Lecture 15: Jurassic 3

Morrison formation herbivores by Marco A. Pineda (source)

Three great clades of dinosaurs

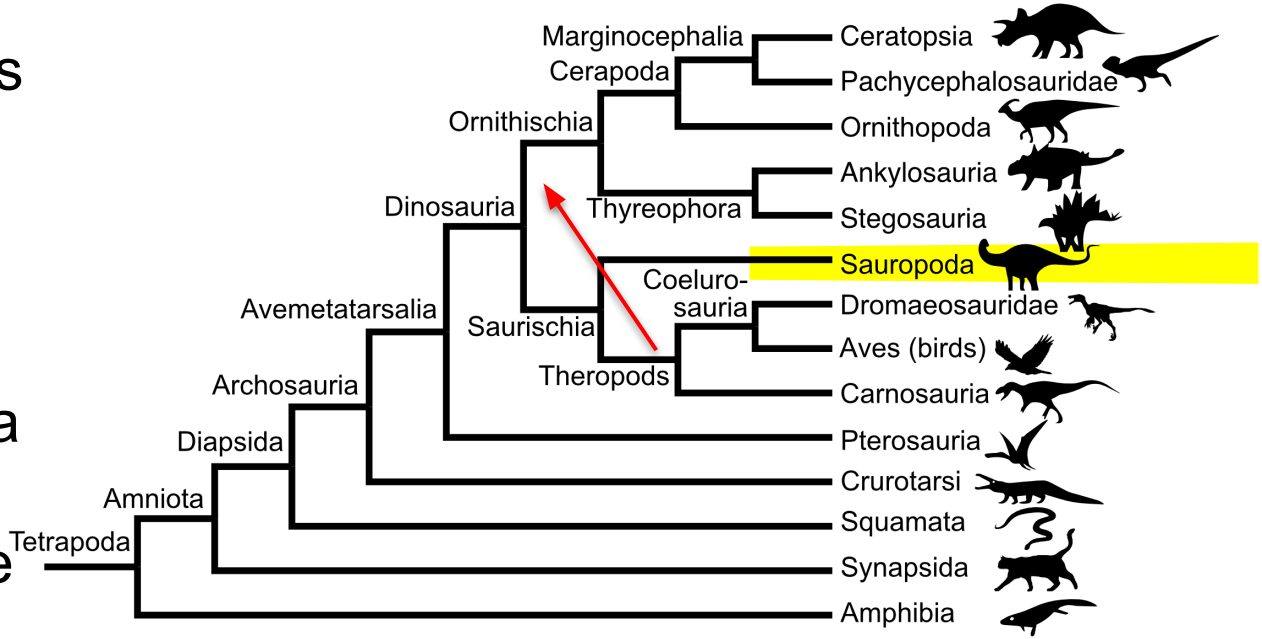
sauropods and **prosauropods**
(clade Sauropodomorpha)
Greek: “sauro” = lizard; “pod” = foot

- The largest dinosaurs
- Notable for their long necks, which contained 10+ vertebrae

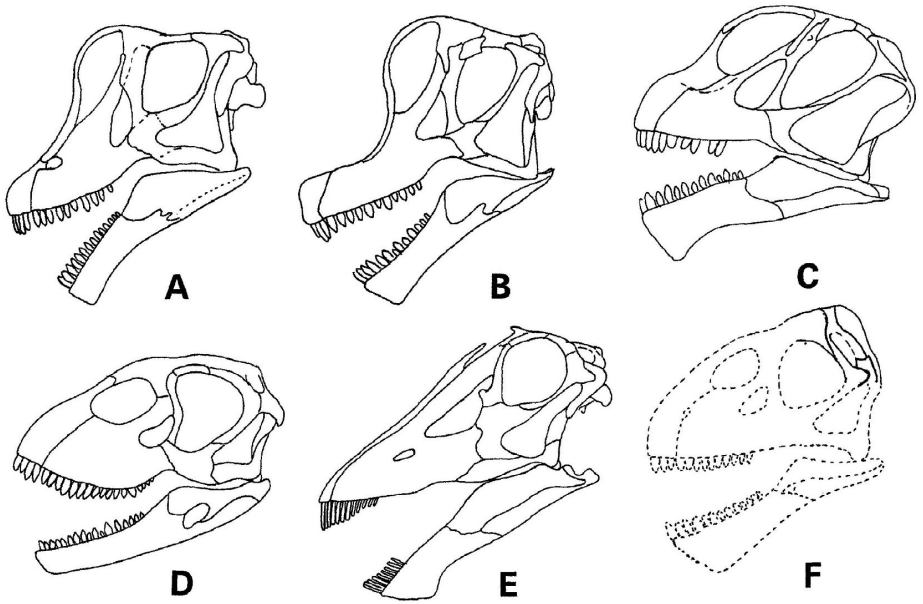
Sauropod diversity by Andrey Atuchin and Santi Mezzei (source)

Where sauropods fit in the tree of life

- Most scientists consider sauropods saurischian dinosaurs
- If theropods and ornithischians are a clade, sauropods would be in a clade by themselves



Sauropod traits



Examples of sauropod skull diversity (source)

- Weak teeth, used stomach stones (gastroliths) to grind up food
- Large naris that sometimes sat high on the skull

