

Introduction to Biology. Lecture 9

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Outline

- 1 Where we are?
 - Photosynthesis
- 2 Archean eon
 - First Life
 - First fossil cells
- 3 Cell
 - Prokaryotic cell
 - How to be a prokaryote



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Where we are?

Photosynthesis



Photosynthesis

- $\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{light, chlorophyll}} \text{carbohydrates} + \text{O}_2$
- Two stages:
 - Ⓐ Light-dependent: production of energy (ATP) and photolysis of water
 - Ⓑ Light-independent: assimilation of CO_2 into carbohydrates
- Then carbohydrates are partly converting into lipids; with addition of N—into amino acids; with addition of N and P—into nucleotides



ATP

- Universal energy source in the cell, “universal currency”
- $\text{ATP} \rightarrow \text{ADP} + \text{P} + \text{energy}$



Archean eon

First Life



Oxygen and iron

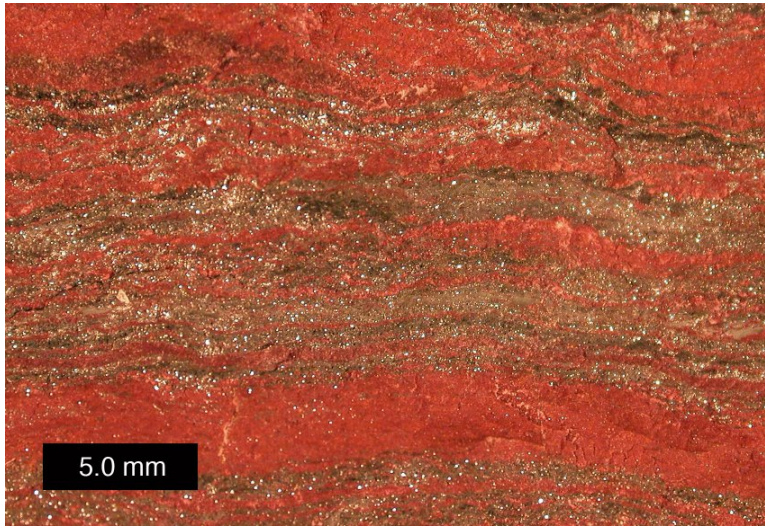
- Initially, Earth atmosphere contained no oxygen
- Photosynthetic oxygen oxidized free iron into quartzite-like rocks contained hematite and other iron minerals
- New iron was always replenished from ocean water
- However, ≈ 2000 Mya, when Proterozoic eon started, almost all iron went deeper into mantle and core



Wheeler Peak, NV



Hematite



From oxygen oases to oxygen revolution

- In Archean, photosynthesis could only produce local “oxygen oases”
- But when no free iron was available anymore, atmosphere started to accumulate oxygen
- When oxygen reached 1% (Pasteur point), *aerobic life* started
- This was the **oxygen revolution** which allowed cells to obtain energy via *respiration*



Fermentation *versus* respiration

- carbohydrates \rightarrow CO_2 + ethanol + 2 ATP
- carbohydrates + $\text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + 38$ (!!!) ATP

Which is better? Do not forget however that oxygen is highly poisonous and destructive molecule.



Archean eon

First fossil cells



First and second

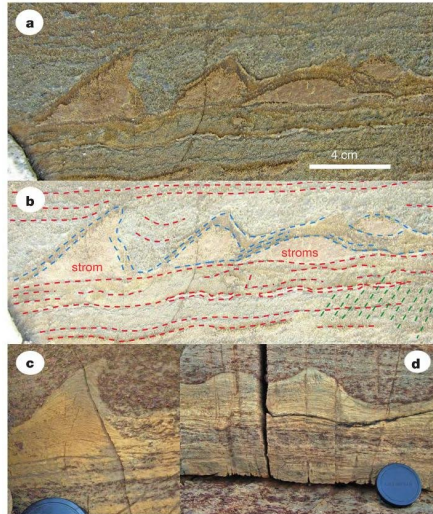
- Stromatolites: microbial mats from (mostly) cyanobacteria (photosynthetic bacteria)
- *Metallogenium* and others: proteobacteria (e.g., aerobic metal-oxidizing bacteria)



