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Topic : History of life on Earth
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Unit : 4
Part : A
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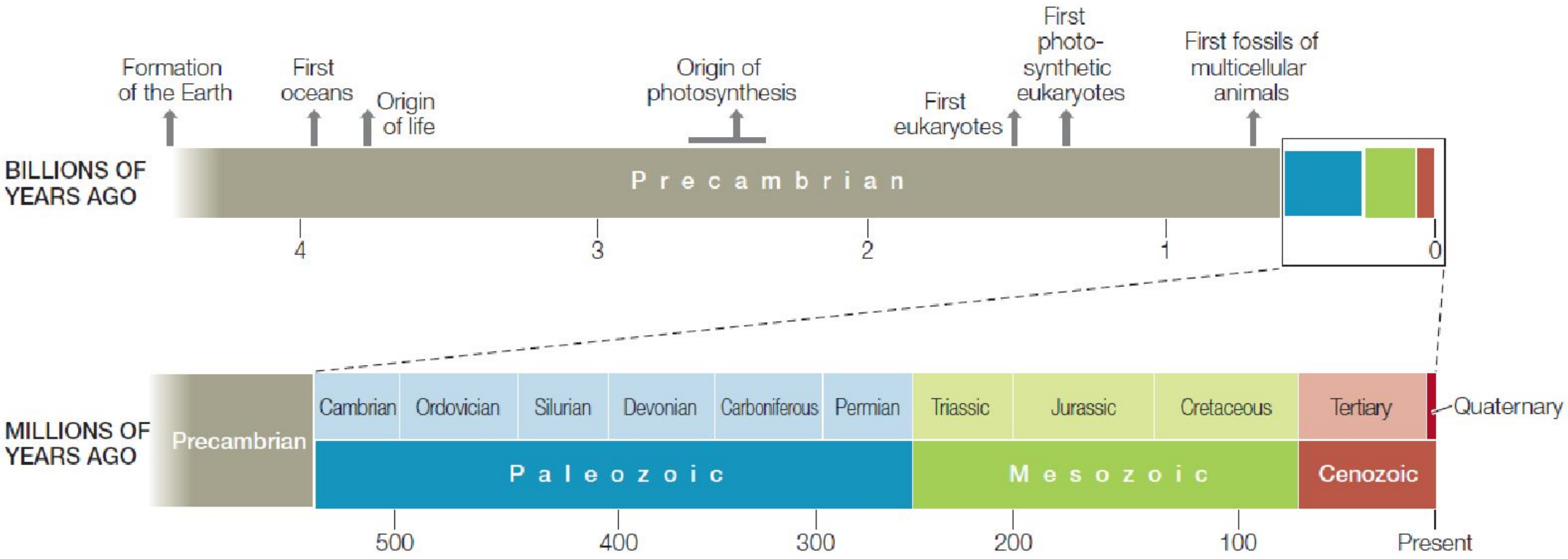
Subject : Environmental Science honours

