

# Introduction to Biology. Lecture 12

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- 1 Where we are?
  - Ways of life
- 2 Basics of ecology
  - Ecological interactions
- 3 Origin of eukaryotes
  - Microbial mats
  - First eukaryotes = first predators
- 4 Eukaryotic cell
  - Organelles and their functions



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# Where we are? Ways of life



# Ways of life

- How to obtain energy?
  - A From sun light: **phototrophy**
  - B From chemical reactions with inorganic matter (“rocks”): **lithotrophy**
  - C From breaking organic molecules into inorganic (typically, carbon dioxide and water): **organotrophy**
- How to obtain building blocks?
  - A From assimilation of carbon dioxide: **autotrophy**
  - B From other living beings: **heterotrophy**



# Basics of ecology

## Ecological interactions





# Two-species model

- Species I and species II may influence each other differently
- For example, species I may facilitate the increase the number of species II individuals (+ interaction)
- At the same time, species II could be neutral to species I (0 interaction)



# Six basic ecological interactions

|   | +         | 0                         | -                         |
|---|-----------|---------------------------|---------------------------|
| + | mutualism | commensalism <sup>1</sup> | exploitation <sup>2</sup> |
| 0 | ...       | neutralism                | amensalism                |
| - | ...       | ...                       | interference <sup>3</sup> |

<sup>1</sup> Includes phoresy (transportation), inquilinism (housing) and “sponging”

<sup>2</sup> Includes predation, parasitism and phytophagy

<sup>3</sup> Includes competition, allelopathy and aggression



# Origin of eukaryotes

## Microbial mats

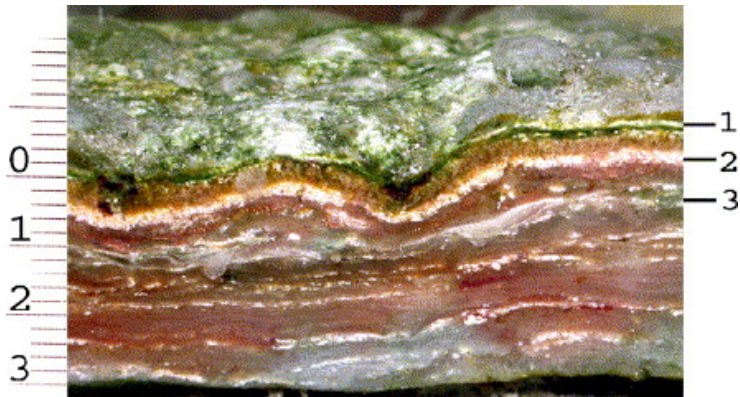


# Microbial mats complexity

- Mats were not only cyanobacteria (aerobic photosynthetic autotrophs), but also
- anaerobic photosynthetic bacteria and
- heterotrophic and chemotrophic bacteria
- All these bacteria form the first **ecosystem**



# Layers in microbial mat



# Origin of eukaryotes

First eukaryotes = first predators



# *Bdellovibrio*

- Bacteria are small and rigid, there is only one example of bacteria which can “eat” others
- However, this *Bdellovibrio* will only eat in the space between membrane and cell wall



# *Bdellovibrio* invading the prey





# Antibiotics

- The other problem was chemicals which bacteria are using to win a competition: antibiotics
- Most of antibiotics change the process of protein synthesis or cell wall construction



# Proterozoic challenge

- Archean ecosystems were based on “clone wars” using antibiotics, horizontal transfer of genes and splitting jobs. However, they were incomplete: no predators.
- To predate, one need to *make large cell and invent the phagocytosis* (cellular “swallowing”)
- To escape from antibiotics, one need a different chemical machines for protein biosynthesis

However,

- Large and complicated cell needs more DNA—but how to divide it equally?
- Horizontal transfer will hinder evolution towards something unusual—but how to stop it?
- Large and complicated cells need much more ATP—how to make it?



# Two most essential problems

- How to escape from antibiotics?
- How to predate?

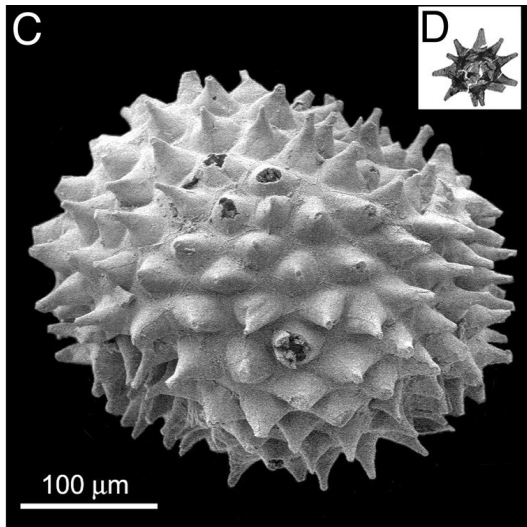
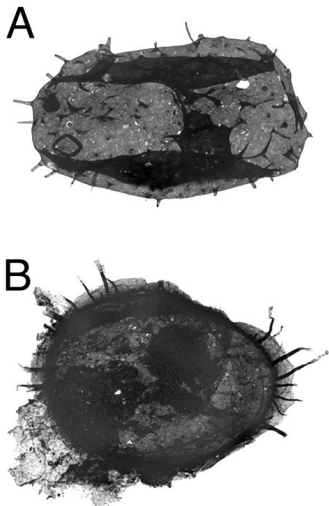


# Eukaryotic cell as a response to Proterozoic challenge

- Predators
- New pathways of protein synthesis
- Cytoskeleton allows for cytoplasm motility
- Nucleus for DNA security and distribution
- Mitochondria make ATP



# Acritarchs in Proterozoic (1,900 Mya)



# Eukaryotic cell

## Organelles and their functions



# *Eukaryotic cell*



# Membrane and cytoplasm

- Cytoplasm is constantly flowing
- Membranes are used for construction of multiple internal organelles





# Summary

- All life styles were exist before eukaryotic origin
- The only interaction absent in prokaryotic communities was predation
- Microbial mats were first ecosystems
- To predate, bacteria must develop the enhanced cell
- Eukaryotic cell is a “second-level”, enhanced cell



# For Further Reading



[Ecological interactions.](#)

[http://en.wikipedia.org/wiki/Biological\\_interaction](http://en.wikipedia.org/wiki/Biological_interaction)



[Eukaryote.](#)

<http://en.wikipedia.org/wiki/Eukaryote>