The skeleton of *Plateosaurus*

Derived traits

10 caudal vertebrae

Weak, leaf shaped teeth

Large claw on first finger

Ancestral traits

Bipedal stance

Plateosaurus by Scott Hartman (source)

Five fingers on the hand

The skeleton of *Plateosaurus*

Derived traits

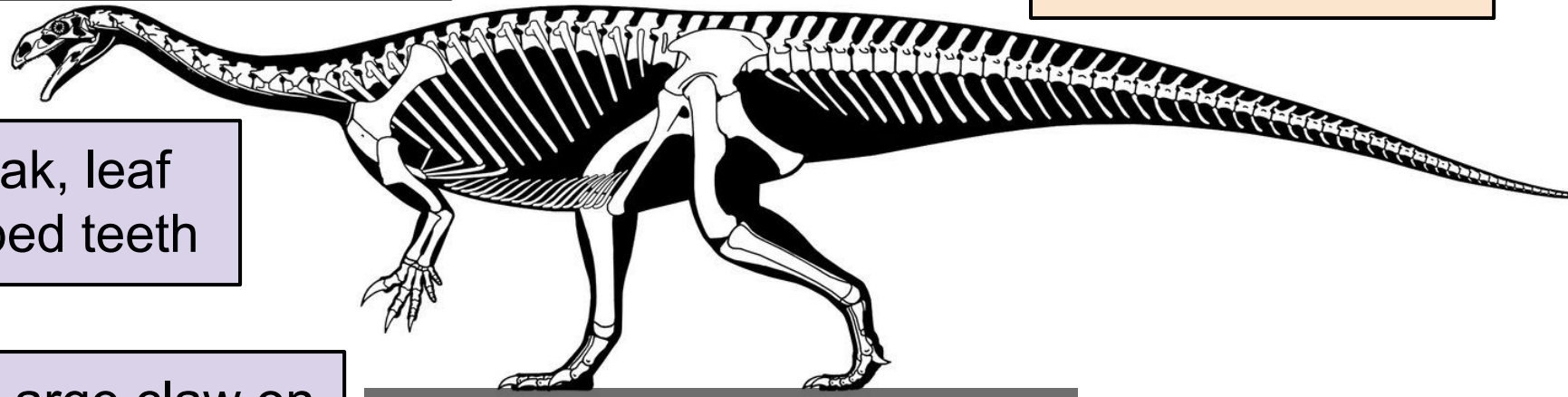
10 caudal vertebrae

Weak, leaf shaped teeth

Large claw on first finger

Ancestral traits

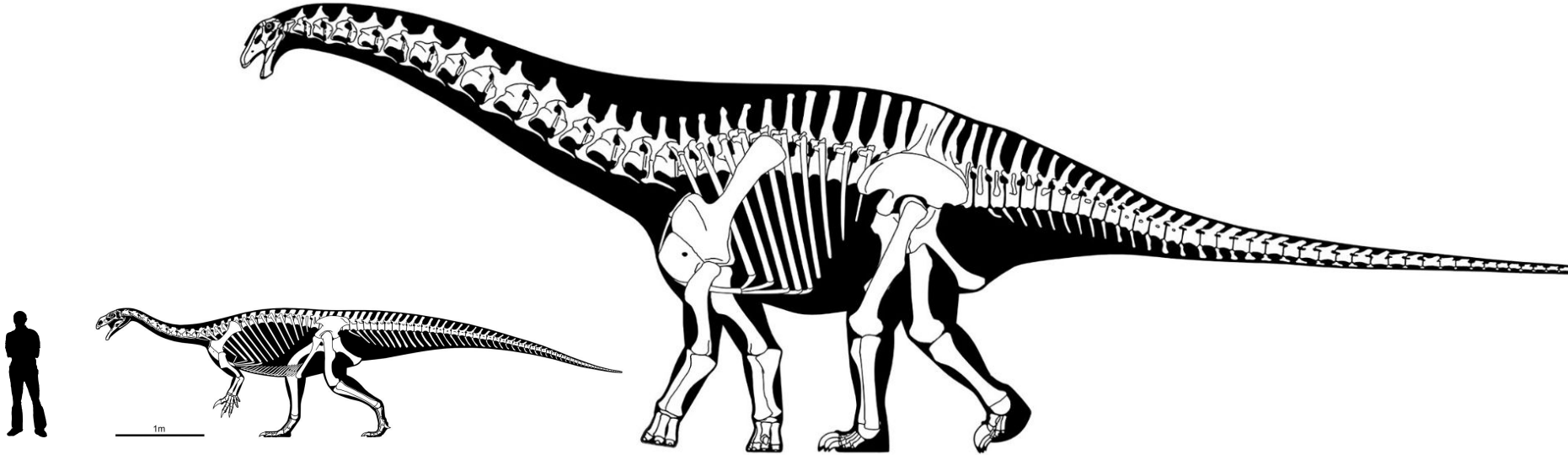
Bipedal stance



Plateosaurus by Scott Hartman (source)

Five fingers on the hand

Plateosaurus versus *Apatosaurus*



Plateosaurus versus *Apatosaurus*

Some traits to consider:

- Skull fenestrae
- Pelvis
- Humerus vs tibia/fibula
- Neural spines

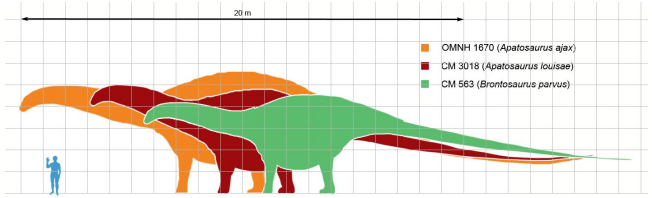
Copyright Scott Hartman, 2022.

