

CHAPTER 3 What the Rocks Say: How Geology and Paleontology Reveal the History of Life

and

CHAPTER 14. Macroevolution: The Long Run (Parts)

First signs of life? (fossil and chemical signature)

What lived on the earth when?

Major Extinctions?

Prokaryotes vs Eukaryotes (what is endosymbiosis?)

Multicellularity (what did your text say?)

- 1. *Precambrian everything* before about 500mya**
2. Paleozoic
3. Mesozoic
4. Cenozoic

Age of earth and solar system....

4.5-4.6 Billion or Million?

(radio-isotopic dating of meteorites-FYI
other isotopes we talk about are **stable**
isotopes)

How did earth form?

Formed from debris in orbit around the sun

Early earth conditions

“the Hadean was so called because of the hellish conditions thought to have prevailed, including cataclysmic meteorite impacts that boiled the oceans into steam and turned Earth’s surface into molten lava. The largest of these impacts... tore a piece from Earth that became the moon.”



© Mark Garlick/Science Photo Library/Corbis

Oxford scientists say a Mercury-like body struck the young Earth (artist's illustration shown). The object would have been the heat source for our planet's core. The same object could have been responsible for creating the moon. It also explains where some rare-Earth elements came from



<https://www.universetoday.com/tag/hadean-eon/>

Over time... collisions decreased in frequency and intensity, the crust cooled, solidified and water accumulated on surface.

Some solid crust by about 4 bya (there are rocks in Canada are 3.96 billion years old).

So what is the first evidence of life????

Evidence for Life- "chemical signature"

Ex #1 Carbon Isotope Data (some disagreement-seems really early)

Examined carbon in graphite bits found in these zircon crystals

Have been heated and squished (so no fossils) but...can look at carbon isotope ratios and detect presence of life at...

Where: Western Australia

Date: **4.1 Billion**

(When they looked at whales what isotopes were they looking at? Carbon? No!)

“The carbon aggregates in the rocks have a ratio of about 100-to-one of Carbon 12 (the most common isotope form of carbon, containing six protons and six neutrons) to C 13 (a rarer isotopic form of carbon, containing six protons and seven neutrons). The light carbon, Carbon 12, is more than 3 percent more abundant than scientists would expect to find if life were not present, and 3 percent is very significant.....”

<http://www.sciencedaily.com/releases/2006/07/060721090947.htm>

Take away point...

**Basically life concentrates the light form (Carbon 12)
The more common isotope (Carbon 12) is EVEN MORE
common in living organisms or the remains of living
organisms.**

CHECK OUT THE ASSIGNED VIDEO THAT EXPLAINS THIS. [First Life](#) (they use the term biogenic carbon)

Evidence for Life-“chemical signature”

Ex #2 Carbon Stable Isotope data (more certain)

Where: In Greenland rocks!

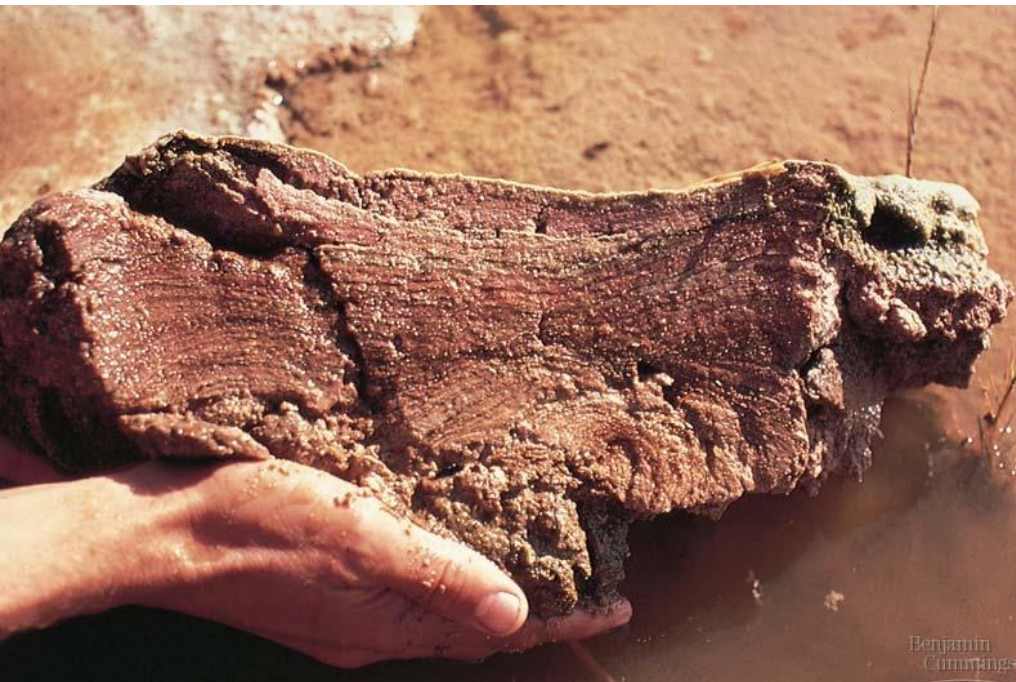
3.8 Billion
(not in text)



Oldest fossils-We are confident since they are fossils!

Stromatolites (3.5 bya) probably Cyanobacteria (a kind of photosynthetic bacteria)

Living relatives still exist in Western Australia



Clues to the origin of life found in the Arb

October 31, 2019 at 9:33 pm

By Samara Kroeger '21



Fossils stromatolites at **Carleton** and in Northern MN!

<https://www.lakesuperior.com/the-lake/natural-world/192feature/>

Did you know that the Arb is home to evidence of early microbial life? A large ancient stromatolite is visible along Spring Creek in the Upper Arb. Stromatolites are microbial reefs created by the activity of cyanobacteria.

Microbial mats, or complex communities of microbes (primarily bacteria and archaea) organized into visible layers, were one of the first ecosystems on Earth. The oxygen-rich air created by ancient photosynthetic mats was crucial to the development of complex life on Earth. Stromatolites are mineralized microbial mat fossils, and hold a record of ancient life on Earth.

https://apps.carleton.edu/campus/arb/programs/student-naturalists/arbtalk/?story_id=1000019744

Who was on the earth during most of this really loooooong period of time called the **Precambrian**?

- Prokaryotes (who are these organisms?)
- Eukaryotes evolved only at the END of this period (who are these organisms?)

Most of this **Precambrian** period dominated by...

Who are the Prokaryotes and Eukaryotes?

How are they different from one another?

Endosymbiosis!!!

Did you watch the video??

What do Eukaryotes have that prokaryotes don't?

Here is a basic list...

- Nucleus
- Mitochondria and chloroplasts (plastids)
Endosymbiosis!!! (look at the video I shared)
- Multiple chromosomes with linear DNA

Most of this period also dominated by...

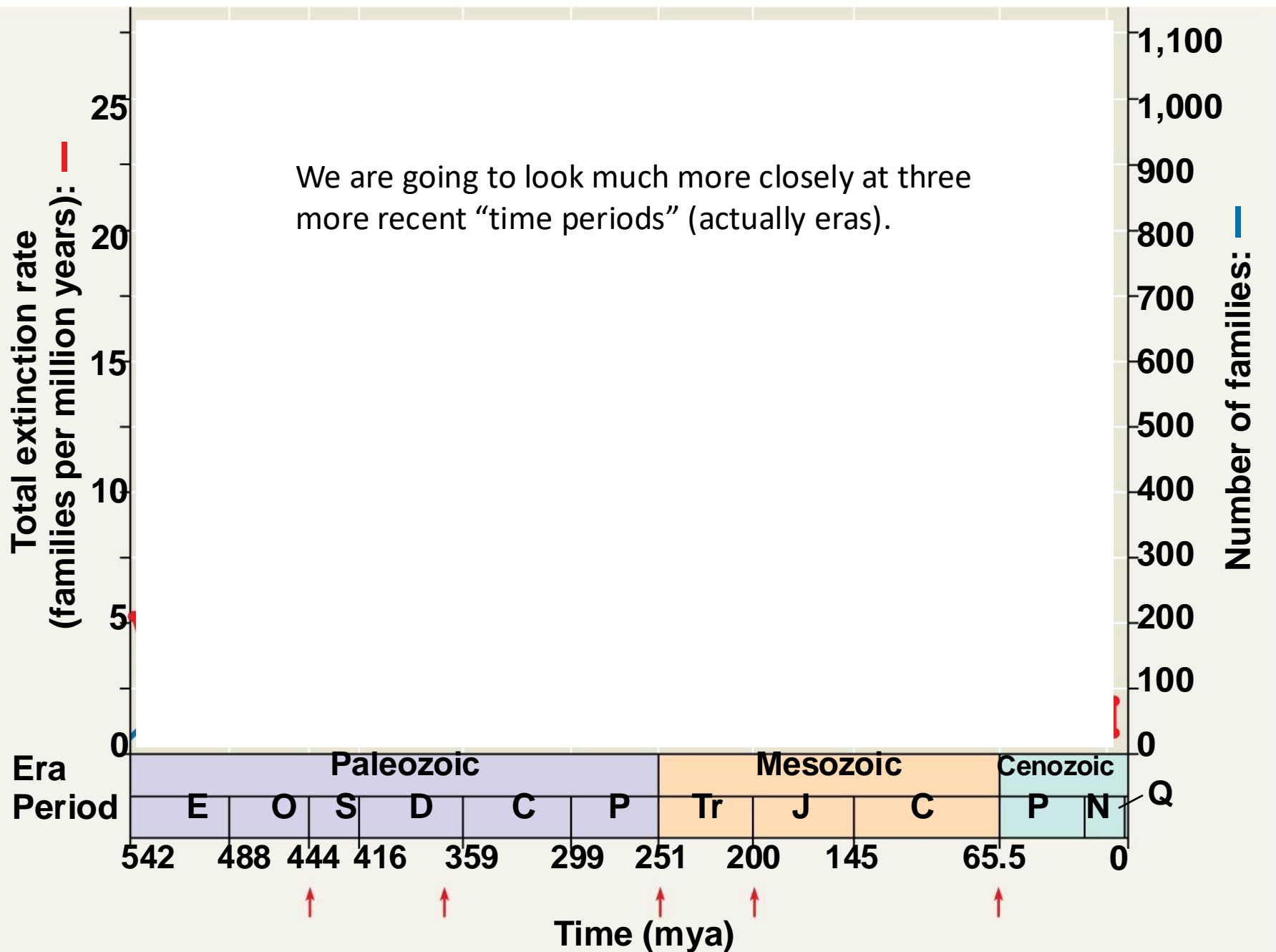
Single celled **Prokaryotes** like bacteria, archaea

