

II. Short Answers (6 points each)

1. In terms of early life, what is the importance of the fact that all organisms situated near the base of the phylogenetic tree (based on rRNA sequences) were isolated from extreme environments?

Since all of the organisms near the tree root are from extreme environments, especially hot ones, it appears that early life arose in hot places such as hydrothermal vents or hot springs

2. Describe the sequence of events that allowed life to slowly remove carbon dioxide from the atmosphere over geologic time.

As life spread, it became the primary agent for weathering rocks. Primary producers like cyanobacteria and later other algae and plants life, removed CO₂ during photosynthesis. When these organisms died and decomposed, the CO₂ released was converted to carbonic acid that weathered rocks. Weathering converted the carbonic acid to bicarbonate that was transported to the sea, and eventually precipitated in sediments as carbonate minerals. These minerals were stored in the sea and subducted during plate tectonics. Hence, CO₂ in the air ended up trapped within the Earth leading to a constant decline in atmospheric CO₂.

3. How do the presence of banded-iron formations and red beds help us to describe how oxygen changed over the first three billion years of Earth?

Once early organisms acquired the ability to produce O₂, it reacted with the abundant reduced iron in the sea to produce banded-iron formations that increased in abundance for hundreds of millions of years. Once the formation of O₂ exceeded the supply of reduced iron in the sea, O₂ was able to escape into the atmosphere where it reacted with reduced iron on the continents forming red beds. The fact that banded-iron formations occurred prior to red beds was evidence that O₂ production occurred for quite some time before O₂ began to enter and accumulate in the atmosphere

4. How did life's role in weathering rocks allow life to last for 4 billion years on Earth?

Weathering without life was too slow to remove CO₂ fast enough to keep up with the increased heat output of the Sun over time. Therefore, without life, Earth would have become too warm to allow life to begin since the CO₂ would have remained too high to balance Earth's temperature.

5. Describe one way that molecular techniques have refuted ideas about the "warm little pond" as the setting for the evolution of life.

1) RNA sequence analysis showed the predominance of thermophiles near the root of the tree of life, indicating that life began in very hot places.

2) The ubiquity of autotrophy in the tree of life suggests that it began early in Earth's history

3) Stable C isotopes show that photosynthesis began early in Earth's history since only life can fractionate C isotopes so thoroughly and this fractionation goes back nearly 4 billion years

EXTRA CREDIT (6 pts): How does deforestation lead to desert formation (desertification)?

Terrestrial plants transpire great amounts of water from soil into the atmosphere through leaves and this moisture falls back as rain. The cycle can occur over and over again before water eventually moves to the sea. Removal of trees stops this cycle and ground water tends to flow directly into rivers and to the sea without entering the atmosphere first. Hence, rainfall is greatly decreased and a desert can eventually take over.