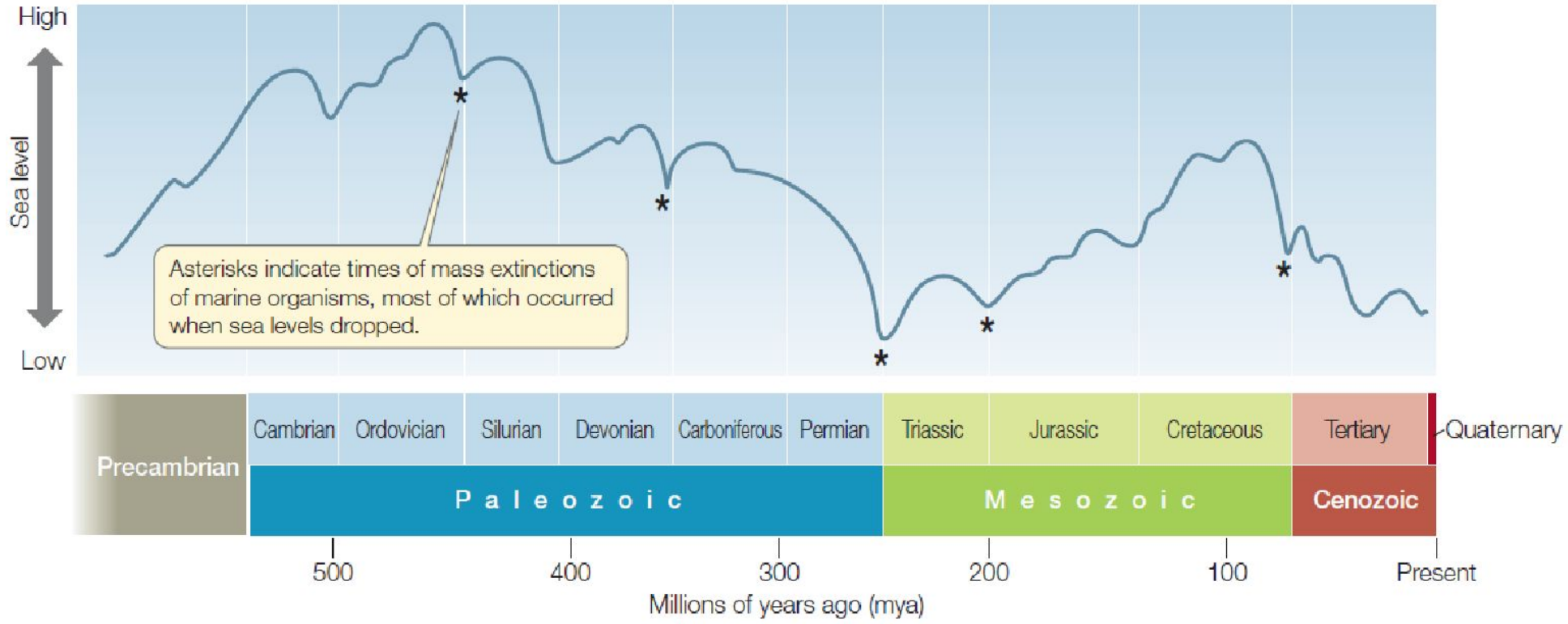
History of life on Earth

Life constitutes only a fraction of Earth's history



Sea Levels Have Changed Repeatedly

Most mass extinctions of marine organisms (indicated by asterisks) have coincided with periods of low sea levels.



