

Introduction to Biology. Lecture 10

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September 24, 2014



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



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



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

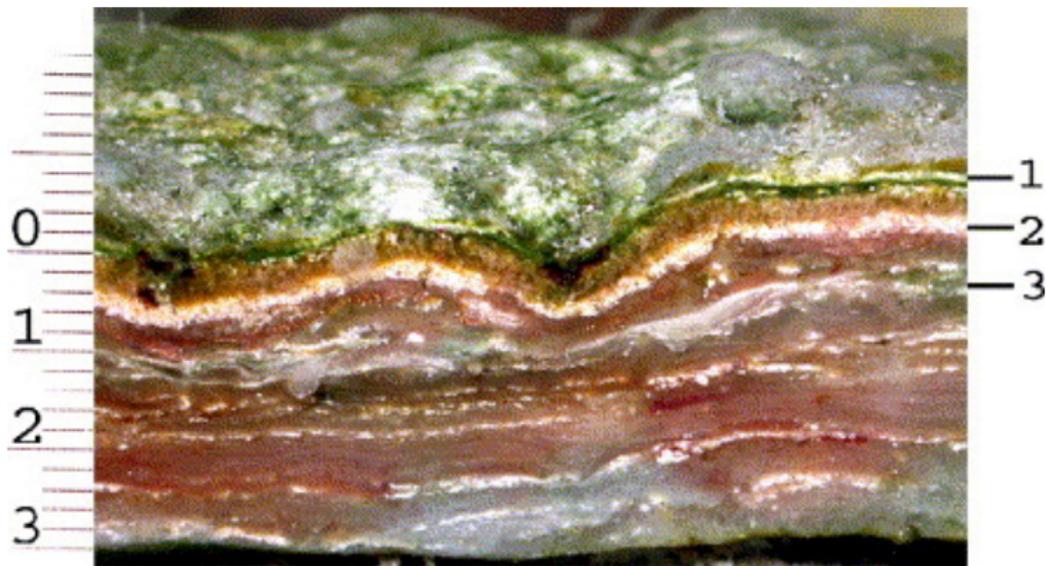


Microbial mats complexity

- 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: 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?



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`

