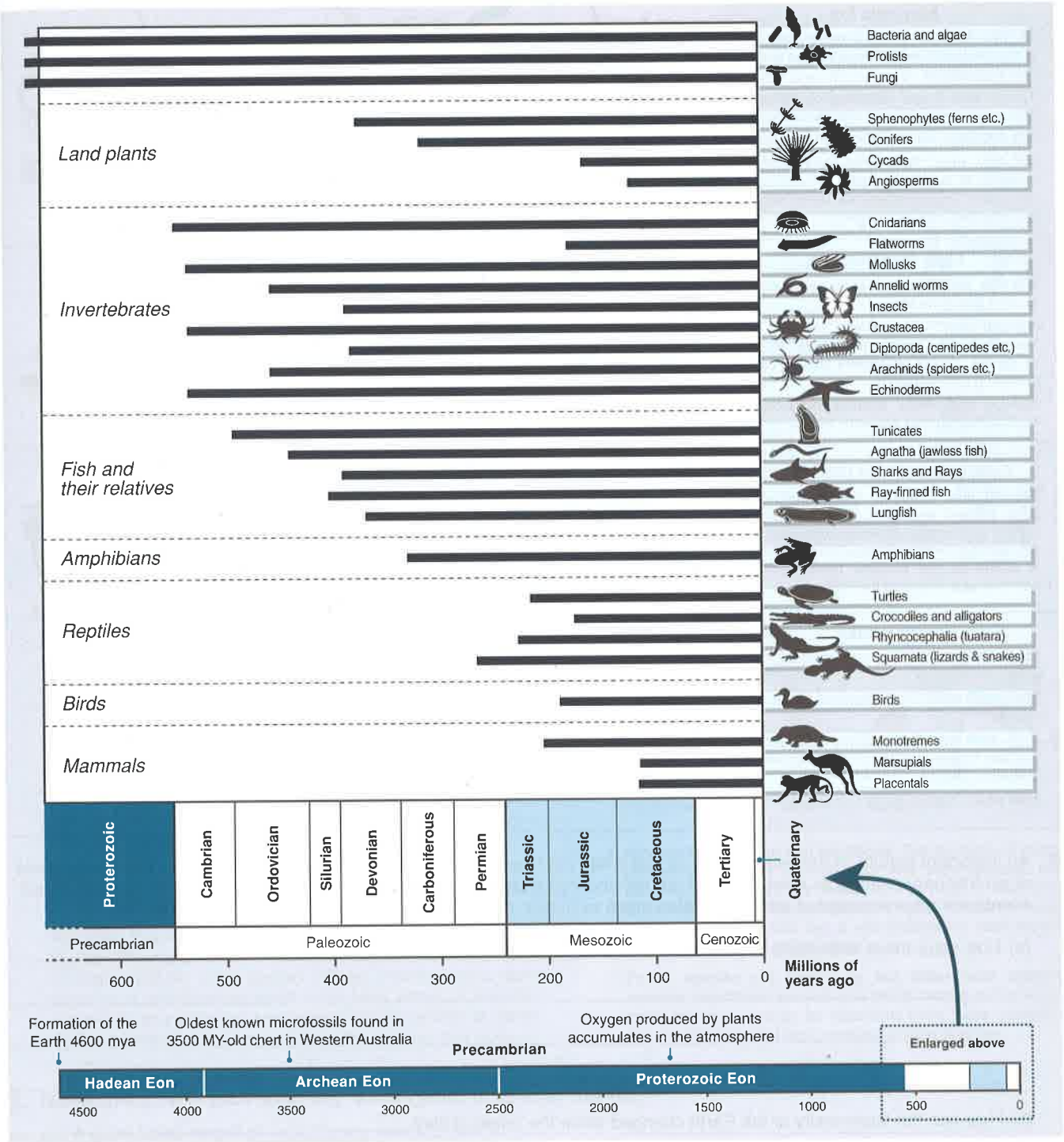
The History of Life on Earth

The history of life on Earth is one of diversification and extinction. Through fossil and biochemical evidence, it traces the processes by which organisms have evolved since life first originated, perhaps as early as 4000 mya. The biochemical similarities between all present day organisms indicate the presence of a universal common ancestor (an ancestral prokaryote) from which all known species have diverged. Autotrophic cyanobacteria were present as far back as 3500 mya and their photosynthetic activities and the buildup of free atmospheric oxygen were crucial to the later evolution of more complex life forms. Once multicellularity arose in the Precambrian, life diversified rapidly, with the Cambrian explosion being notable for the extraordinary number of new adaptive radiations from Precambrian forms. The rest of Earth's biological history is marked by major geologic and paleontological events, such as mass extinctions, which divide the record of biological diversity into geologic eras and periods.



1. What was the significance of the buildup of free oxygen in the atmosphere for the evolution of animal life?

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2. Using the diagram above, determine how many millions of years ago the fossil record shows the first appearance of:

(a) Invertebrates: _____ (b) Fish (ray-finned): _____ (c) Land plants: _____

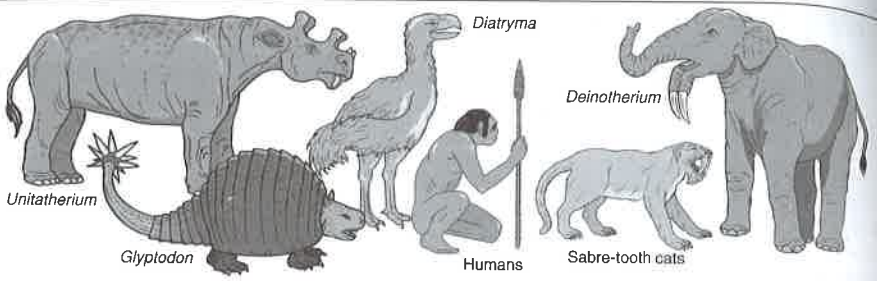
(d) Reptiles: _____ (e) Birds: _____ (f) Mammals: _____

Cenozoic Era

1.65 mya: Modern humans evolve. Their activities, starting at the most recent ice age, are implicated in extinction of the megafauna.