Copyright Scott Hartman, 2022.

Key Taxon: *Brontosaurus*

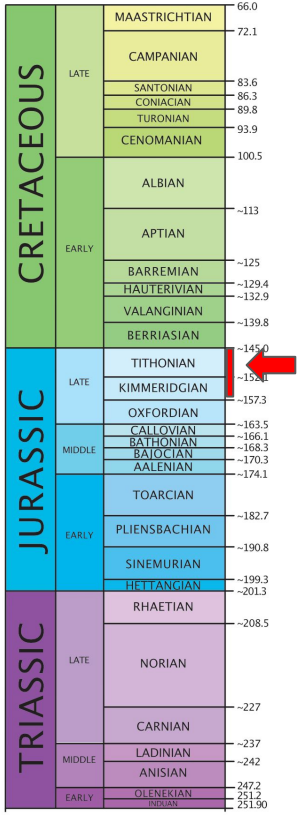
Brontosaurus

Greek: “bronto” = thunder; “saurus”=lizard



- ~70 feet long, 17 tons

Brontosaurus by Davide Bonadonna (source)

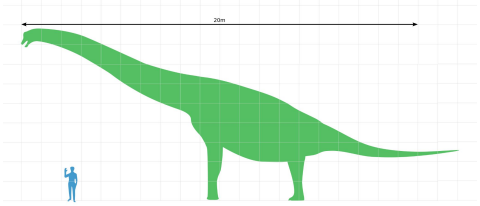


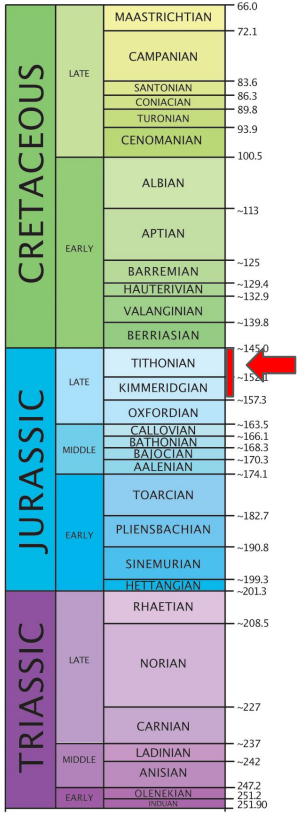
Key Taxon: *Brachiosaurus*

Brachiosaurus

Greek: “brachio” = arm; “saurus”=lizard

- ~70 feet long,
- ~30-40 feet tall,
