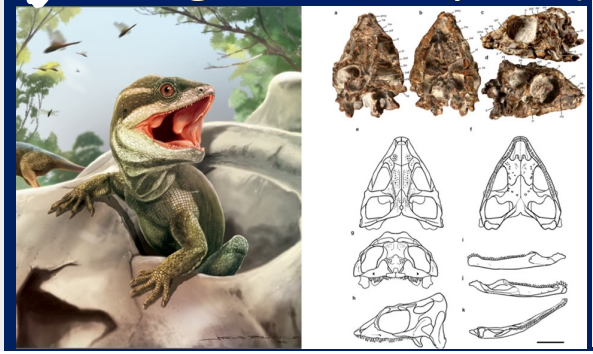


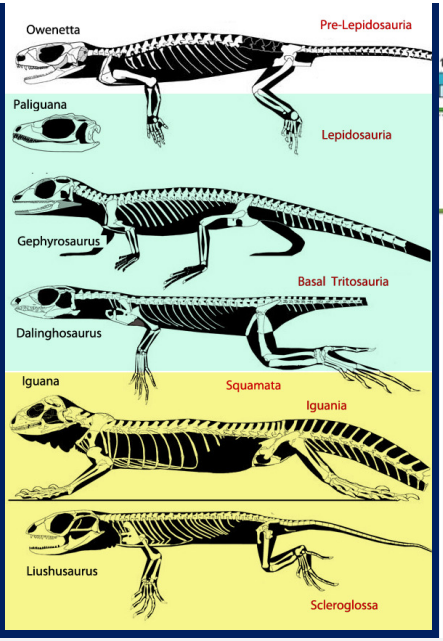
Advanced snakes, such as this Halys pit viper, have more than 300 vertebrae, almost all of which bear ribs, These snakes lack all the bones of the limb and pelvic girdle.