Single celled **Eukaryotes** we will call “Protists”

*(Although there were prokaryotic **biofilms** and or mats of cells hanging out together-think stromatolites)*

At end of this period “true” **multicellular organisms** evolved.

What traits are needed to evolve for cells to gather together into a true multicellular organism? What do Multicellular organisms have to be able to do that single celled organisms don't have to do?
(What did your text say?)



2. *Paleozoic* 500-250 mya

begins with **Cambrian explosion**

Nearly all major lineages of animals appear!

Originally found in Burgess Shale in B.C. Canada
(now also evidence from from China and Greenland)



Cambrian explosion community

Did you check out the link?

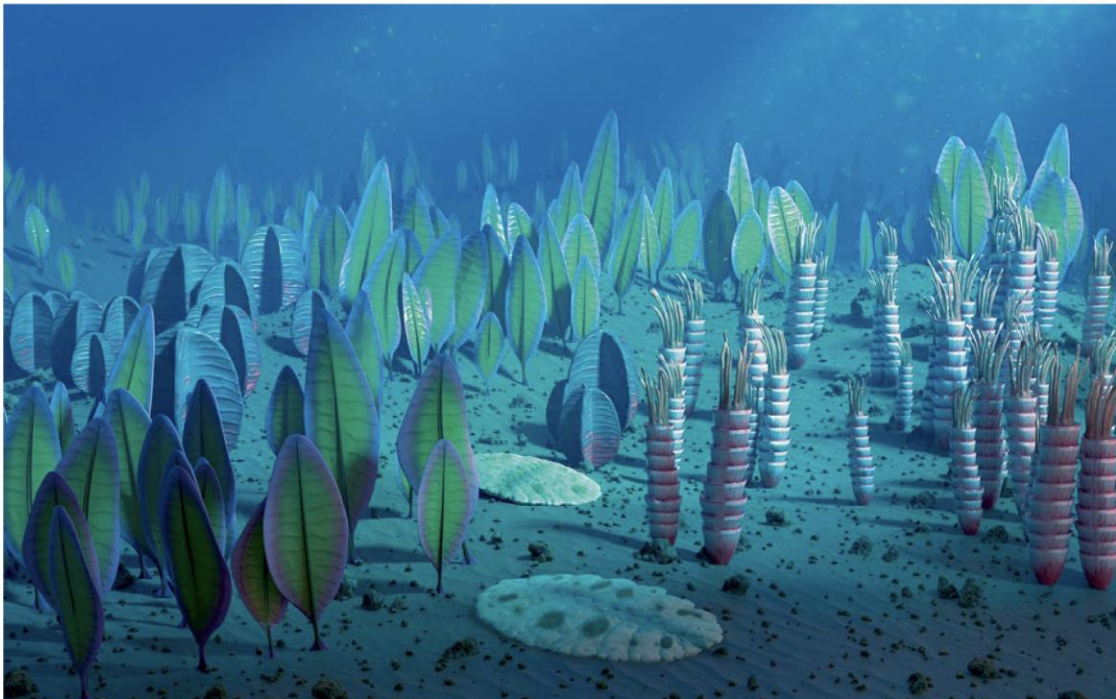
Did you find the opabinia in Regents?

What do you notice?



There are earlier fossils of animals!!!!

Don't forget this..... but they are soft and squishy= Ediacaran



During the **Paleozoic** climate was generally moist and swampy
Plants-ferns, mosses, horsetails
Giant insects



Lots of Vertebrate Evolution Happening in this period!

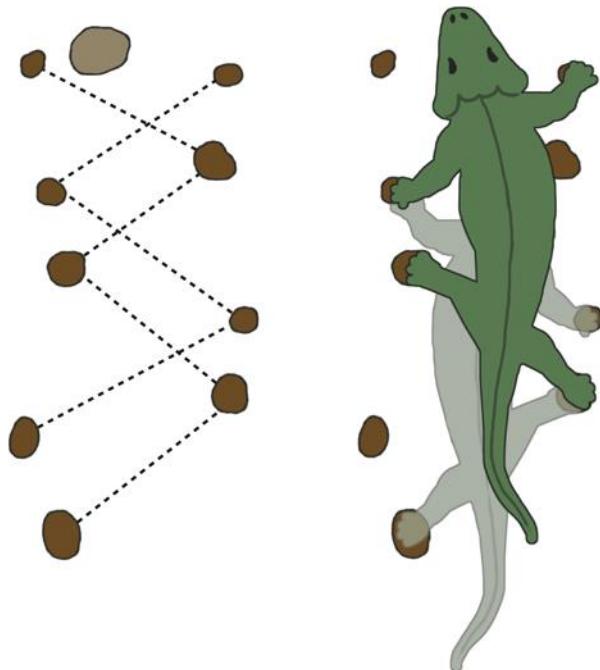
First terrestrial vertebrates

Oldest **trackways** date to 390 mya

(no need to know this date)

Oldest fossils of **tetrapods** date to 370 mya

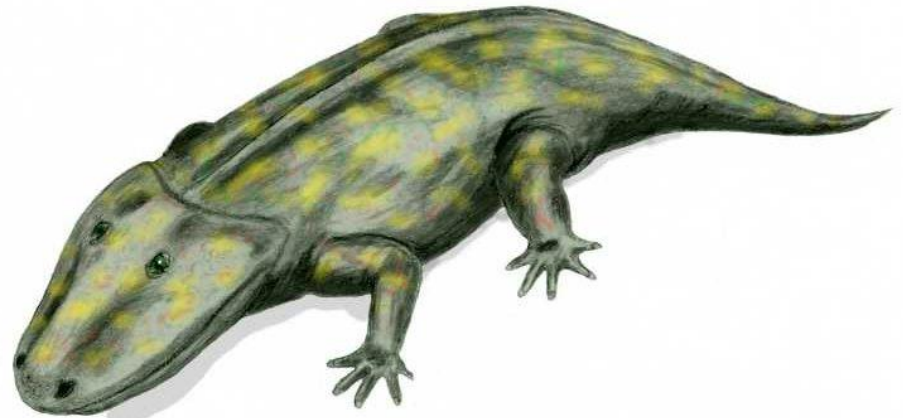
^A *(no need to know this date)*



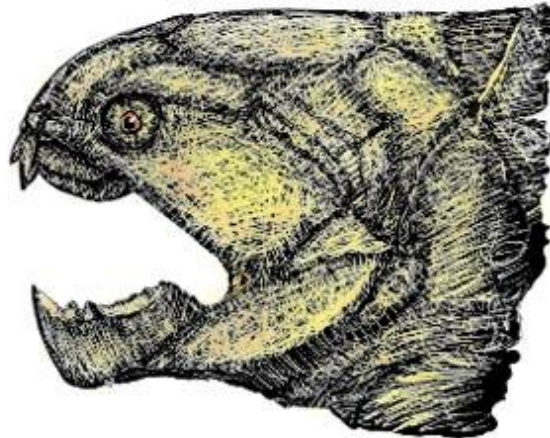
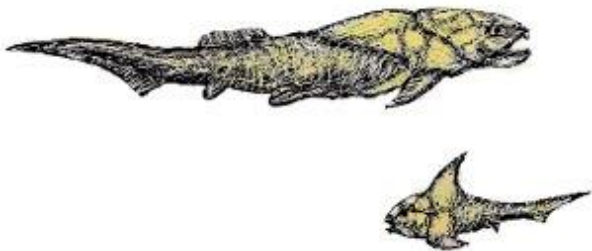
Many diverse amphibians (aquatic and terrestrial), some were large! 9ft



What kind of plant?