- ~tons



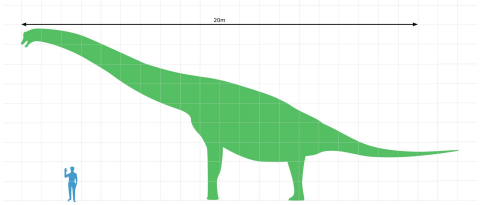


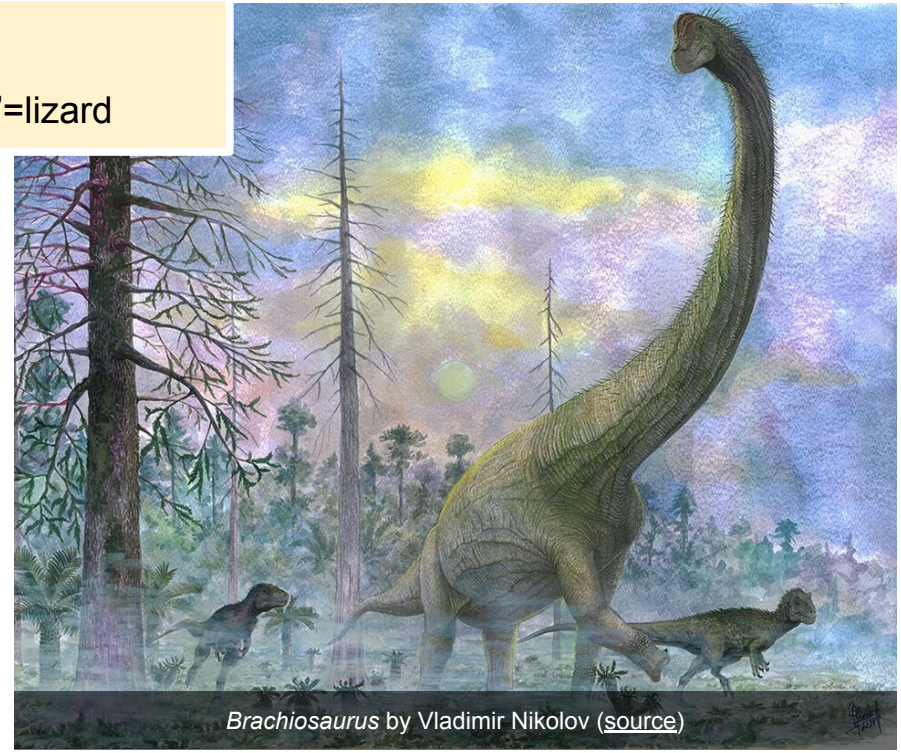
Key Taxon: *Brachiosaurus*

Brachiosaurus

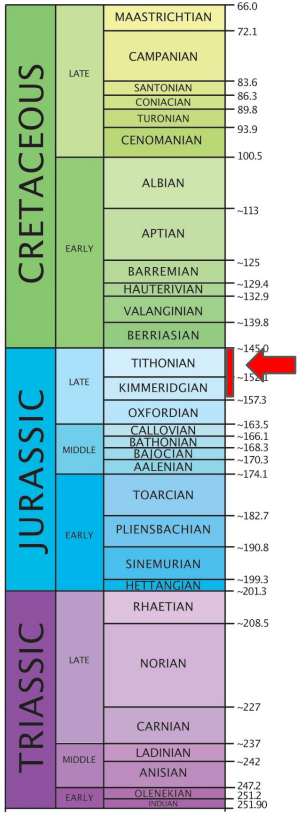
Greek: “brachio” = arm; “saurus”=lizard

- ~70 feet long,
- ~30-40 feet tall,
- ~tons

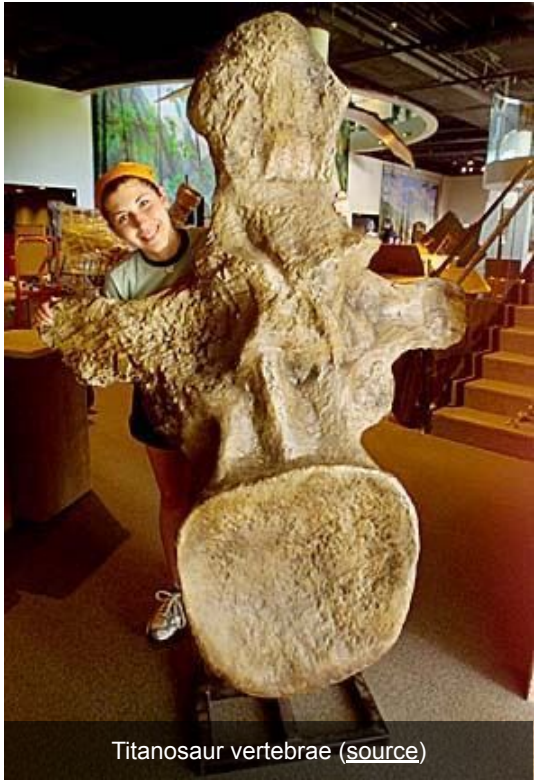




Brachiosaurus by Vladimir Nikolov (source)

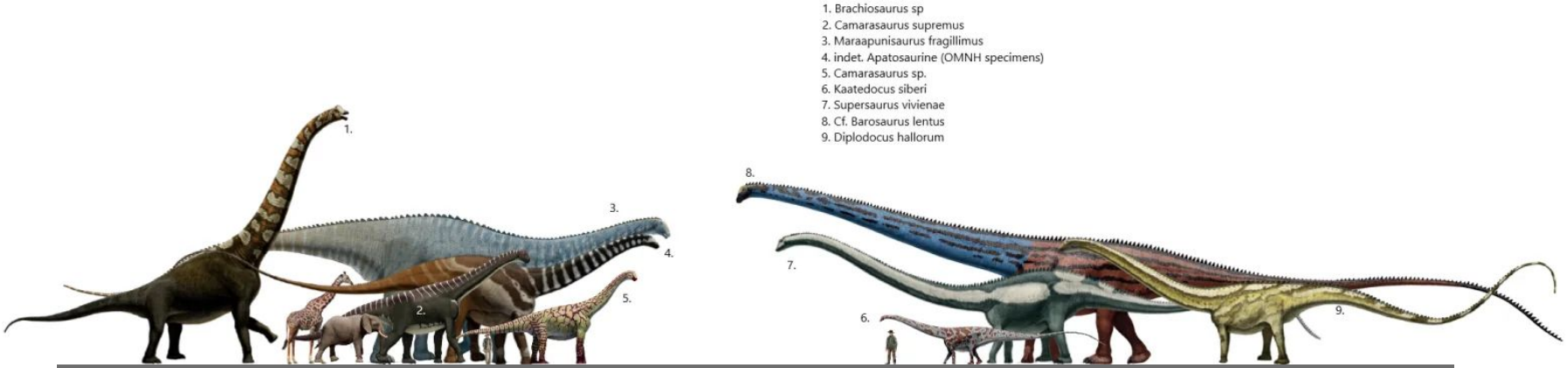


Why did they get so big?