Hot/Humid and Cold/Dry Conditions Have shaped Earth's History

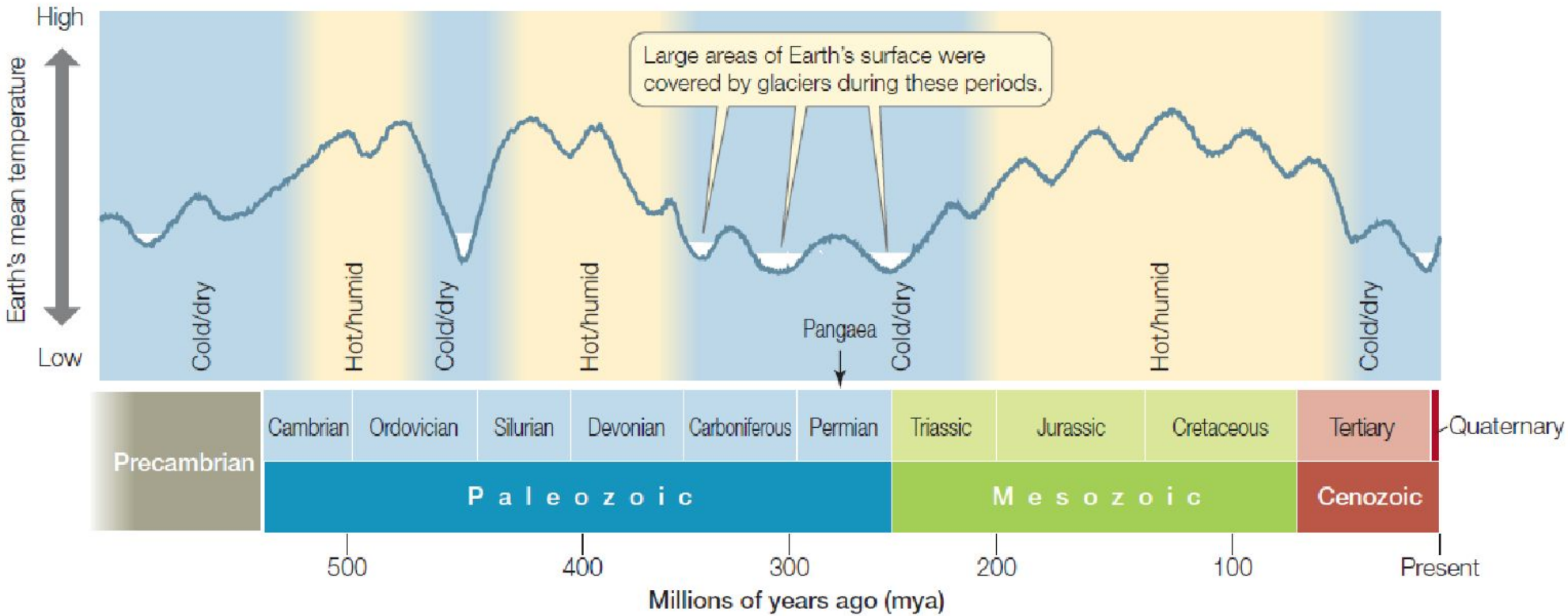
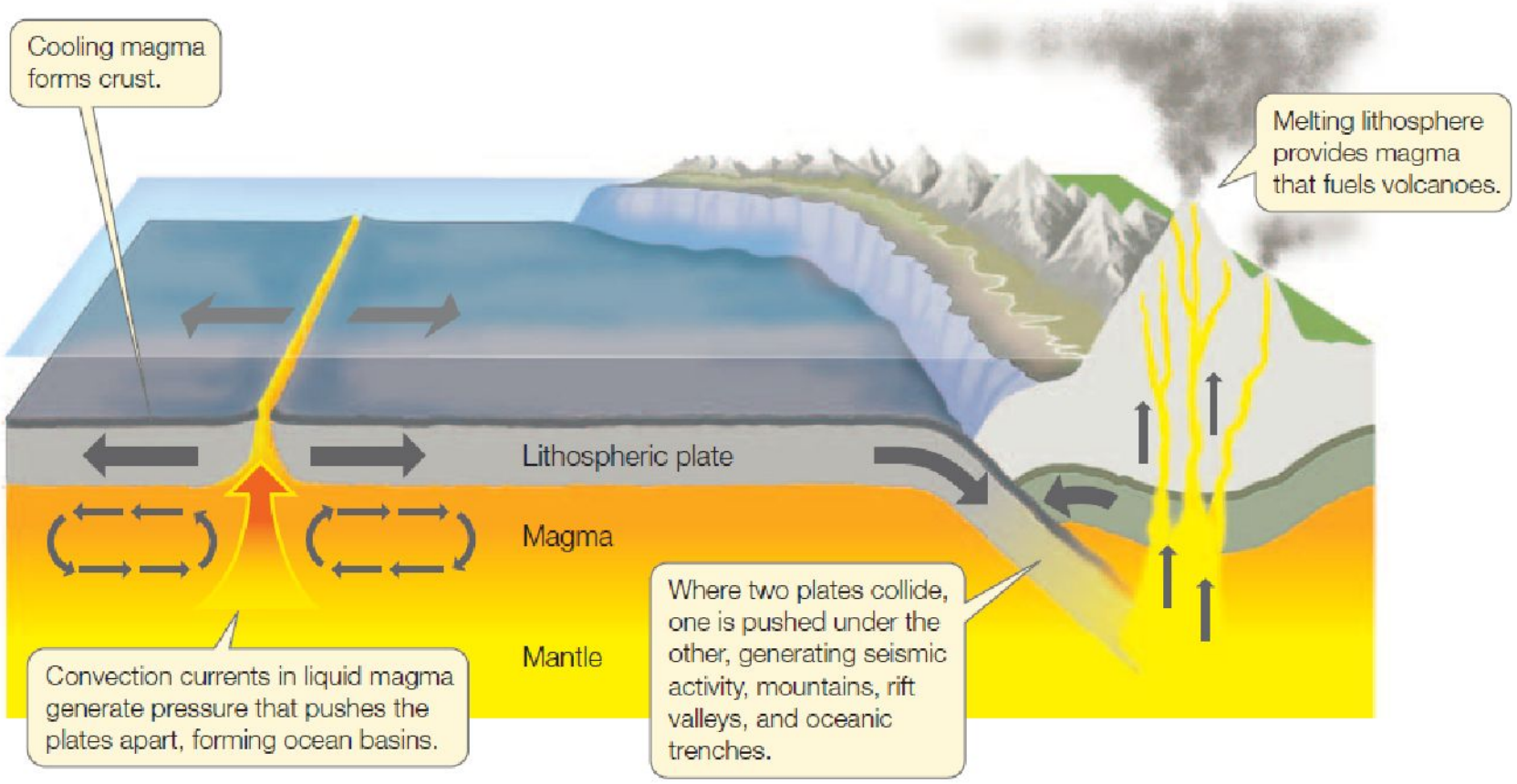
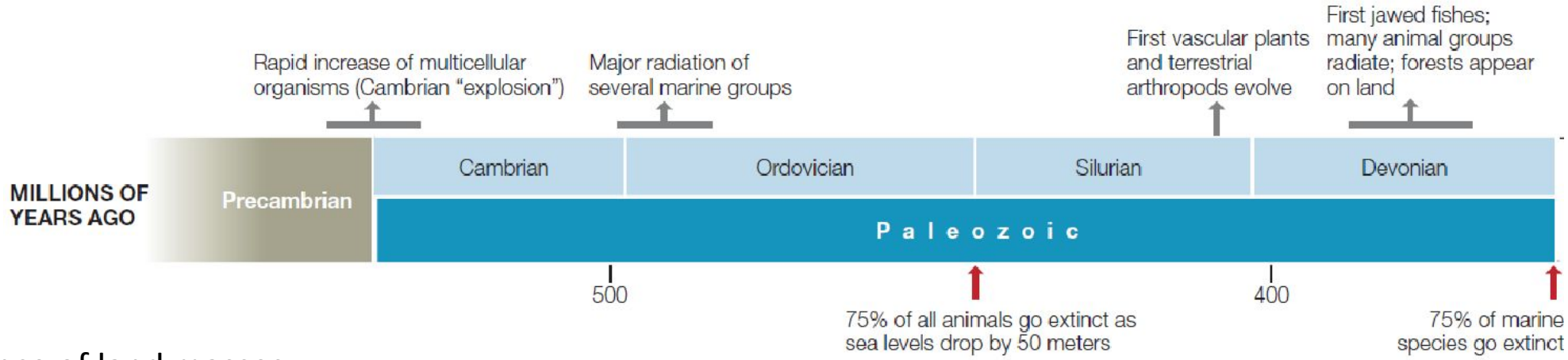


Plate tectonics and Continental drift

- We now know that at times the drifting of the plates has brought continents together and at other times has pushed them apart.
- The positions and sizes of the continents influence oceanic circulation patterns, global climates, and sea levels.
- Major drops in sea level have usually been accompanied by massive extinctions—particularly of marine organisms, which could not survive the exposure of vast areas of the continental shelves and the disappearance of the shallow seas that covered them.