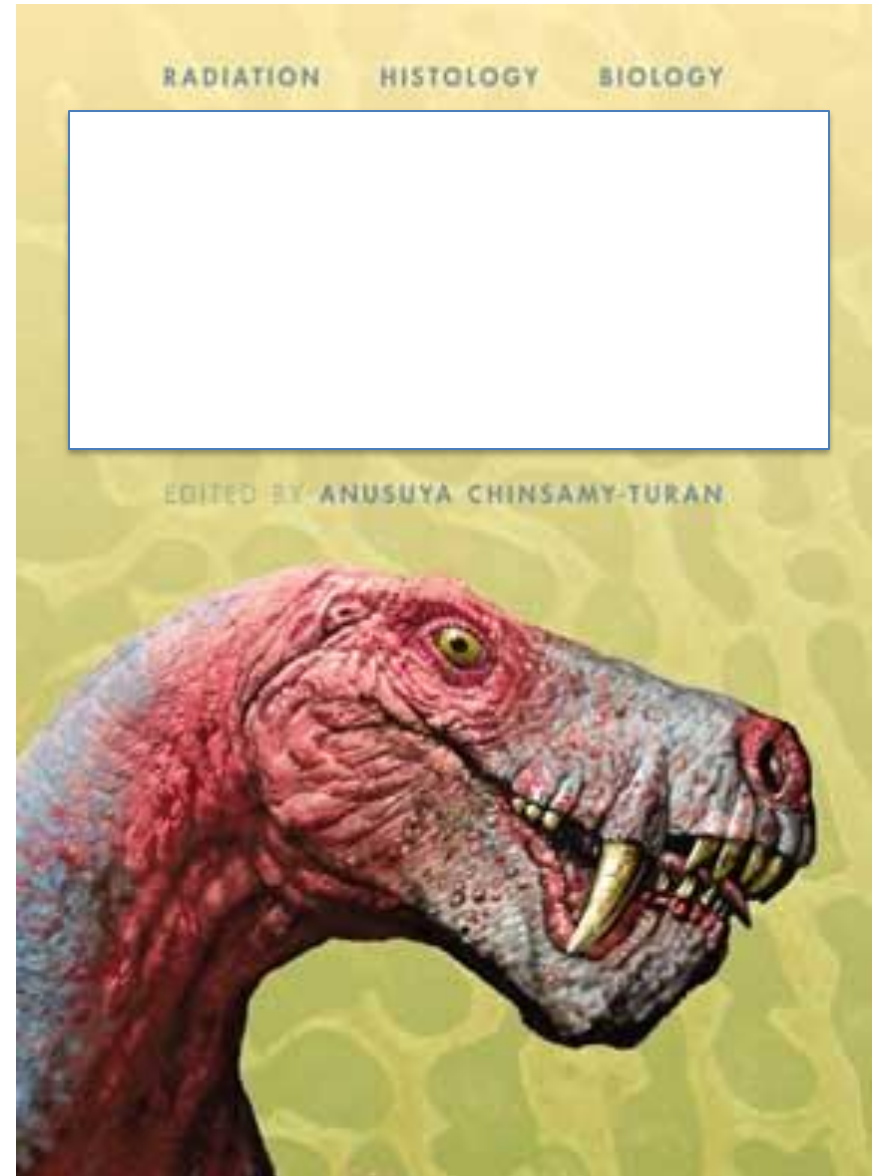


And scary fish

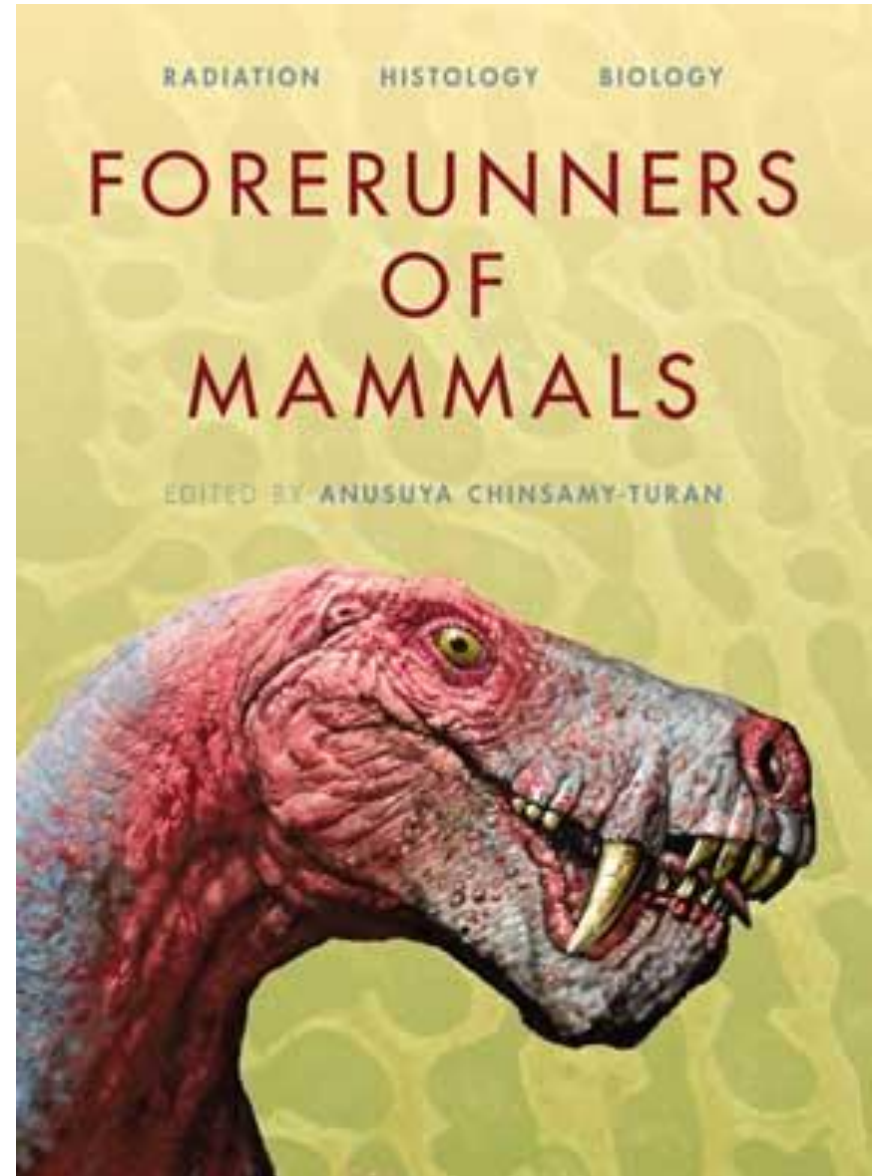


[Tiktaalik roseae](#), an early tetrapodomorph (late Devonian period, ~380 M. y. ago) (Credit: Arthur Weasley)

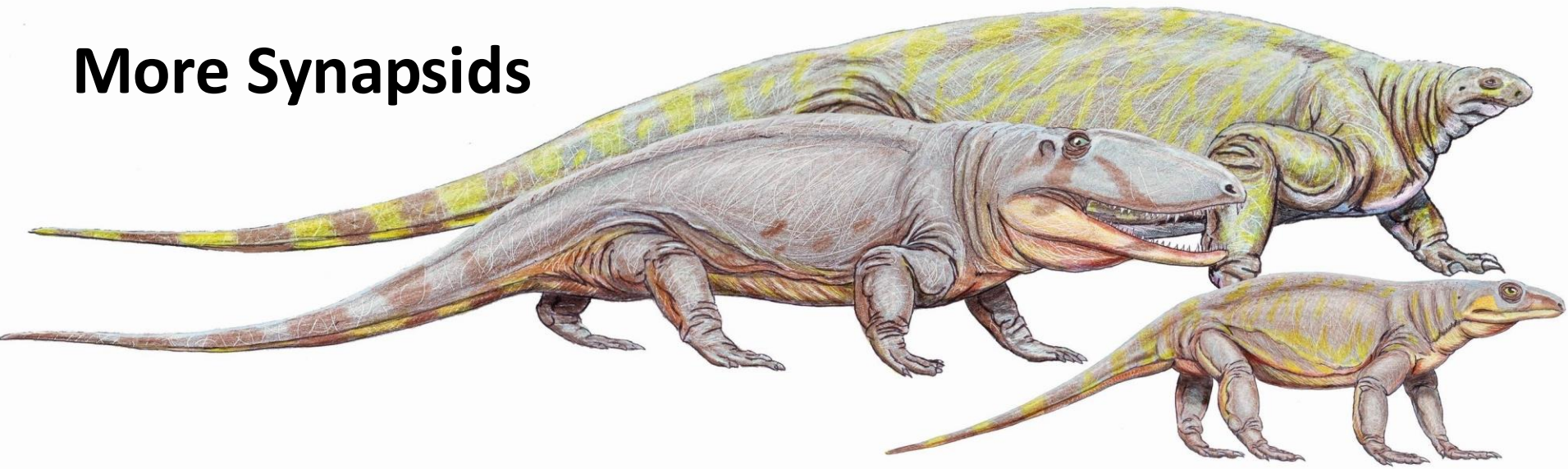
And really cool Synapsids!