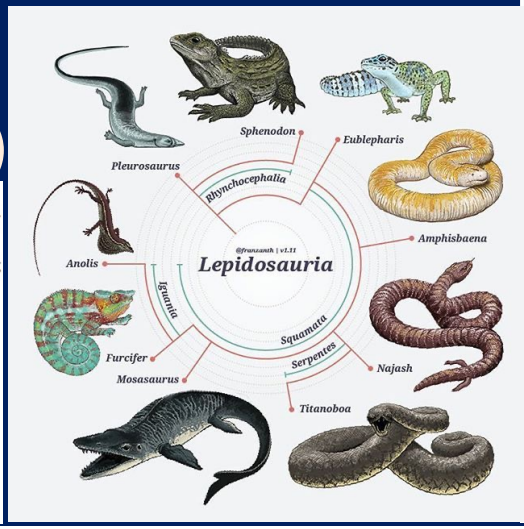
Lepidosaurs

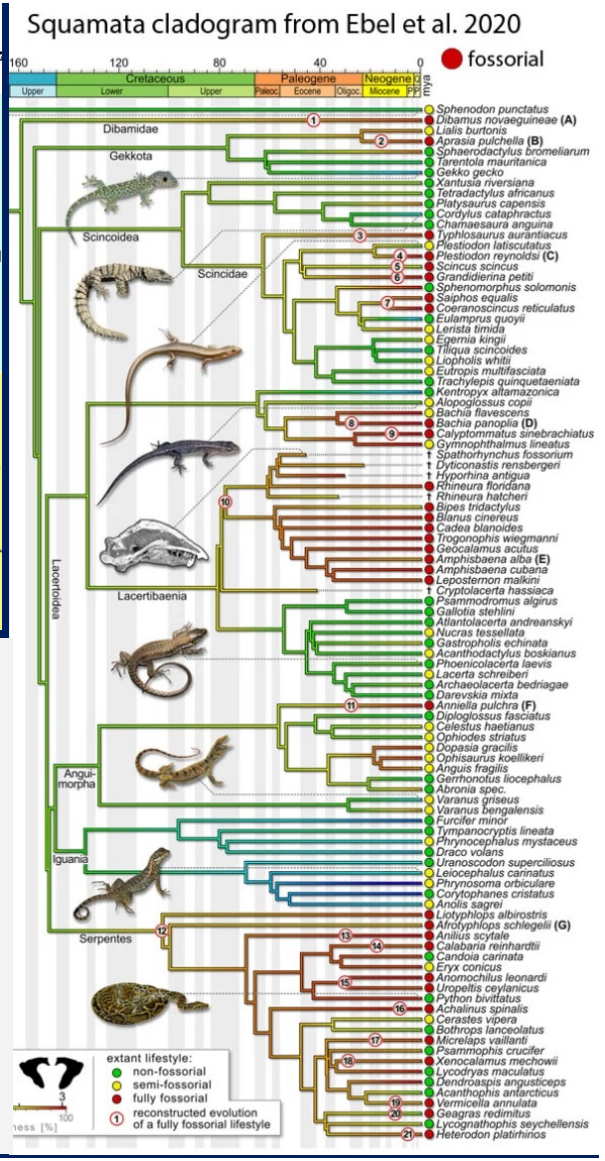
Snakes, Lizards, Tuatara, Mosasaurs

- Low metabolic rate, ectothermic
- Oldest fossils: 240-238Ma
- Taytalura 231.4Ma
- Serpentes 167Ma: long body before limbless (fossorial=burrow/live underground adaption)





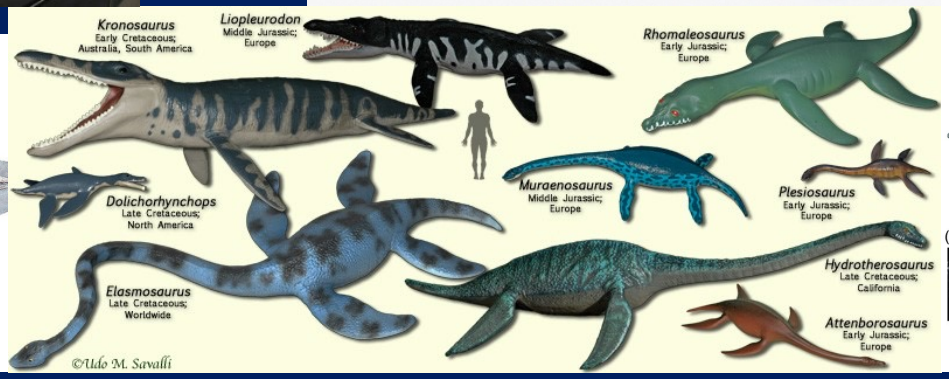


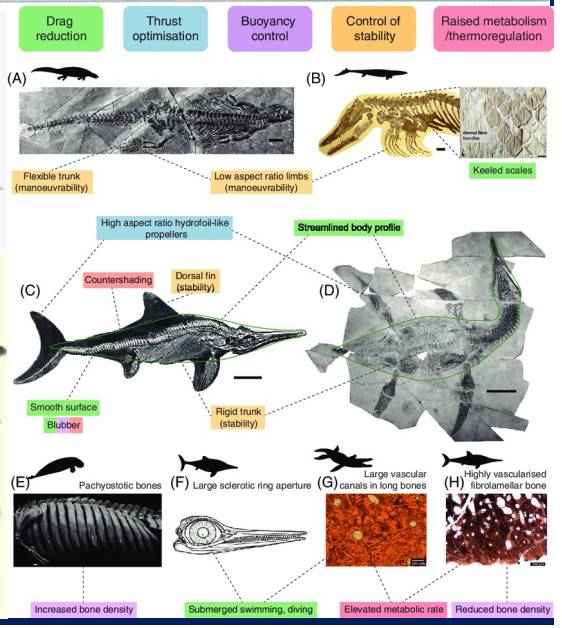


Marine Reptiles

~246Ma Marine reptiles = Euryapsids+Diapsids

- Sauropterygians “lizard flippers” (Diapsids): Plesiosauria, Pachypleurosaurs, Placodonts, Nothosaurs
- Icthyosaur (Diapsids?)
- Mosasaurus (Lepidosaurs)





Testudines

Molecular clock: turtles & archosaurs diverged ~225Ma

- Low metabolic rate, ectothermic
- Oldest fossil: 220Ma
- Anapsida or Diapsid?
- Most recent ancestor of living turtles ~157Ma
- 80-74Ma Archelon

https://www.sciencephoto.com/media/1240826/view/evolution-of-turtle-shell-animation