Titanosaur vertebrae (source)

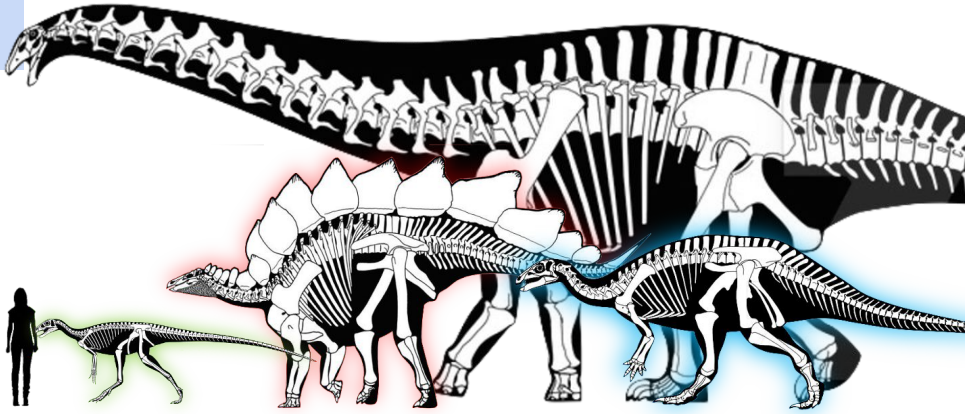
Sauropods of the Morrison formation



Sauropods (source)

Niche partitioning

- **Niche partitioning**: a process where competing species use the environment differently in a way that helps them coexist.
- Not purposeful–the result of natural selection and competition
- Allows for greater diversity



Niche partitioning in sauropods

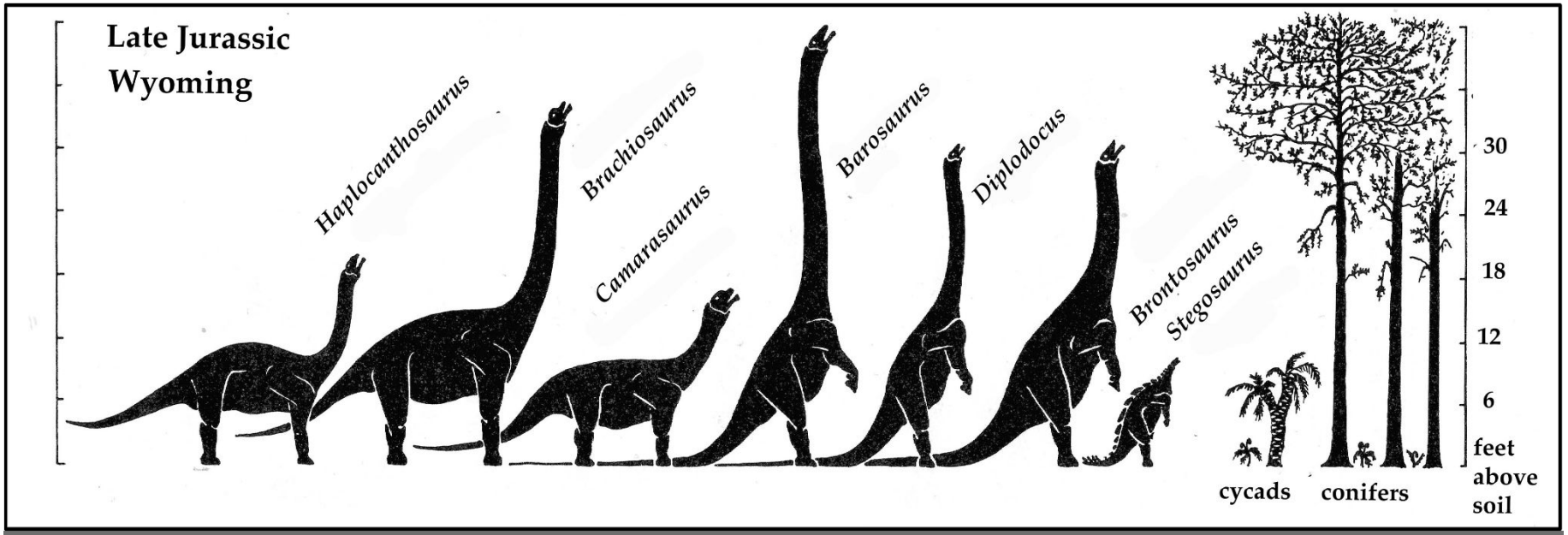
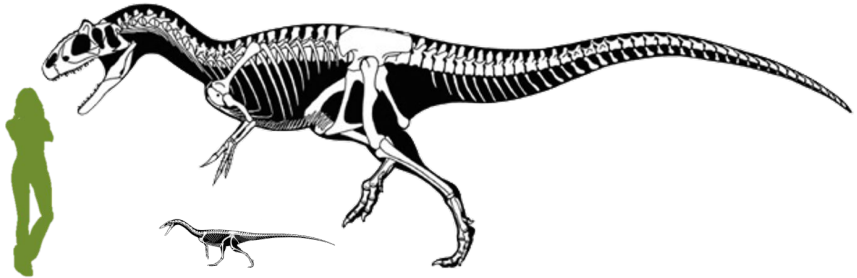
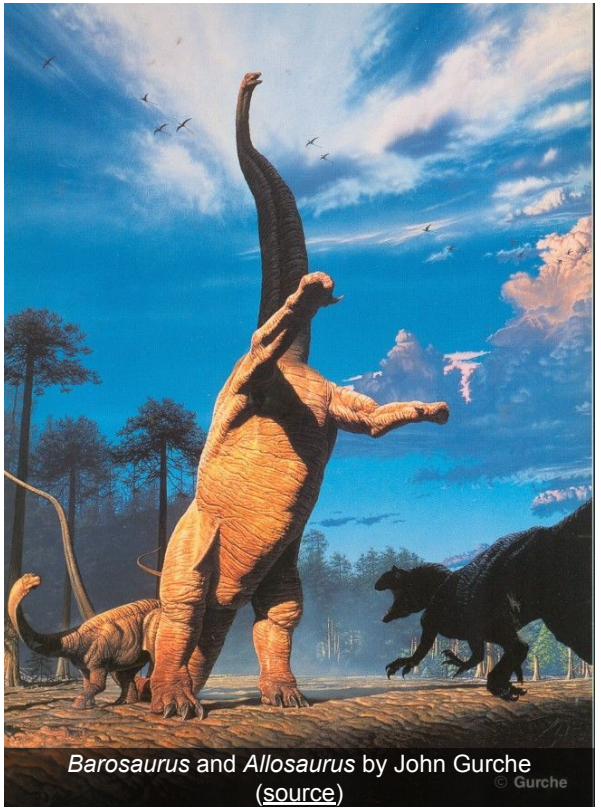