Origin and Evolution of life along with shifting of continents (landmasses)



Appearance of land masses as isolated terrestrial masses

Cambrian

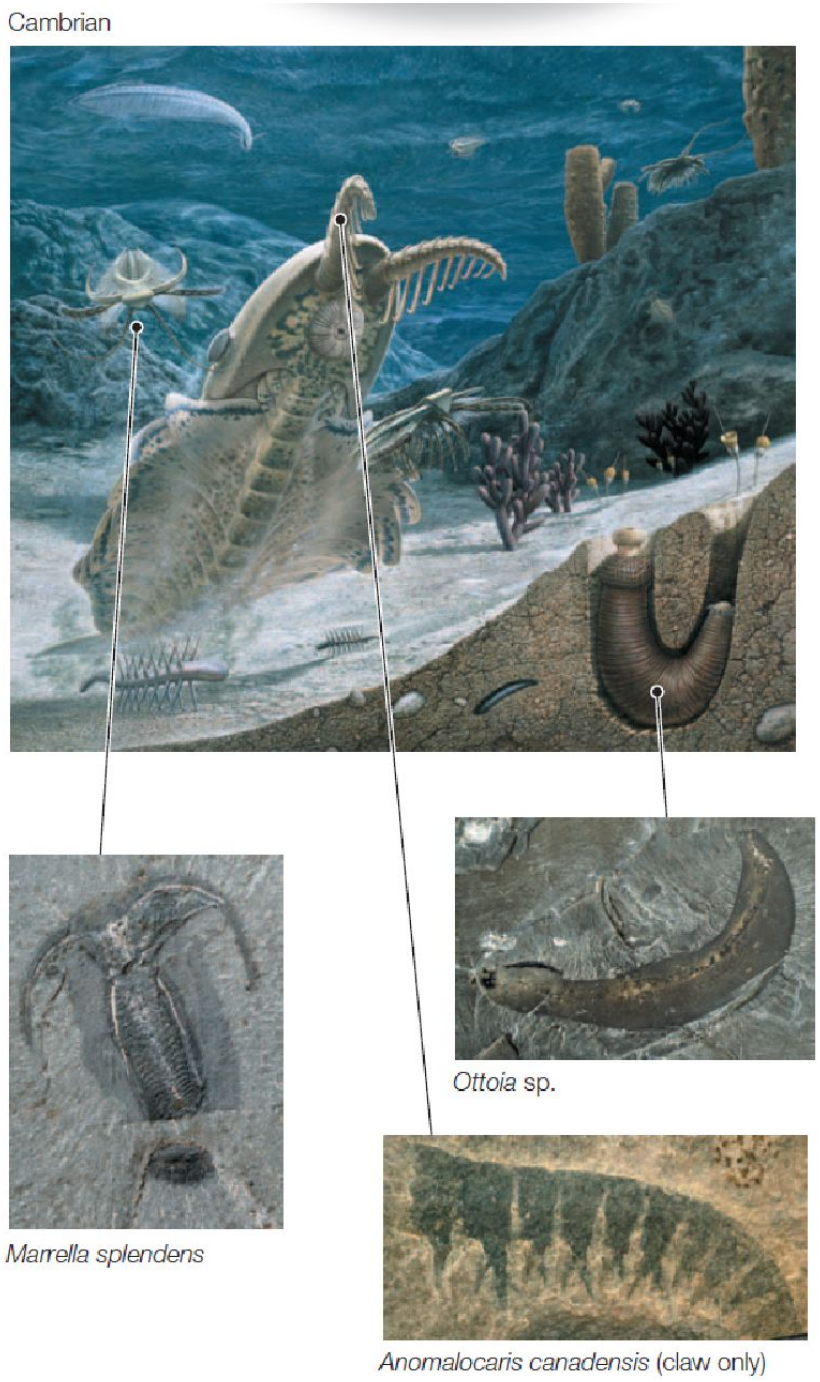
Devonian

Movement of land masses possibly driven by the Plate-tectonic activities underlying the masses

Cambrian explosion

- Sudden appearance of most of the existing animal body plans (most extant phyla and some which are no longer alive) in Fossil record
- Invertebrates – vertebrates both made appearance
- “sudden” should be read in geological time scale. That means, all the Cambrian animal/plant forms originated within a span of few *million* years
- Conceptually very important – shows that origin/evolution of life on earth is NOT a gradual process with a steady rate
- Post-Cambrian, most animal and plant groups went through tremendous adaptive radiation – creating more diversity

Mass extinction: The first mass extinction event took place just after the next period – Ordovician. This mass extinction wiped out most of the Cambrian fauna (75%). It was caused by a severe ice age when massive glaciers formed radically receding the ocean water. The temperature of the remaining water was also very low.



