

Welcome to
Class 11:
Origin of Life on
Earth



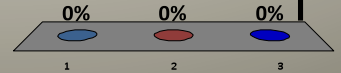
When and where did life start on Earth?

When was the atmosphere safe for us to exist?

Which of today's learning objectives
seem most difficult?

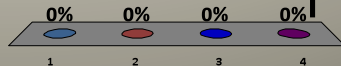
1. Evidence of earliest life and how long ago.
2. 3 arguments for why life started at vents at the ocean base.
3. Chemical Evolution of Earth's atmosphere.

Remember to set your channel to 80!



Which of these listed below gives the
earliest evidence of life?

1. Radiometric dating
2. Ancient stromatolites
3. microfossils
4. Altered isotopic ratios

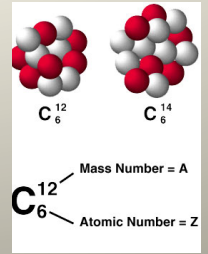


The earliest evidence of life

Altered Isotopic ratios

Seen in unique spots within rocks dating back 3.85 billion years ago.

Most isotopic ratios were set in the rock during Earth's formation, 4.5 b. y. ago



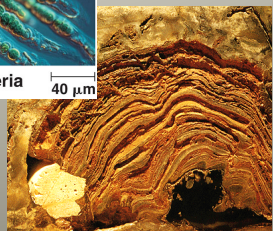
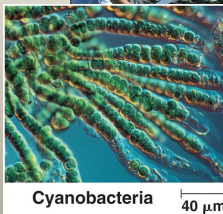
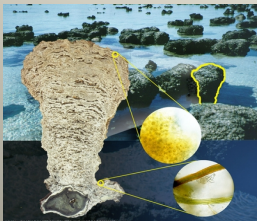
Why would altered ratios be consistent with life?

Which Carbon is 'heavier'?

What kind of altered ratios would you expect to find if life had been present in the rock? Is this proof of life this far back?

Stromatolites

Accretionary structures formed from the layering and waste of biofilms of microorganisms.

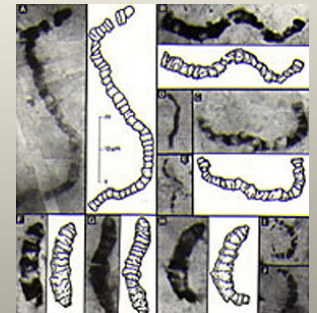
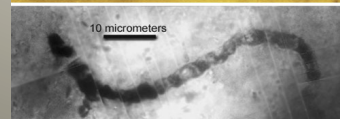
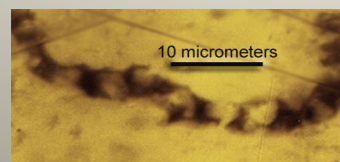


This life was photosynthetic. An algae called Cyanobacteria.

The earliest *candidate* fossils date 3.5 b. y. ago.

Ancient microfossils

Cell walls and tissue are long gone, but they show the shape and organic content consistent with life.

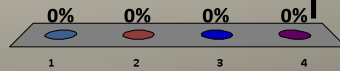


Ages?? Still controversial. But ~2-3 billion years old

J. William Schopf, UCLA (claims up to 3.46 byo, but probably wrong)

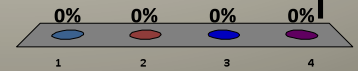
How soon after the largest (sterilizing) impacts is the earliest evidence for life?

- 1 billion years
- Few 100 million yrs
- 1 million years
- < 1 million years.



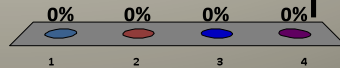
Where would the earliest life be the most safe during the early bombardment phase on Earth?

- Air
- Shallow seas
- Deep ocean
- Caves

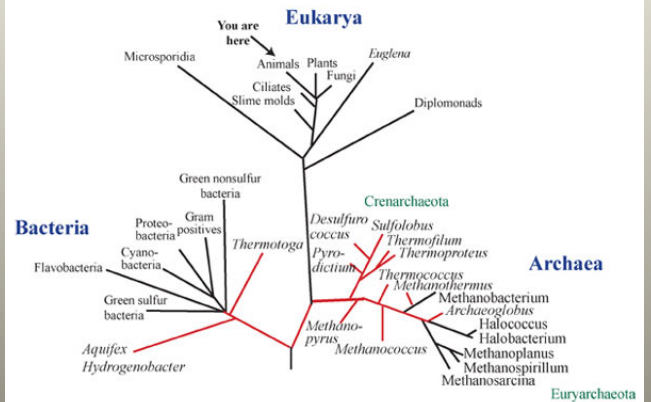


Which extremophile is genetically closest (base of life tree) to the 'universal ancestor' of all life?