Image by Robert Bakker

Predation

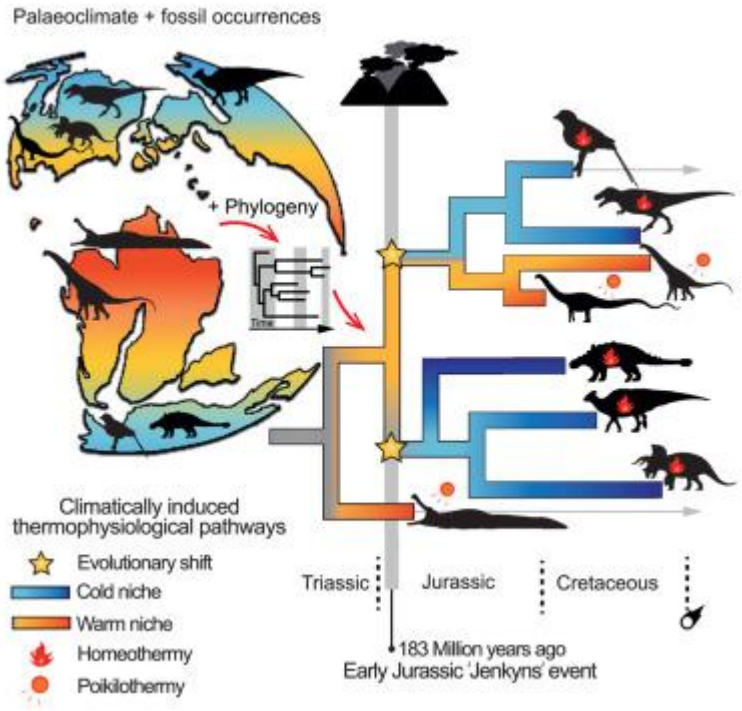


- The maximum size of **theropods** increases through the Jurassic
- Staying larger than the carnivores offers protection



Barosaurus and *Allosaurus* by John Gurche (source)

Body temperature



- In the Jurassic, dinosaurs move away from the warm interior towards the poles
- Sauropods remain restricted to warmer regions

Chiarenza et al. "Early Jurassic origin of avian endothermy and thermophysiological diversity in Dinosauria." *Current Biology* (2024): 2023-12.

Body temperature

- When you are little, the hard part is keeping heat (high surface area)
- When you are big, the hard part is getting rid of heat (low surface area)

Pacific pocket mouse *Perognathus* (source)

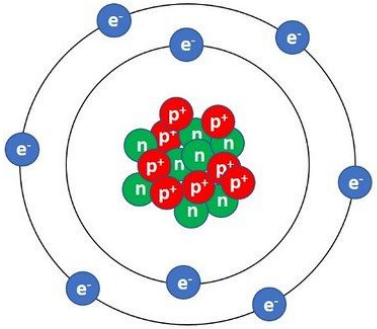
African elephant *Loxodonta* (source)

Body temperature

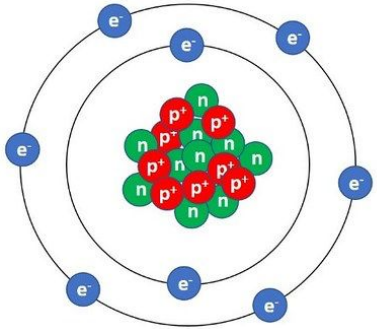

Image by Andrey Atuchin (source)

- **Gigantothermy**: the ability to maintain a constant body temperature without endothermy
- Large animals lose heat slowly
- They can take advantage of this to stay warm even when the environment is cool

How hot was a sauropod?