Fossil stromatolite



Oldest stromatolite: Isua, Southern Greenland



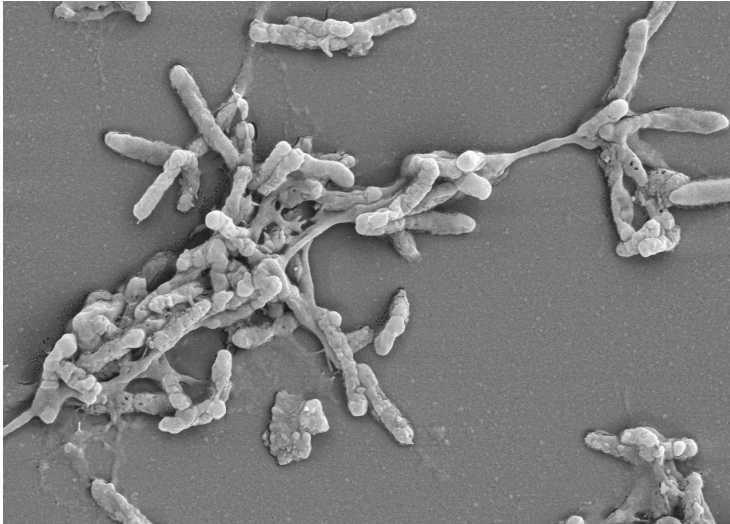
3.7 Myr!



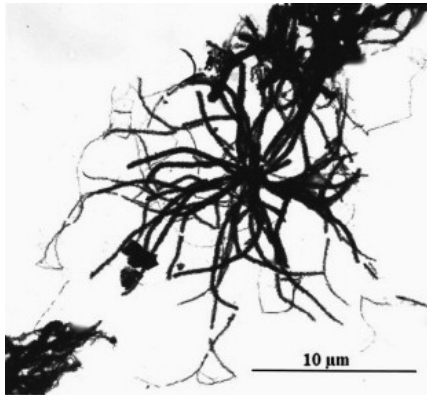
Present-day stromatolite (Shark Bay, Australia)



Present-day iron-oxidizing bacteria



Fossil *Metallogenium*



First life

- In Archaean, cyanobacteria (fossilized as stromatolites) were first
- Photosynthesis changed the atmosphere
- Aerobic life respire to obtain more ATP



Cell

Prokaryotic cell



Prokaryotic cell



Main components of prokaryotic cell

- Cell wall
- Membrane
- Cytoplasm
- DNA
- Ribosomes
- Membrane folds and pockets
- Vesicles
- Flagella



Cell

How to be a prokaryote



How to make energy

Two ways:

- Cell respiration and other destructive processes make ATP for all cell
- Photosynthesis and other synthetic processes make ATP (but later, they spend it)



How to make proteins

To build factory, we need energy (see before) and also need *machines*. These are *proteins*. To build machines from scratch, we need *instruction* books. This is *DNA*. To work with instructions, it is better to keep them in library but copy only some *pages* for immediate use. These are *RNAs*.

- DNA and RNA contain four types of nucleotides
- The sequence of nucleotides is a cypher
- Each tree nucleotides will encode amino acid (“genetic code”)
- Ribosomes translate triplets into amino acids and make proteins



Summary

- Bacteria were first
- Photosynthesis changed the atmosphere
- Aerobic life respire to obtain more ATP
- Prokaryotic cells are simplest cells



For Further Reading



Photosynthesis.

<http://en.wikipedia.org/wiki/Photosynthesis>
(introduction)



Cellular respiration.

http://en.wikipedia.org/wiki/Cellular_respiration
(introduction)