3-5 mya: Early humans arise from ape-like ancestors.

65-1.65 mya: Major shifts in climate. Major adaptive radiations of angiosperms (flowering plants), insects, birds, and mammals.



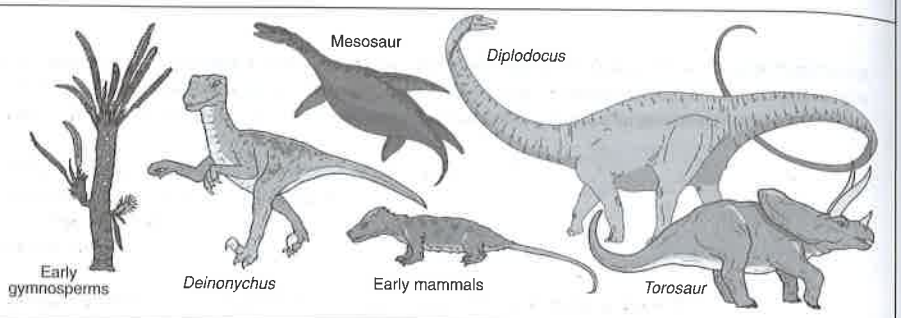
Mesozoic Era

65 mya: Apparent asteroid impact implicated in the mass extinction of many marine species and all dinosaurs.

135-65 mya: Major radiations of dinosaurs, fishes, and insects. Origin of angiosperms.

181-135 mya: Major radiations of dinosaurs.

240-205 mya: Recoveries and adaptive radiation of marine invertebrates, dinosaurs, and fishes. Origin of mammals. Gymnosperms become dominant land plants.

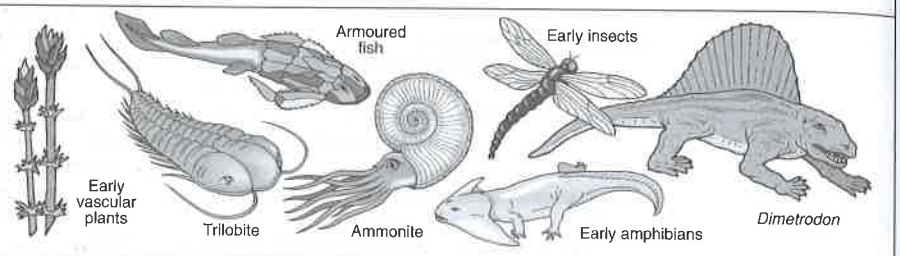


Later Paleozoic Era

240 mya: Mass extinction of nearly all species on land and in the sea.

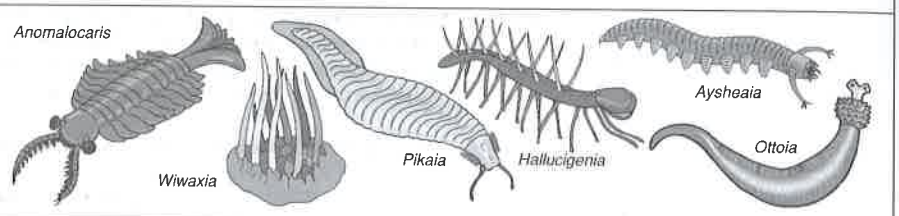
435-280 mya: Vast swamps with the first vascular plants. Origin and adaptive radiation of reptiles, insects, and spore bearing plants (including gymnosperms).

500-435 mya: Major adaptive radiations of marine invertebrates and early fishes.



Early Paleozoic Era (Cambrian)

550-500 mya: Origin of animals with hard parts (appear as fossils in rocks). Simple marine communities. A famous Canadian site with a rich collection of early Cambrian fossils is known as the Burgess Shale deposits; examples are shown on the right.



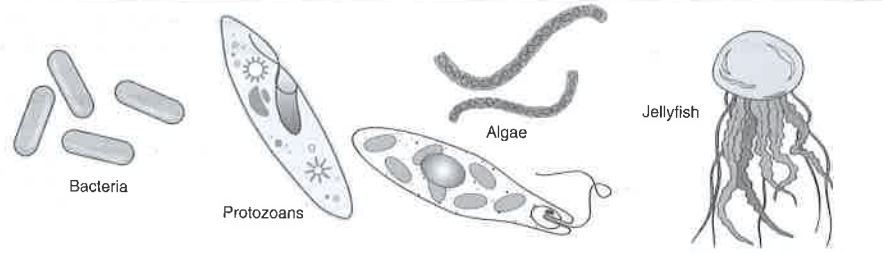
Precambrian

2500–570 mya: Origin of protists, fungi, algae, and animals.

3800–2500 mya: Origin of photosynthetic bacteria.

4600–3800 mya: Chemical and molecular evolution leading to origin of life; protocells to anaerobic bacteria.

4600 mya: Origin of Earth.



3. An important feature of the history of life is that it has not been a steady progression of change. There have been bursts of evolutionary change as newly evolved groups undergo **adaptive radiations** and greatly increase in biodiversity. Such events are often associated with the sudden mass extinction of other, unrelated groups.

   (a) How were mass extinctions important in stimulating new biodiversity? _____

   _____

   _____

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   (b) How has the biodiversity of the Earth changed since the origin of life? _____

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