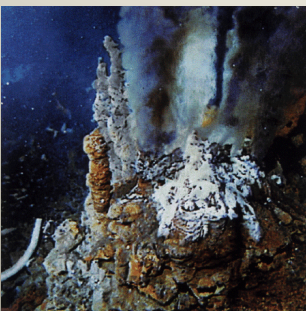
- Psychrophiles
- Thermophiles
- Endoliths
- Xerophiles



Red lines indicate heat loving organisms



Thermophiles love the Deep Sea spreading centers.

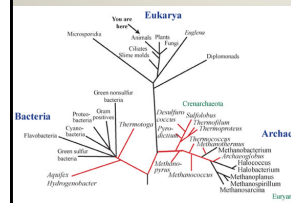


Off of the microbial life, a plethora of large, complex life can live. These tubeworms and mussels are miles below the sea.

The black smoker vents are a source of abundant chemical energy and carbon for Chemoautotrophic life

To see movies of black smokers, go here:
<http://www.youtube.com/watch?v=XRHM9HPe1BQ&feature=related>

What are the three pieces of evidence that life started near deep-sea vents?



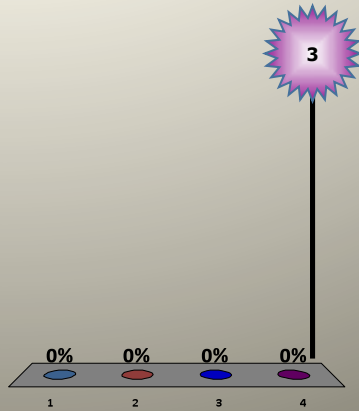
- DNA evidence (Tree of life) indicates thermophiles genetically closest to universal ancestor.
- Early impacts and UV radiation would have made everywhere but the deepest ocean floors unsafe.

3) Geothermal vents provide ample energy (through heated chemical reactions) and raw materials (dissolved in the hot water) for Chemo autotrophic life to flourish.



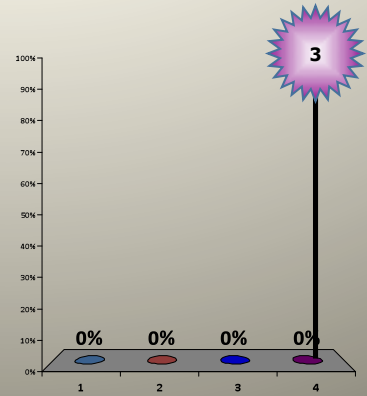
When did the first multi-celled life appear?

1. 2 Billion years ago
2. 1.2 billion years ago
3. 550 million years ago
4. 500,000 years ago



PRS: When did the Cambrian explosion occur?

1. 2 Billion year ago
2. 1.2 Billion years ago
3. 550 million years ago
4. 500,000 years ago



The Cambrian Explosion was the start of visible life

Theories to explain this phenomenon:

- Oxygen levels
- Genetic complexity
- Climate change
- Absence of predators

The rest of the development

Plants moved to land about 475 million years ago (evolved from algae).

Vast forests and insects to eat them existed 360 million years ago. But there was no fire.. Why?

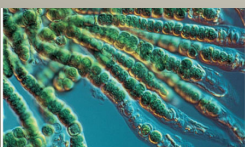
No large land animals (dinosaurs) until 250 m.y. ago (plenty of large animals in the oceans). Why the delay?

Oxygen levels in air important for all!!

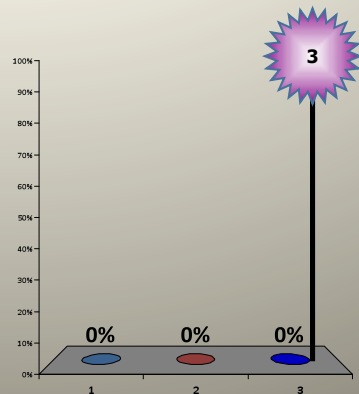
Where did our first atmospheric oxygen come from?