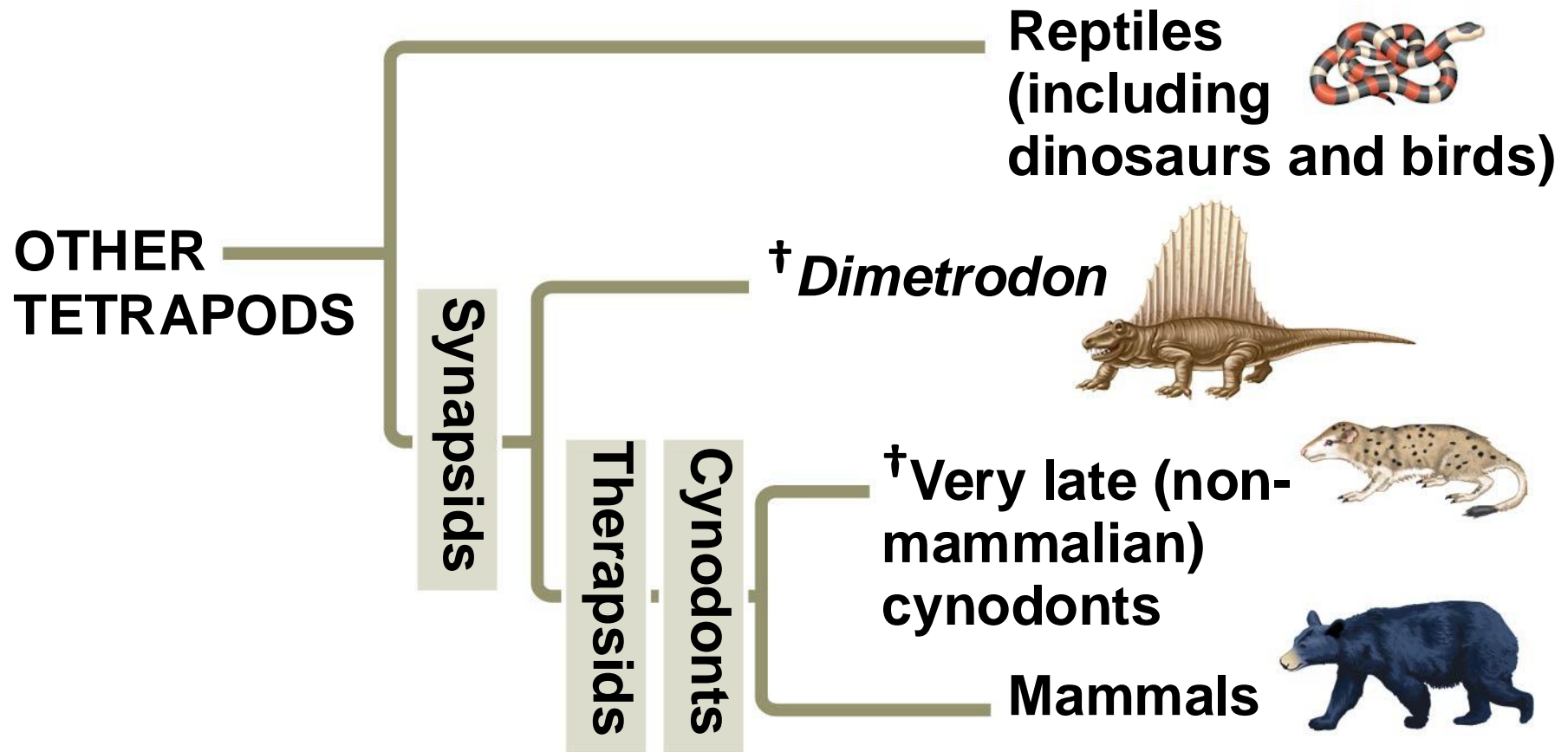
And really cool Synapsids!



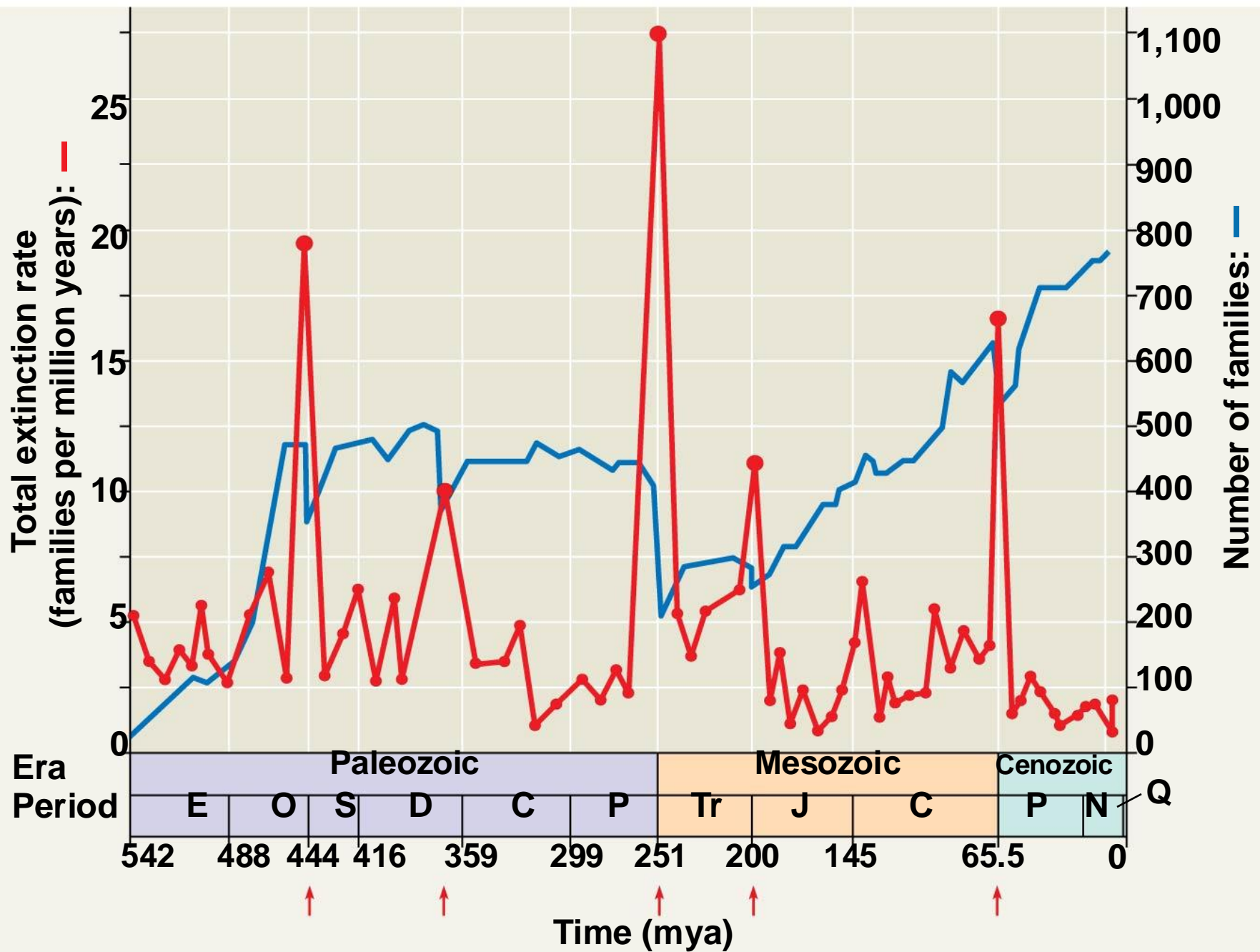
More Synapsids



Why do we care about Synapsids?



Because mammals evolved from one lineage of synapsids!



End Permian-250mya

Effect 90-96% of all species

Who Extinct?

Most synapsids, many Amphibians!

Giant insects like dragonflies and cockroaches

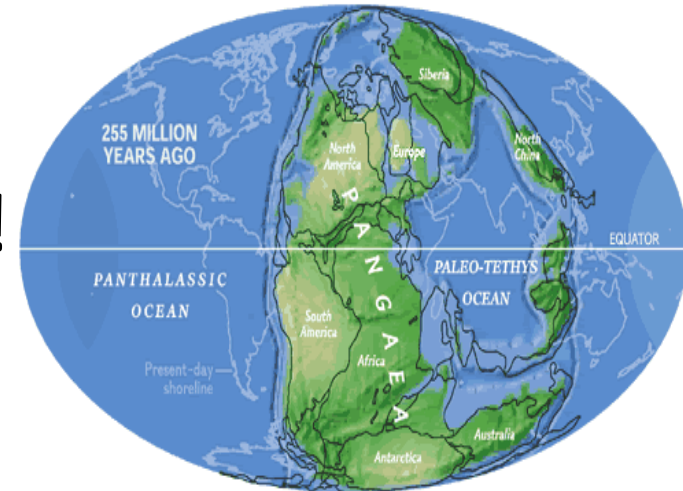
Horsetail trees, Tree ferns (some)

Why?