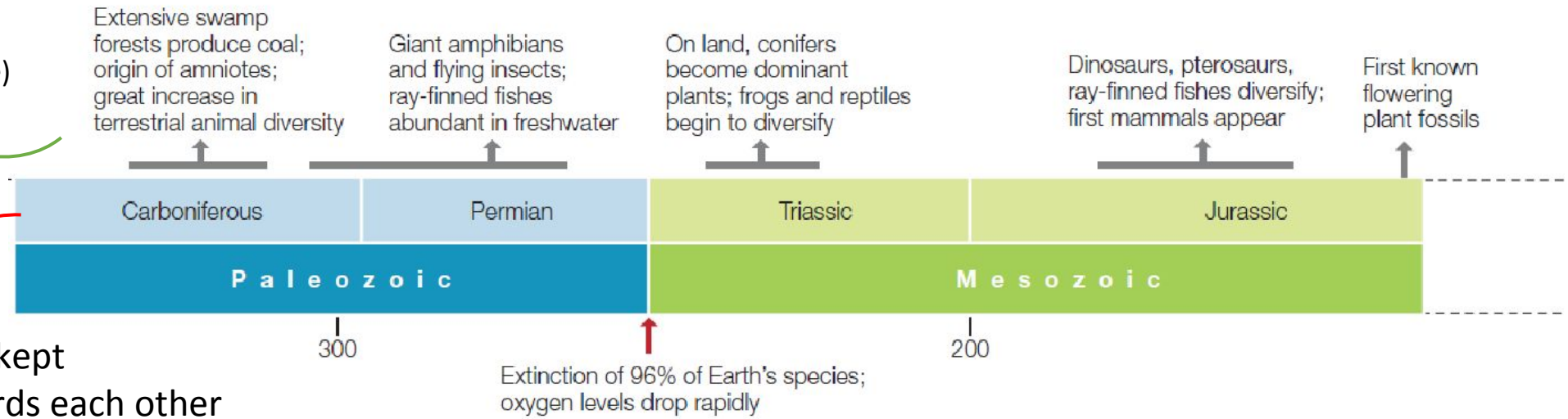
Devonian life forms were extremely rich

- More radiation of invertebrate life forms
- First appearace of jawed vertebrates
- Terrestrial habitats covered with wooded forests

Mass extinction: At the end of Devonian, a massive mass extinction wiped out 75% of all living forms in the ocean. This was triggered possibly by two meteorite collisions. In addition, rapid movement of the continental shelves may also have resulted in geological activities that could have caused catastrophic events.

Origin and Evolution of life along with shifting of continents (landmasses)

Fossilization of the plants (giant ferns) of this period resulted in the fossil fuel Including coal (hence, the name)



Land masses kept moving towards each other congregating to form Pangaea – one big interconnected continent