^{16}O Isotope

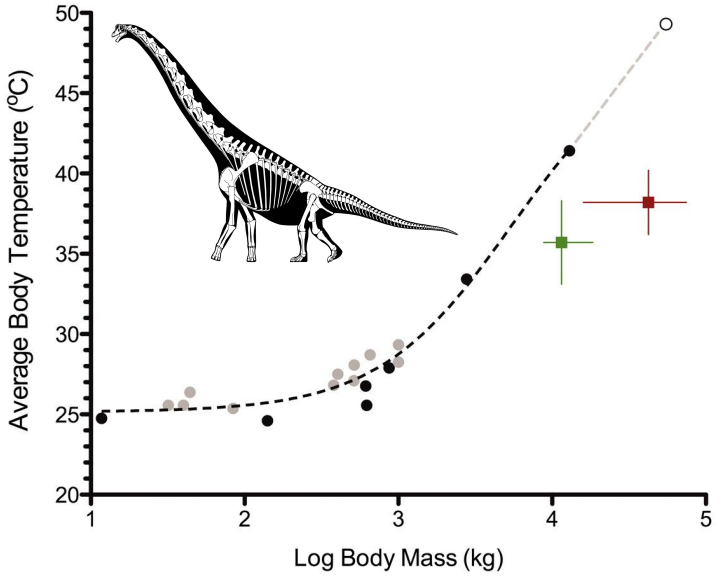


^{18}O Isotope

- This has been tested using clumped isotope thermometry
- thermodynamic preference of heavy isotopes to bond in minerals
- Hotter body = more heavy isotopes

How hot was a sauropod?

- Clumped isotopes from sauropod teeth give body temperatures of 36-38°C
- similar to most modern mammals.
- 4-7°C lower than predicted by scaling body temperature with mass



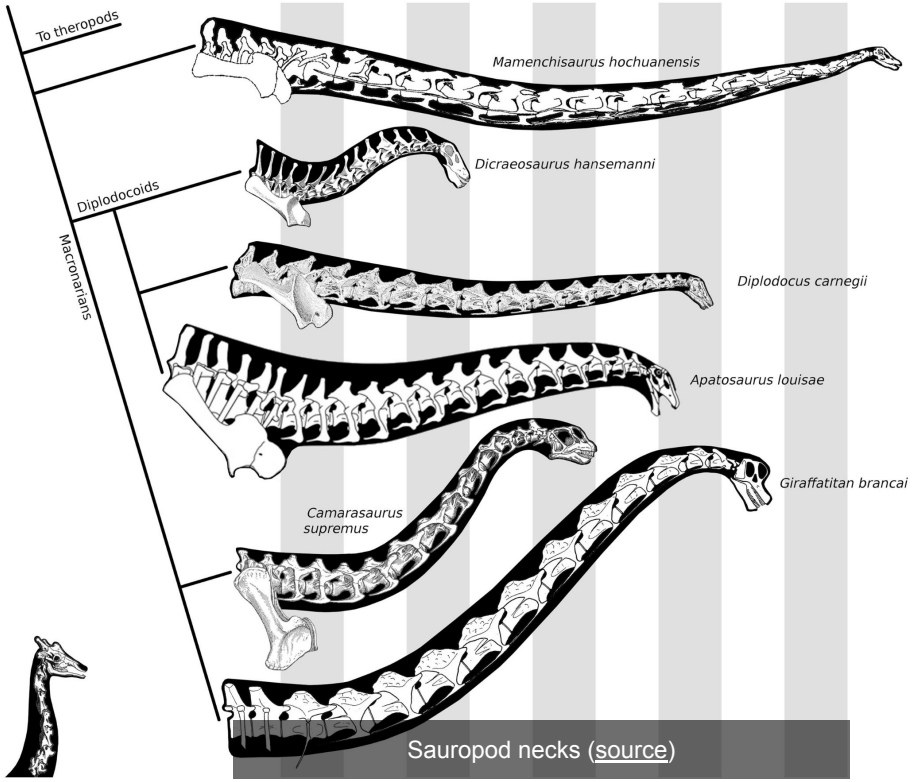
- Modern Crocodiles
- Dinosaur body temperatures calculated from growth rate analysis
- *Sauroposeidon proteles* body temperature calculated by extrapolation
- *Camarasaurus* sp. body temperature from Δ_{47} measurements
- *Brachiosaurus brancai* body temperature from Δ_{47} measurements

Eagle, Robert A., et al. "Dinosaur body temperatures determined from isotopic (13C-18O) ordering in fossil biominerals." Science 333.6041 (2011): 443-445.

How did they get so big?

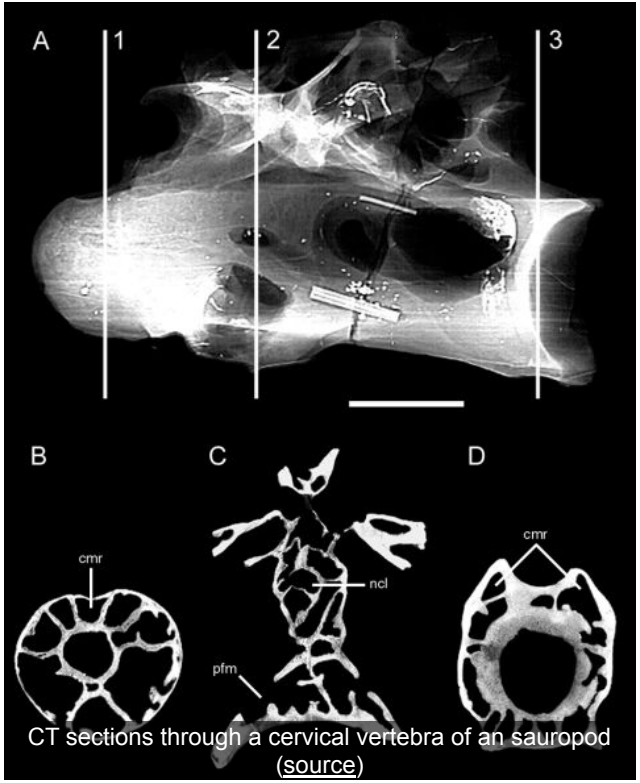
- Legs tucked underneath the body provide pillar-like supports for very long necks and tails

- The number of neck bones in dinosaurs is not constrained as in mammals



Sauropod necks (source)

How did they get so big?