Huge amounts of lava oozing out of the earth Siberia

Formation of Pangaea

Mixing of oceans slows-anoxic



3. Mesozoic about 250-65mya



- Since Pangaea had formed===DRY
- Plants-mostly conifers/evergreens/pines...
- **Dinos** super diverse!
- **Mammals** technically there but rare
- **Pollinating insects begin** to diversify at the same time as **flowering plants begin** to diversify
- Biggest dino ever found (from Argentina)

<https://www.sciencenews.org/article/world%E2%80%99s-l>



Many different reptile groups

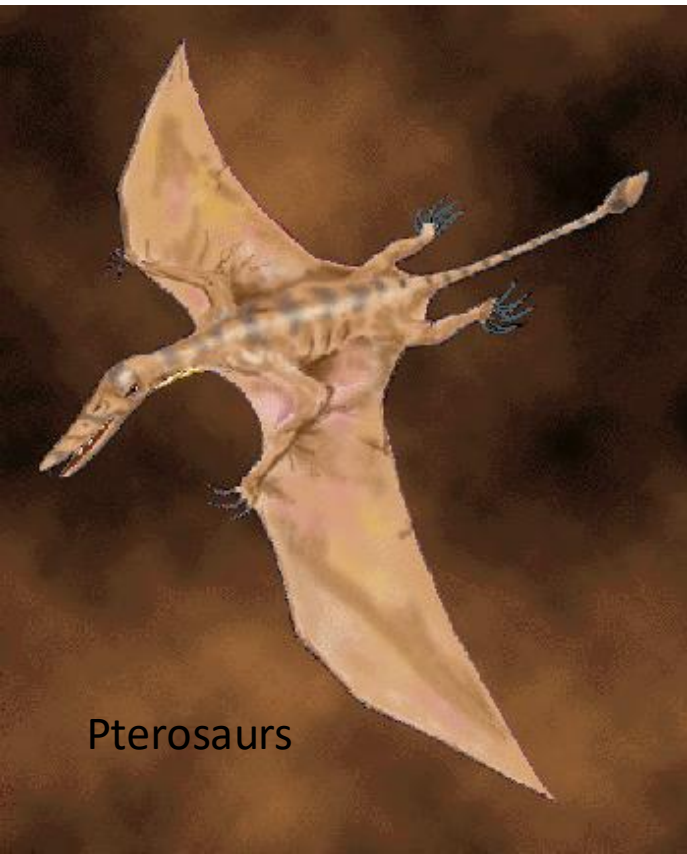
Pterosaurs

Plesiosaurs

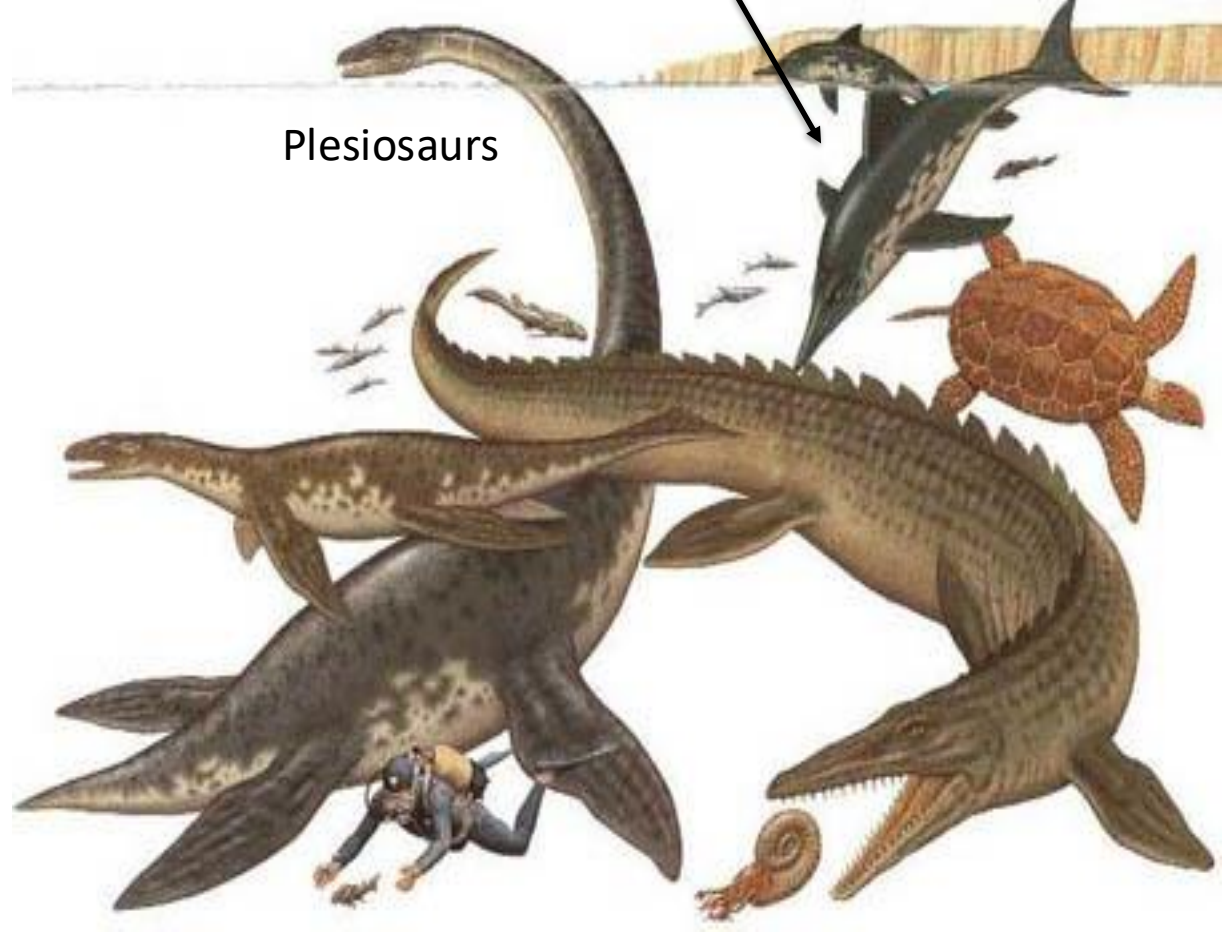
Ichthyosaurs