*continued till Permian

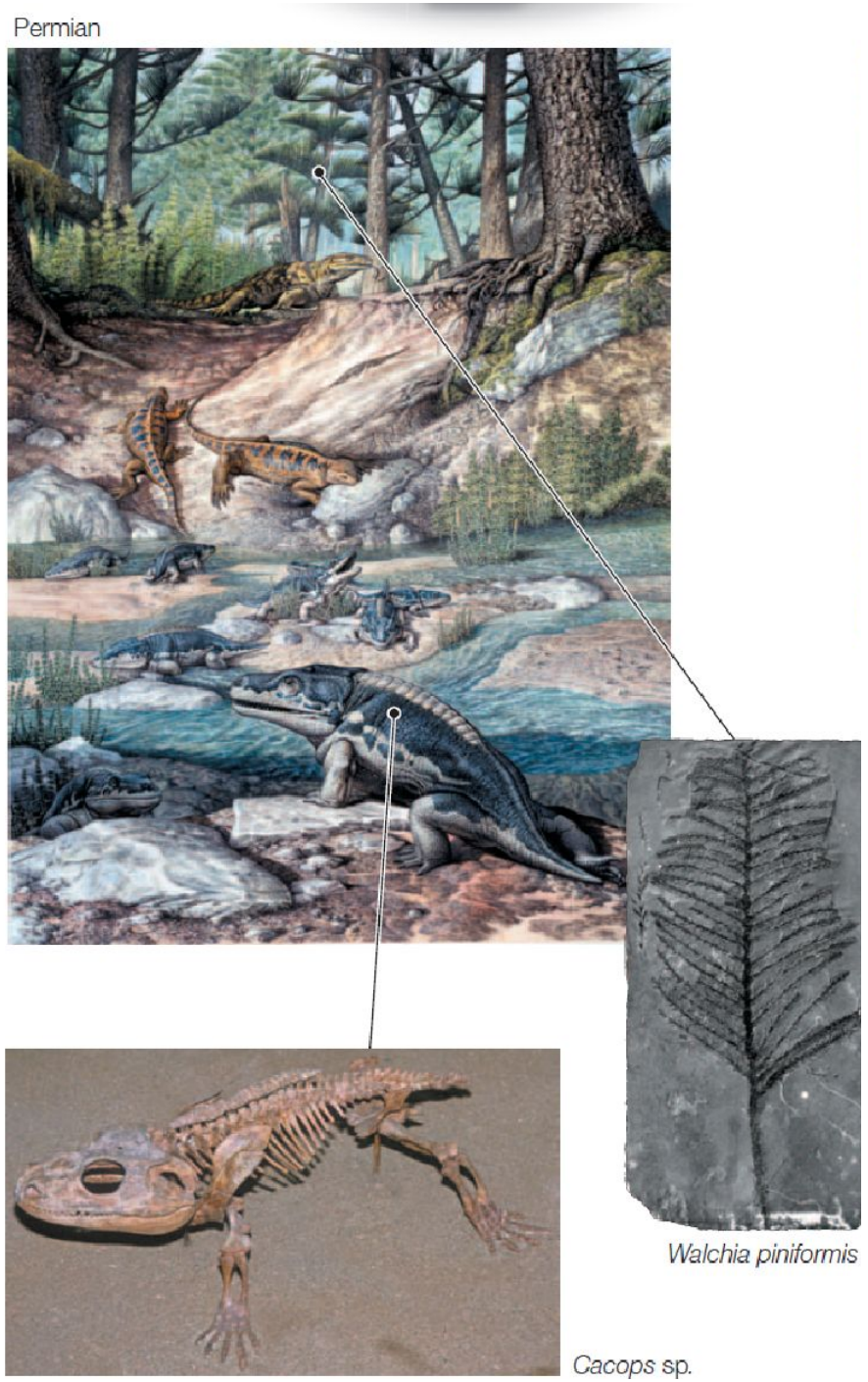
Permian

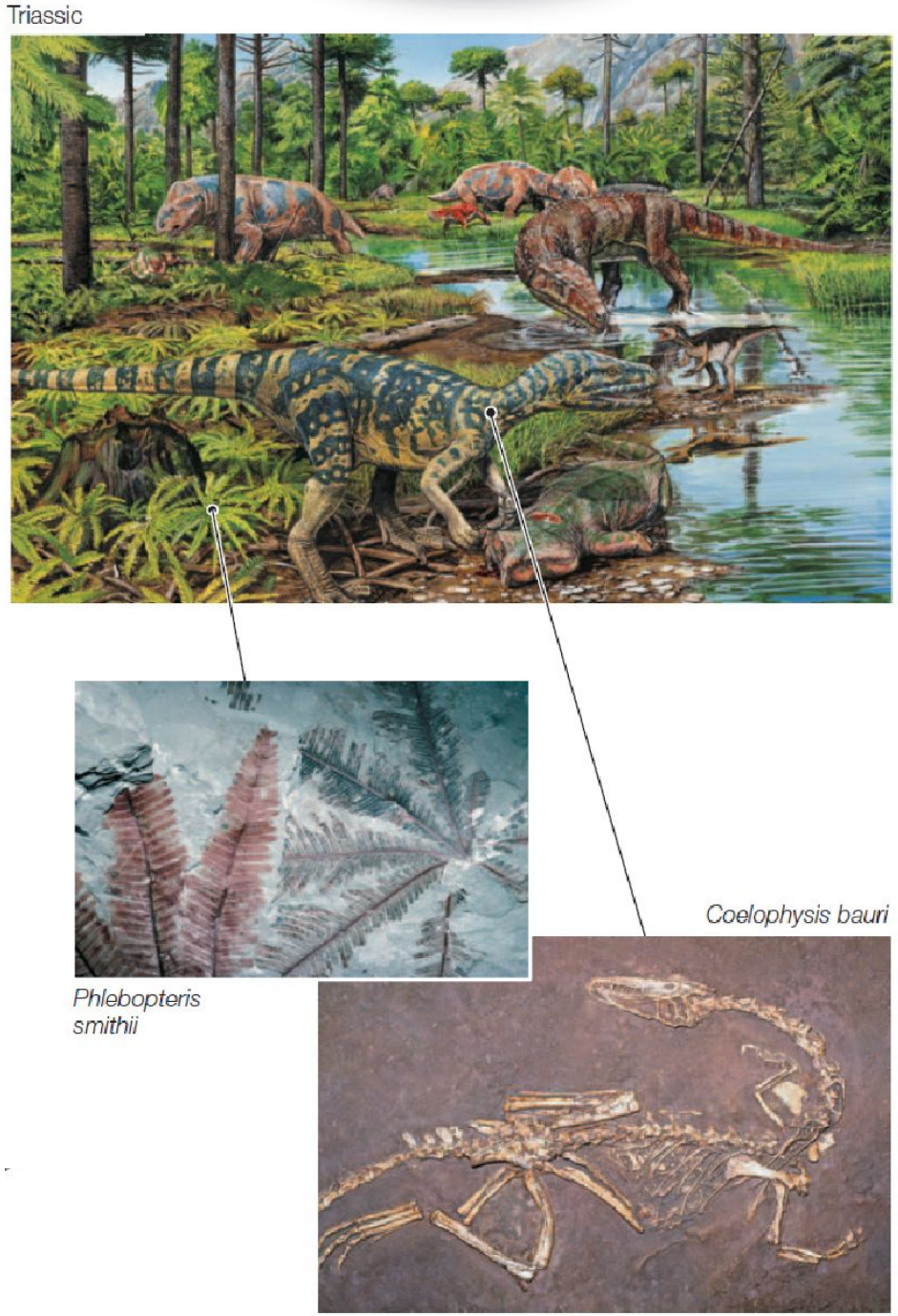
Triassic

Permian

- Formation of supercontinent – Pangaea.
- Further diversification of the terrestrial plants and animals – that had already started in Carboniferous. Especially, insect (including winged) diversified radically.
- Advent and diversification of the giant Amphibians.
- Origin of reptiles by the end of this period
- Abundance of freshwater waterbodies and diversification of freshwater animals, including ray-finned fishes.