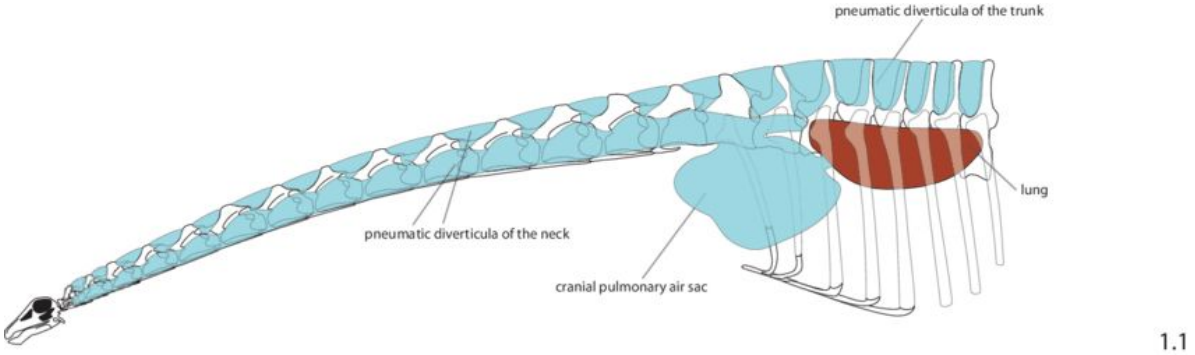
CT sections through a cervical vertebra of an sauropod (source)

- **Pneumatic bones**: bones that are filled with air sacs
- Modification of the hollow bones and air sac breathing seen in the earliest theropod and sauropod dinosaurs
- Also allows extra oxygen

Wedel, Mathew J., and Michael P. Taylor. 2023. The biomechanical significance of bifurcated cervical ribs in apatosaurine sauropods. Vertebrate Anatomy Morphology Palaeontology. 11:91-100.

How did they get so big?

- Modification of the hollow bones and air sac breathing seen in the earliest theropod and sauropod dinosaurs



Schwarz-Wings, D., & Frey, E. (2008). Is there an option for a pneumatic stabilization of sauropod necks?: an experimental and anatomical approach. *Palaeontologia Electronica*, *11*(3), 1.

How did they get so big?

Prehistoric Planet (2022) © Apple TV+

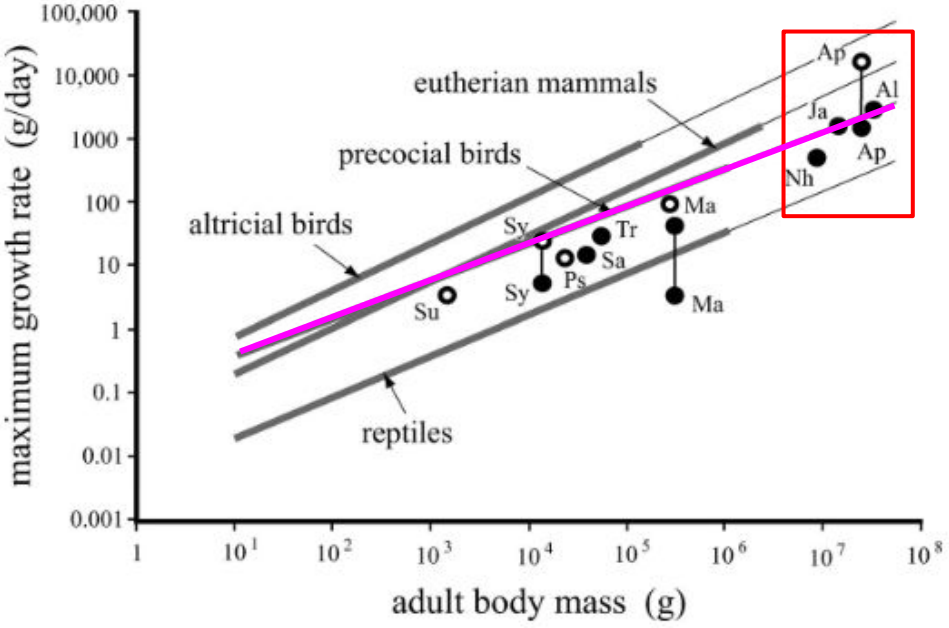
How did they get so big?

Fossil of sauropod nest (source)

- Sauropod babies started small
- Limited by the size of eggs
- Fossil nests of sauropods demonstrate that large clutches were laid

How did they get so big?

- growth-lines on bones tell us how fast sauropods grew
- Sauropods grew fast, with some adding 1000g (~2.2 pounds) a day
- Some reached full size in 20 years (1,000 fold increase!)



Lehman, Thomas M., and Holly N. Woodward. "Modeling growth rates for sauropod dinosaurs." *Paleobiology* 34.2 (2008): 264-281.

How did they get so big?

Mamenchisaurus by Júlia d'Oliveira (source)

Next class

Diablosceratops by Andrey Atuchin (source)