Ichthyosaurs



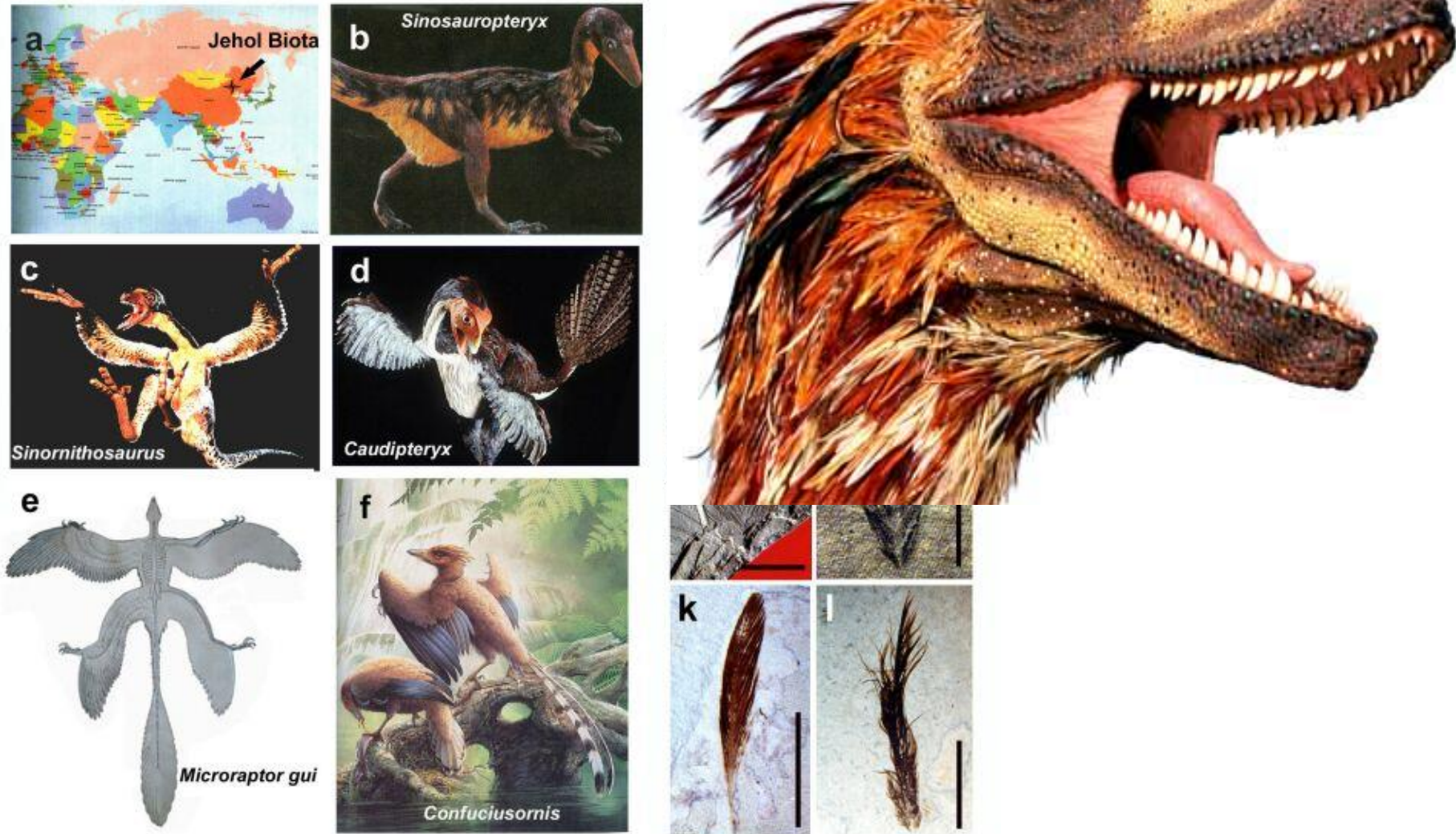
Pterosaurs



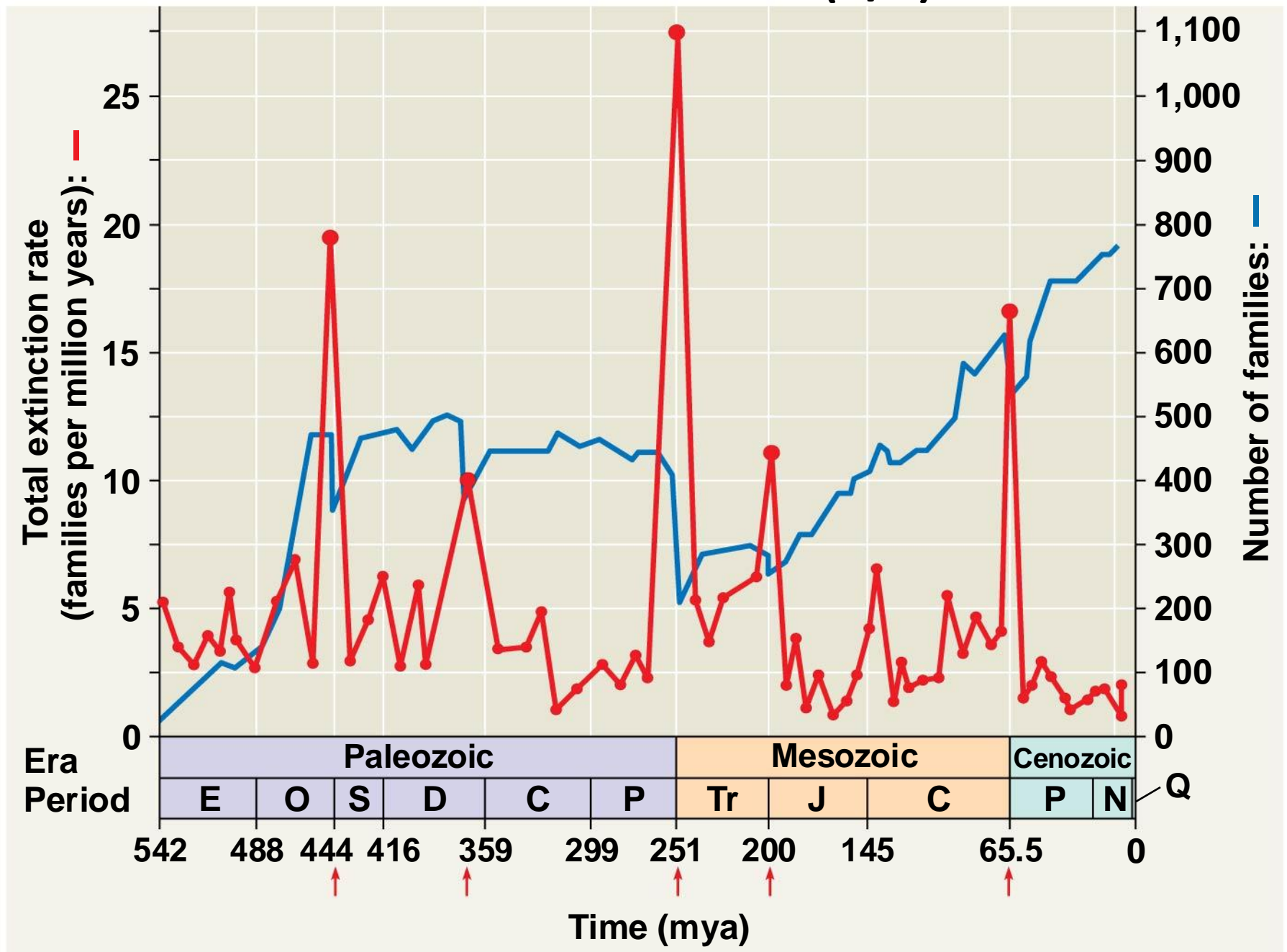
Plesiosaurs

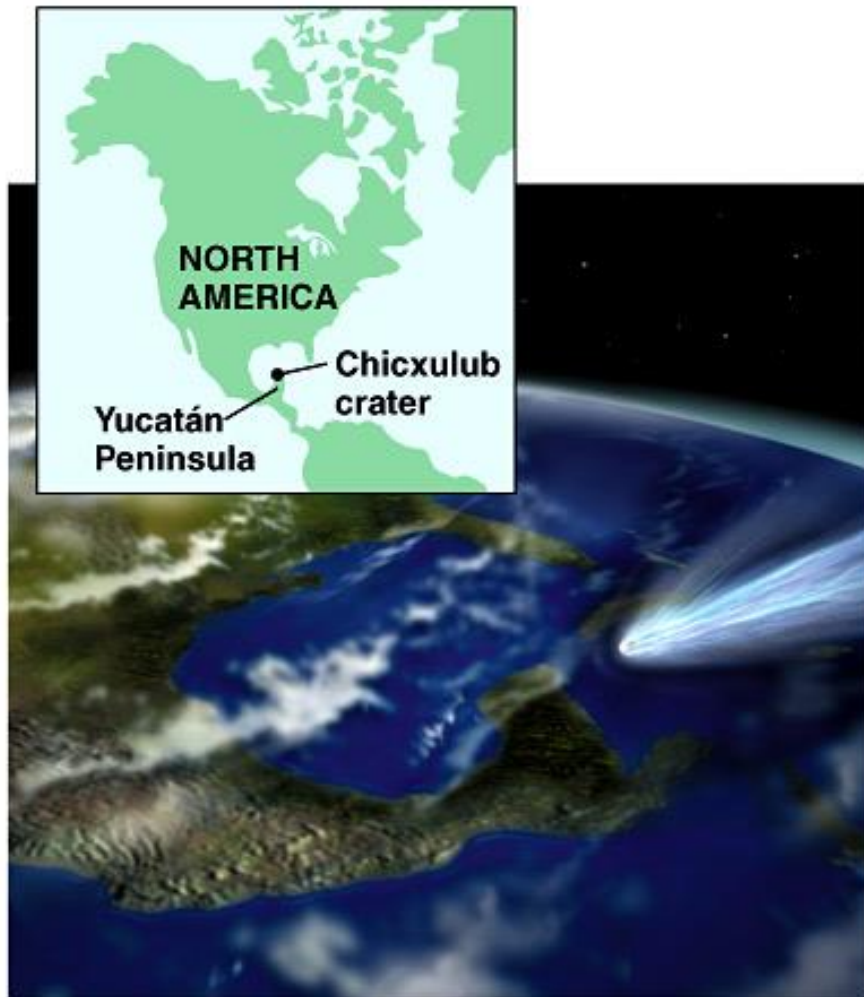
Evolution of feathers and birds (in chapter 4)

Figure 1



Cretaceous Extinction event (K/T)!





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7 miles across...

Cretaceous Extinction Event (K/T)

Effect 50% of all species

Who? Dinosaurs, Pterosaurs, Plesiosaurs, **many** small marine species

On land nothing bigger than 25 kgs survived-all survivors were small

Why? Impact

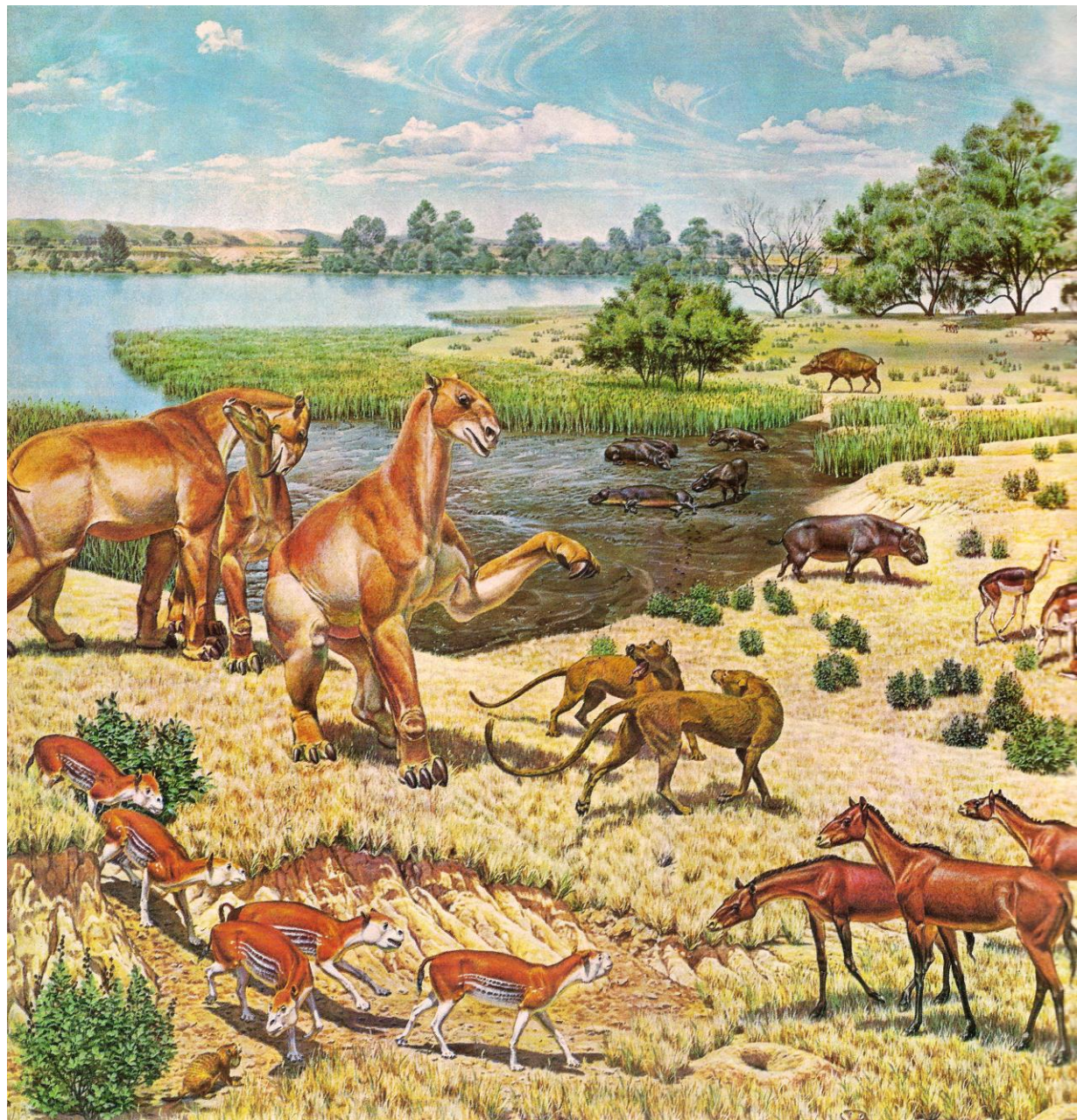
4. Cenozoic

65mya to present

Spreading apart
of continents..