Mass extinction: Massive volcanic eruptions resulted in mass extinction and resulting in the largest glaciers in Earth's history. About 96 percent of all species became extinct at the end of the Permian.



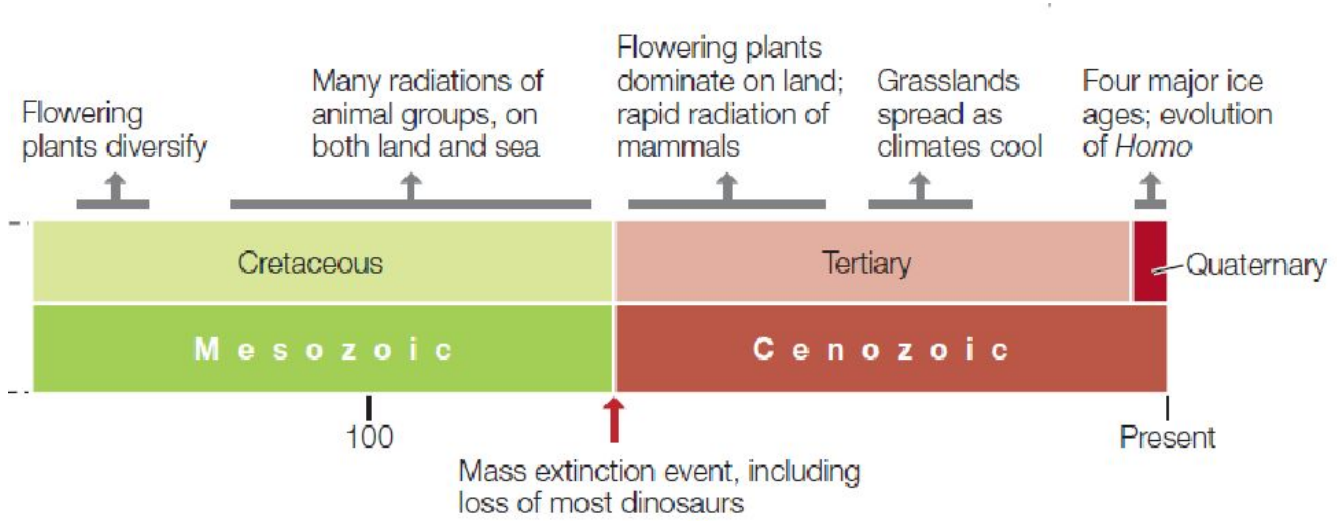


Triassic: the age of reptiles

- After the volcanic erruption, the Pangaea began to break. By the next period, Jurassic, two continents – Laurasia and Gondwana were formed.
- A new brand of plants started dominating the terrestrial habitats.
- The great reptile explosion started – which eventually gave rise to crocodiles, dinosaurs and bird.
- This was the beginning of the age of reptiles. Jurassic terrestrial habitat was mostly dominated by dinosaurs, while mammals made their appearance towards the end.

Mass extinction: Almost 65% of all living organisms were wiped out by a mass extinction event at the end of Triassic. However, unlike the end-Permian extinction, this was possibly a gradual process. The extinction was caused most likely by a *Climate change* event, possibly triggered by one or more volcanic erruptions that liberated a large amount of greenhouse gasses. However, the cause of this mass extinction is still a matter of debate due to the lack of direct evidence.

Origin and Evolution of life along with shifting of continents (landmasses)



