**History of the Earth: Four Eons:**

- **Hadean Eon:** 4500 – 3800 ___________ of years ago (mya)
- **Archean Eon:** __________ - 2500 mya
- **Proterozoic Eon:** 2500 - 542 mya
- **Phanerozoic Eon:** 542 mya - Present

**Hadean Eon:**

- For its first billion years, the Earth’s surface was molten rock
- It was too ______ for life to exist or to originate
Archean Eon:
(Image: American Museum of Natural History)

- Prokaryotic life originated soon after Earth cooled and oceans were formed
- Earth was _____________
- Photosynthetic bacteria, including cyanobacteria evolved (bumps are “stromatolites”, made by them)

Photosynthetic Bacteria:

- Some photosynthetic bacteria (such as green sulfur bacteria) use Hydrogen sulfide ($H_2S$) & do not produce oxygen:
  __________ + CO$_2$ + Light $\rightarrow$ Sugars + Sulfur
- _________________ (& in eukaryotes, chloroplasts) use water instead, & produce oxygen:
  H$_2$O + CO$_2$ + Light $\rightarrow$ Sugars + O$_2$

Cyanobacteria:

(http://universe-review.ca/F11-monocell.htm)

Key Dates in the Early Evolution of Life:

- **Origin of Life:** (the first prokaryotes) c. 3800 mya
- **Origin of Photosynthesis:** c. 3500 mya ??
- **Origin of _______ Photosynthesis:**
  (oldest cyanobacterial fossils) c. 2900 mya
- **Origin of Aerobic Respiration:** c. 2400 mya ??
- **Origin of Eukaryotes:** (the first protists) c. 2000 mya
Oxygen Terminology:

- An environment lacking oxygen is: **Anoxic**.

- **Anaerobe**: an organism that lives without oxygen (many are killed by oxygen).

- **Aerobe**: an organism that requires oxygen to live.

The Oxygen Revolution:

- The first O₂ on Earth was a _______________ of a new type of photosynthesis invented by **cyanobacteria** (oxygenic photosynthesis)

- This caused formation of oxidized compounds (banded iron formations - or “rusty rocks”)

- Oxygen first dissolved in the oceans, then accumulated in the atmosphere - it currently makes up 21% of the air.

Gradual Increase in Atmospheric O₂:

- [Gradual Increase in Atmospheric O₂](http://www3.ncc.edu/faculty/bio/fanellis/biosci119/marineorg.html)

Banded Iron Formation: (c. 2400 mya)

- formed by the oxidation of iron, forming rust

- [Banded Iron Formation](http://rst.gsfc.nasa.gov/Sect19/Sect19_2a.html)
Consequences of Oxygen in the Environment:

- Caused a mass extinction of anaerobic prokaryotes, for whom it is toxic
- Made evolution of aerobic respiration in bacteria possible (later, some of these oxygen-respiring bacteria were eaten by eukaryotes, and became ________________).
- These aerobic bacteria were very successful, since aerobic respiration produces much more ATP than anaerobic bacteria can produce

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