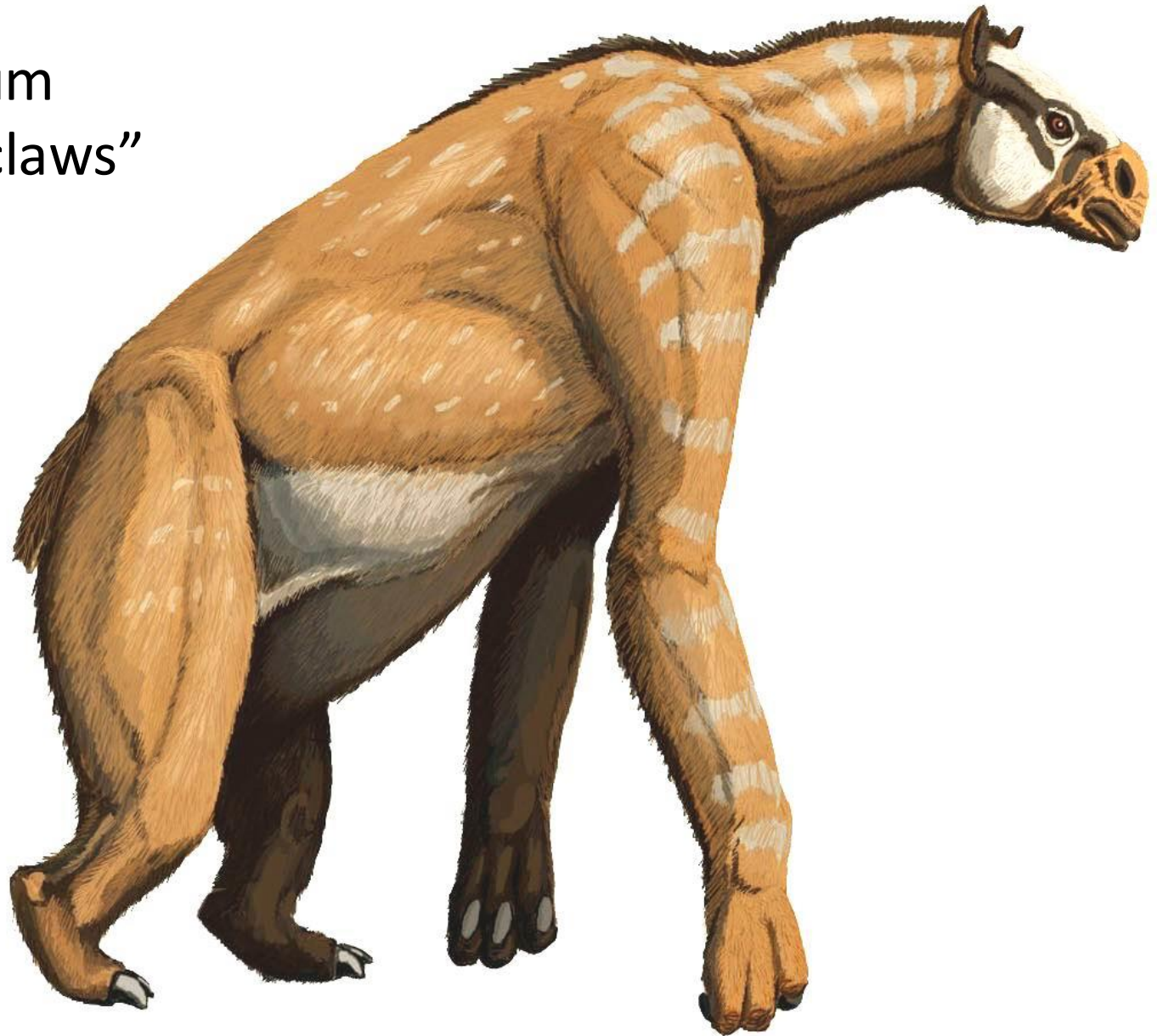
What kinds of
animals are
these?

What kinds of
plants are these?



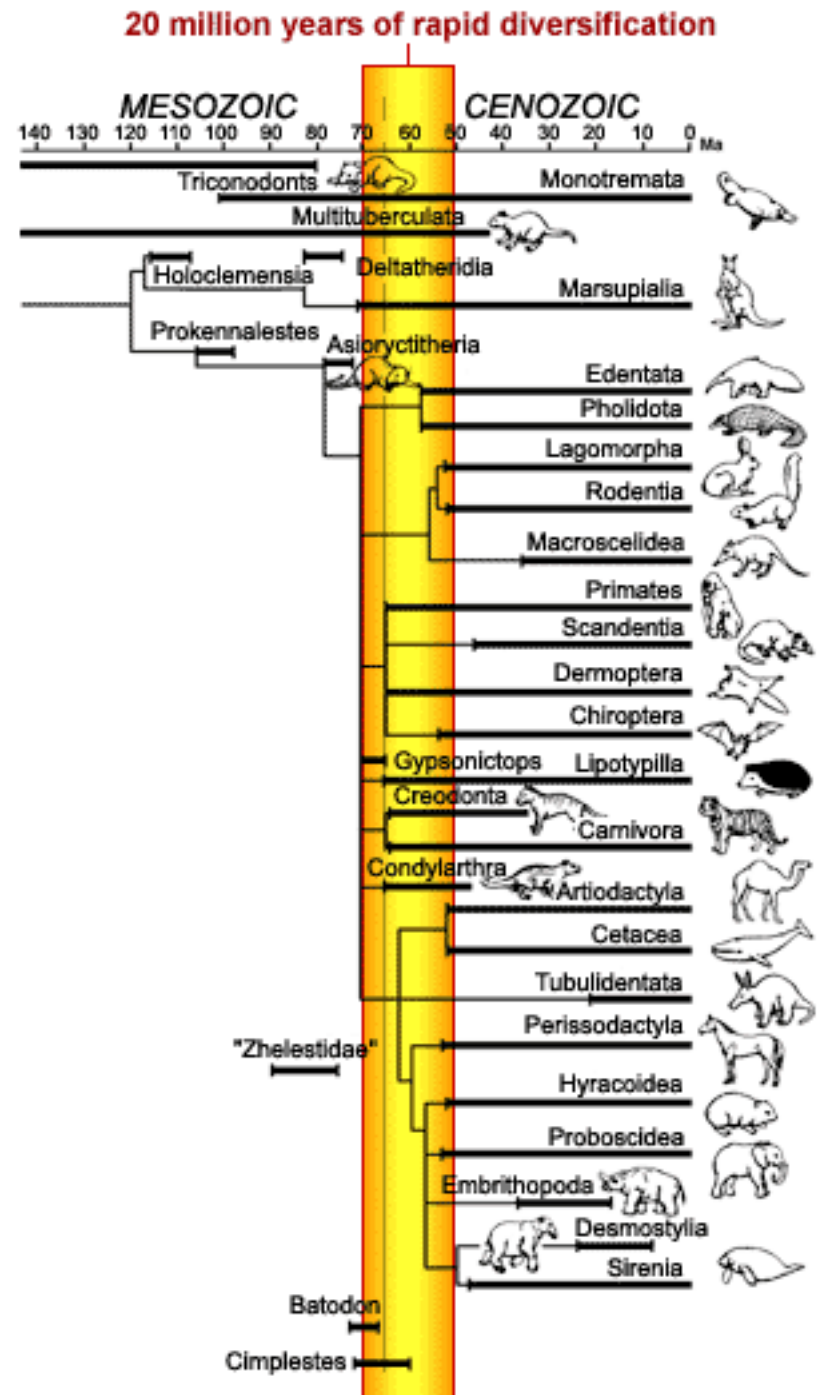
Remember this Perissodactyl?

Chalicotherium
“horse with claws”



**Mammals diversify
dramatically!**

An adaptive radiation!