1. Early forests
2. Plants in the water
3. Bacteria

More specifically:

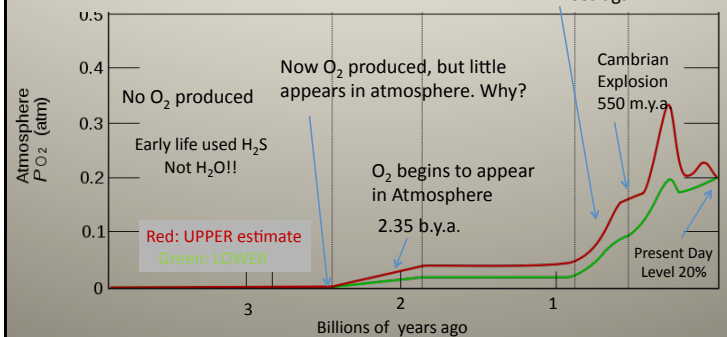
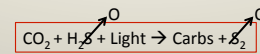


Cyanobacteria 40 μm



Stromatolites date back 3.5 b.y. Oxygen began to show up 2.35 b.y. ago.

Why so slow?



Benefits of an O₂-rich atmosphere

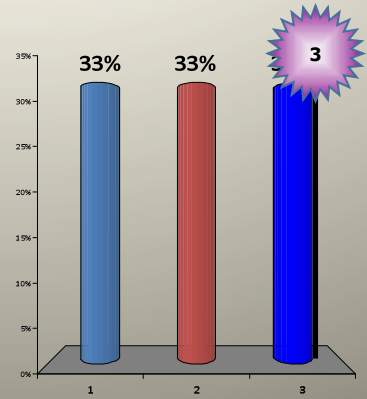
Oxidation reactions (using oxygen to break down food, releases energy. CO₂ and H₂O which are expelled) lead to very efficient cellular energy production, to support LARGE organisms



The free O₂ in the air, also lead to the formation of the OZONE LAYER (O₃). This protected life on land from harmful UV radiation.

Where did our first atmospheric oxygen originate in?

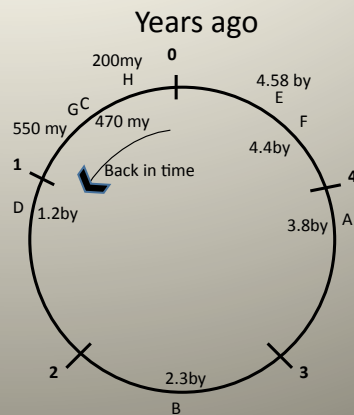
1. The air
2. The land
3. The oceans



Important events in the history of life

Draw a circle representing 5 billion years of time:

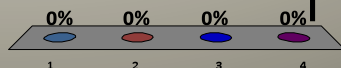
- A. Earliest *evidence* of life
- B. First oxygen in Atmosphere
- C. Plants on the Land
- D. First multi-cellular organisms
- E. Formation of Earth
- F. Oceans & atmosphere form
- G. Cambrian Explosion
- H. Modern Oxygen levels



Let's do the final quiz of today's topics

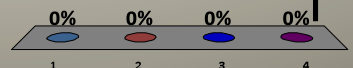
1. The earliest *evidence* of life is from _____

1. Ancient microfossils
2. Fossilized stromatolites
3. Isotopic ratios
4. Sea floor fossils



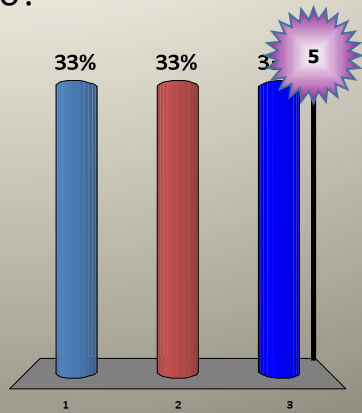
2. The black smoker vents are a source of _____ for early life

1. water
2. protection
3. Iron
4. energy



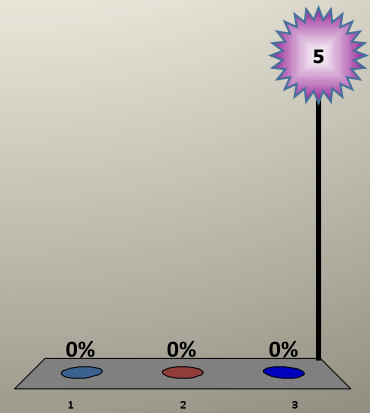
3. Why was there no fire on Earth until 200 million years ago?

1. No fuel to burn.
2. No land yet.
3. Not enough oxygen.



4. *Where* did the Cambrian explosion start?

1. Deep sea Vents
2. On the land
3. In the oceans



5. What kept oxygen levels low from 3 to 1 billion years ago on earth?

1. Life respiration
2. Absorption by the land & oceans.
3. Volcanism
4. Plate tectonics