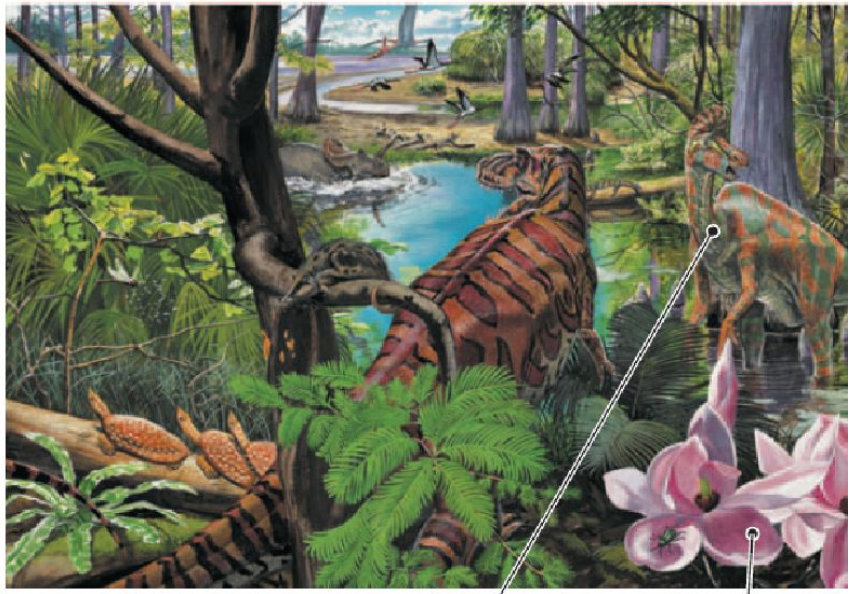
Cretaceous

Tertiary

Cretaceous

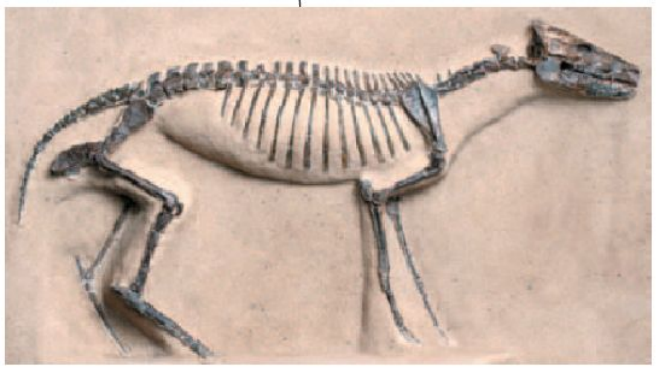
- Laurasia and Gondwana had started breaking up further – giving rise to the continents as we know today. But the continents continued drifting for many millions of years until it reached the present location.
- Dinosaurs were most abundant land (large) animals. Insects and arthropods were also very common. Flowering plants made their first appearance.

Mass extinction: A massive asteroid hit earth (near now Mexico) – creating an enormous explosion and tsunami. This triggered a mass extinction event that wiped out almost all dinosours. Extinction of dinosaurs allowed the mammals to flourish in the subsequent periods.



Gryposaurus sp.

Magnolia sp.



Hyracotherium leporinum

Plesiadapis fodinatus (jaw)

Tertiary: the advent and diversification of mammals

- Flowering plants dominant plant form
- Rapid diversification of the mammals
- Invertebrate fauna was almost as we see it today.
- Together with the Quaternary period, the entire Cenozoic era has about 4 major and 20 minor ice ages. During these ice ages massive glaciation redistributes the flora and fauna across the world. The last ice age ended about 15,000 years ago – which had a major role to play in human distribution and evolution.
- Right at the beginning of Tertiary, Australia started drifting away southward from the main Gondwana – taking a relatively newly evolved Marsupials in it. Due to the absence of other mammals (or any other competitors), marsupials went through a radical adaptive radiation in Australia – giving rise to its unique fauna.

Mass extinction: Though there were no mass extinction event in Tertiary. But in the subsequent period Quaternary, are we observing the sixth mass extinction?

History of Earth in a nut-shell

Earth's Geological History

RELATIVE TIME SPAN	ERA	PERIOD	ONSET	MAJOR PHYSICAL CHANGES ON EARTH	MAJOR EVENTS IN THE HISTORY OF LIFE
Precambrian	Cenozoic	Quaternary	2.6 mya	Cold/dry climate; repeated glaciations	Humans evolve; many large mammals become extinct
		Tertiary	65 mya	Continents near current positions; climate cools	Diversification of birds, mammals, flowering plants, and insects
	Mesozoic	Cretaceous	145 mya	Northern continents attached; Gondwana begins to drift apart; meteorite strikes Yucatán Peninsula	Dinosaurs continue to diversify; mass extinction at end of period (≈76% of species disappear)
		Jurassic	200 mya	Two large continents form: Laurasia (north) and Gondwana (south); climate warm	Diverse dinosaurs; radiation of ray-finned fishes; first fossils of flowering plants
		Triassic	251 mya	Pangaea begins to slowly drift apart; hot/humid climate	Early dinosaurs; first mammals; marine invertebrates diversify; mass extinction at end of period (≈65% of species disappear)
	Paleozoic	Permian	297 mya	Extensive lowland swamps; O_2 levels 50% higher than present; by end of period continents aggregate to form Pangaea, and O_2 levels begin to drop rapidly	Reptiles diversify; giant amphibians and flying insects present; mass extinction at end of period (≈96% of species disappear)
		Carboniferous	359 mya	Climate cools; marked latitudinal climate gradients	Extensive "fern" forests; first reptiles; insects diversify
		Devonian	416 mya	Continents collide at end of period; meteorite probably strikes Earth	Fishes diversify; first insects and amphibians; mass extinction at end of period (≈75% of species disappear)
		Silurian	444 mya	Sea levels rise; two large land masses emerge; hot/humid climate	Jawless fishes diversify; first ray-finned fishes; plants and animals colonize land
		Ordovician	488 mya	Massive glaciation, sea level drops 50 meters	Mass extinction at end of period (≈75% of species disappear)
		Cambrian	542 mya	O_2 levels approach current levels	Rapid diversification of multicellular animals; diverse photosynthetic protists
	Precambrian		900 mya	O_2 level at >5% of current level	Ediacaran fauna; earliest fossils of multicellular animals
			1.5 bya	O_2 level at >1% of current level	Eukaryotes evolve
			3.8 bya	O_2 first appears in atmosphere	Origin of life; prokaryotes flourish
			4.5 bya		

Note: mya, million years ago; bya, billion years ago.