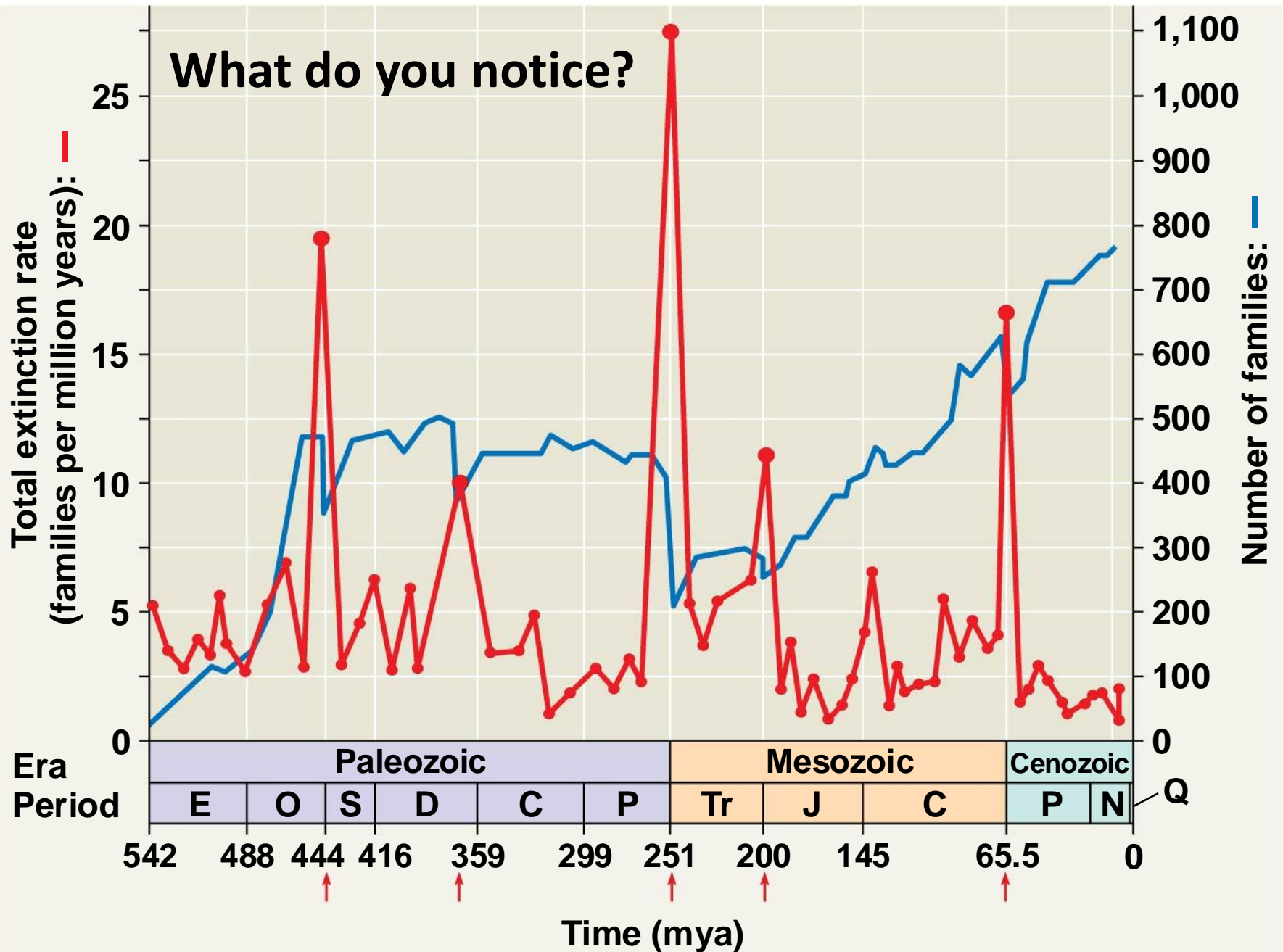
Flowering plant continues and diversity accelerates

(remember this started in Mesozoic)

Insects continue dramatic diversification due to coevolution of pollinators and flowering plants!

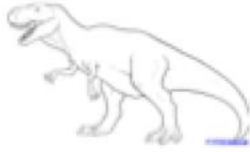


What do you notice?





1



2

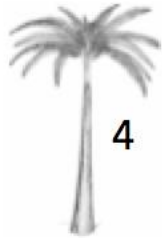


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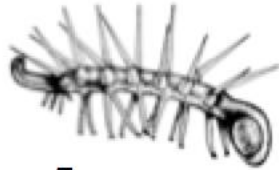


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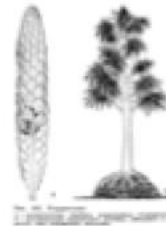
Sort the following into
Paleozoic, Mesozoic and
Cenozoic organisms.



4



5



9



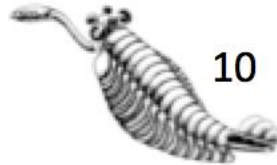
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10



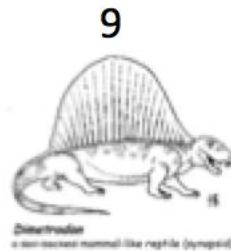
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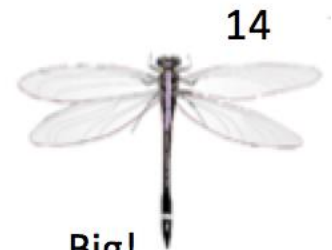
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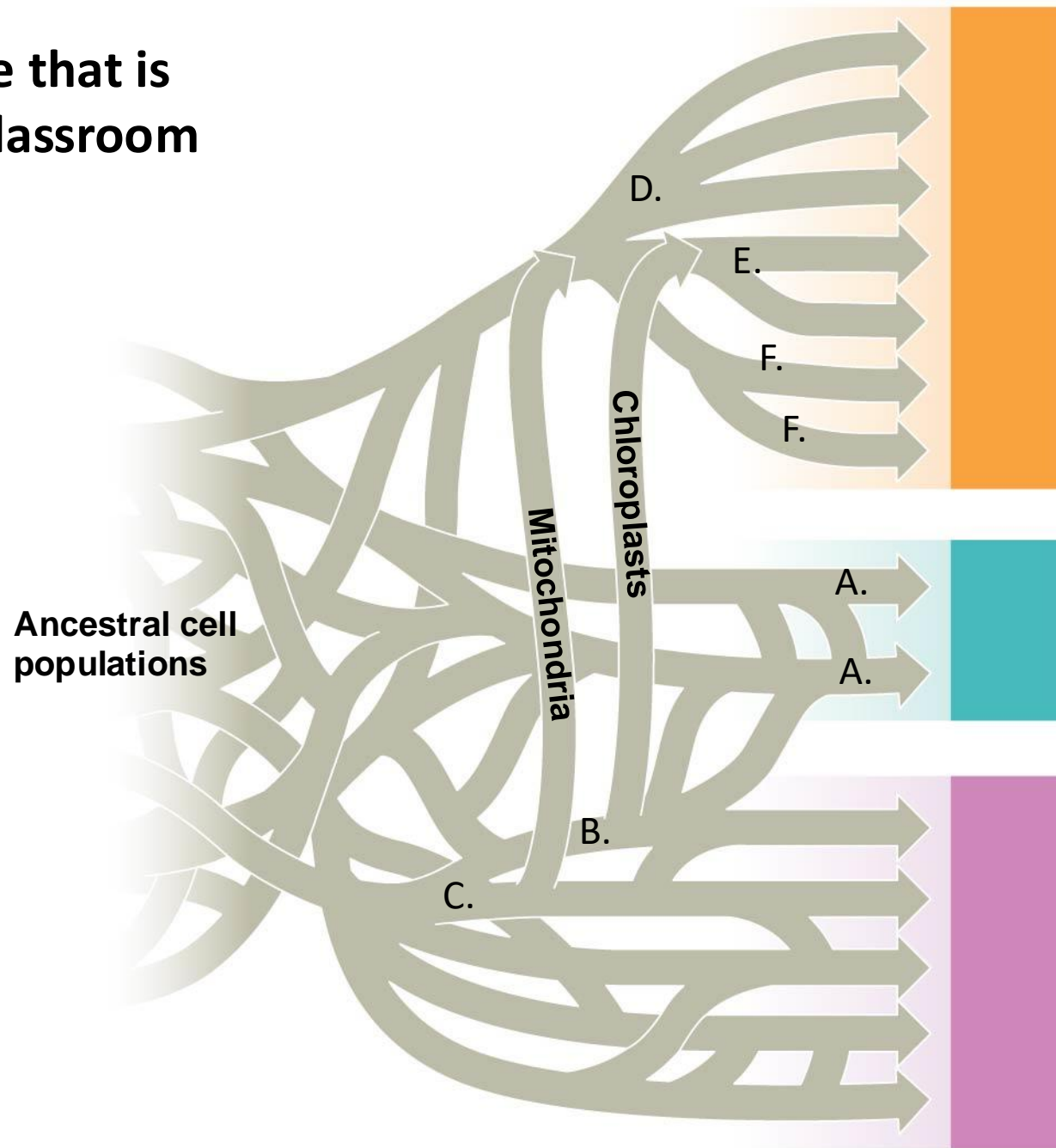
13



14

Big!

And here is the image that is
also in your Google classroom
assignment!



1. Match the Domains (Bacteria, Archaea, Eukarya) with the color blocks.

Orange=

Teal=

Purple=

2. Which are the Prokaryotic Domains?

3. Match the lineages (A-H) onto the tree

Methanogens (or “Eury” group)

Fungi

Cyanobacteria

Thermophiles (or “Cren” group)

Animals

Proteobacteria

Plants

“Protists”

