

# Introduction to Biology. Lecture 10

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# Outline

- 1 Where we are?
  - How to be a cell
- 2 Origin of eukaryotes
  - Microbial mats
  - First eukaryotes: the real predators
  - Eukaryotic cell

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# Where we are?

## How to be a cell

# Main duties

- Making energy
- Making proteins
- Digesting food
- Constructing body
- Multiplying
- Making sex

# How to make proteins I

- Proteins are chemical machines of cell
- Each machine is described in gene
- The only way to make them is DNA  $\rightarrow$  RNA  $\rightarrow$  proteins
- DNA is a folded double spiral; it has two chains
- Every chain consists of four “letters”—nucleotides (A, T, G, C)
- Two chains are complimentary, and only A–T and G–C pairs are possible

## How to make proteins II

- DNA may duplicate, then new DNAs will build complimentary chains and become exact copies
- DNA may also “produce” RNA: one of chains serves as matrix for new RNA
- RNA also has four letters (A, U, G, C)
- When RNA is building on DNA, RNA’s “U” will be complimentary with DNA’s “A”; all other rules are the same

# How to make proteins III

- New RNA is a matrix RNA (mRNA)
- It will come into ribosome, and ribosome will translate every three letters (triplet) into amino acid
- mRNA moves within ribosome, and new amino acids are joining into growing protein
- Translation rules are known as “genetic code”
- There are 64 possible triplets and only 20 amino acids—genetic code is redundant





# Translation rules: “genetic code”

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } UCC } Ser UCA } UCG }	UAU } Tyr UAC } UAA Stop UAG Stop	UGU } Cys UGC } UGA Stop UGG Trp	U C A G
	C	CUU } CUC } Leu CUA } CUG }	CCU } CCC } Pro CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } Arg CGA } CGG }	U C A G
	A	AUU } AUC } Ile AUA } AUG Met	ACU } ACC } Thr ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } Val GUA } GUG }	GCU } GCC } Ala GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } Gly GGA } GGG }	U C A G

# How to make sex

- If DNA will stay unchanged, cells cannot evolve
- To make evolution possible, there are processes which modify DNA:
  - Mutations
  - Recombinations
- Sexual process allows DNA recombination
- Prokaryotic cells simply connect and exchange pieces of DNA (“bacterial conjugation”)

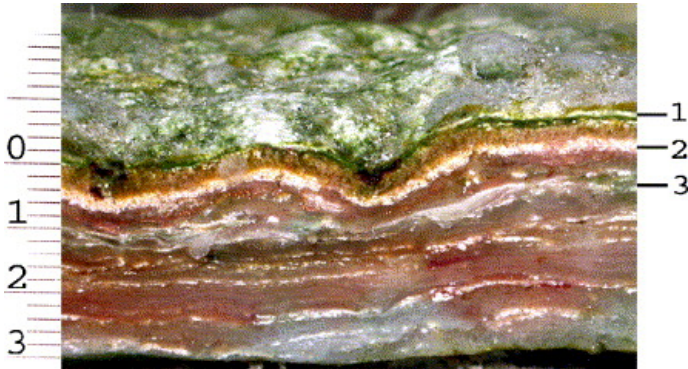
# Origin of eukaryotes

## 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: the real 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





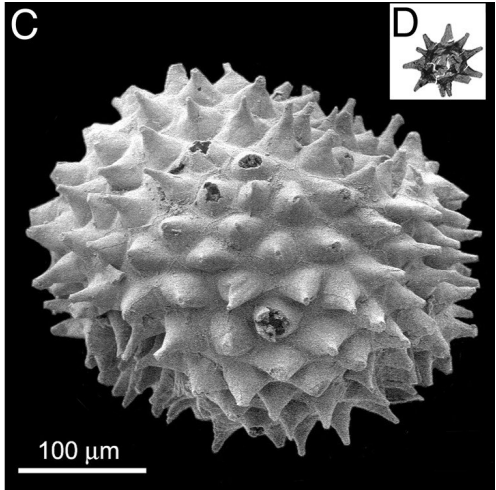
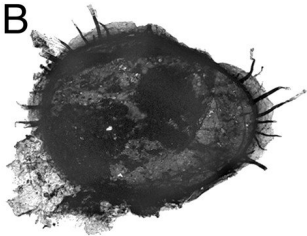
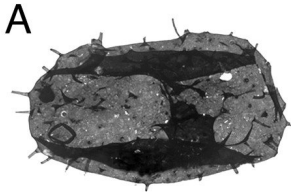
# Antibiotics

- 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

- To predate, we need to make large cell
- and invent the phagocytosis
- To escape from antibiotics, we need a different chemical machines in protein biosynthesis
- Large and complicated cell needs more DNA—but how to isolate and then to divide it?
- Large and complicated cell needs more ATP—how to make it?

# Acritarchs in Proterozoic (1,900 Mya)



# Origin of eukaryotes

## Eukaryotic cell

# Eukaryotic cell is a response to Proterozoic challenge

- Microtubules made from actin and other cytoskeleton proteins
- Cytoplasm motility based on cytoskeleton
- Specific protein synthesis pathways
- Nucleus for interphase and chromosomes for mitosis
- Mitochondria for ATP

## *Eukaryotic cell*

# Summary

- Sexual process is the requirement for evolution
- Microbial mats were first ecosystems
- To predate, bacteria must develop the enhanced cell

## For Further Reading



### Bacterial conjugation.

[http://en.wikipedia.org/wiki/Bacterial\\_conjugation](http://en.wikipedia.org/wiki/Bacterial_conjugation)



### Eukaryote.

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