



# **TEORIJE BIOGENEZE II**

**19. 10. 2012.**

**Astrobiologija  
2012**

# **3 MISTERIJE BIOGENEZE**

## **1. Kako?**

- Kombinatorika sastavljanja makromolekula

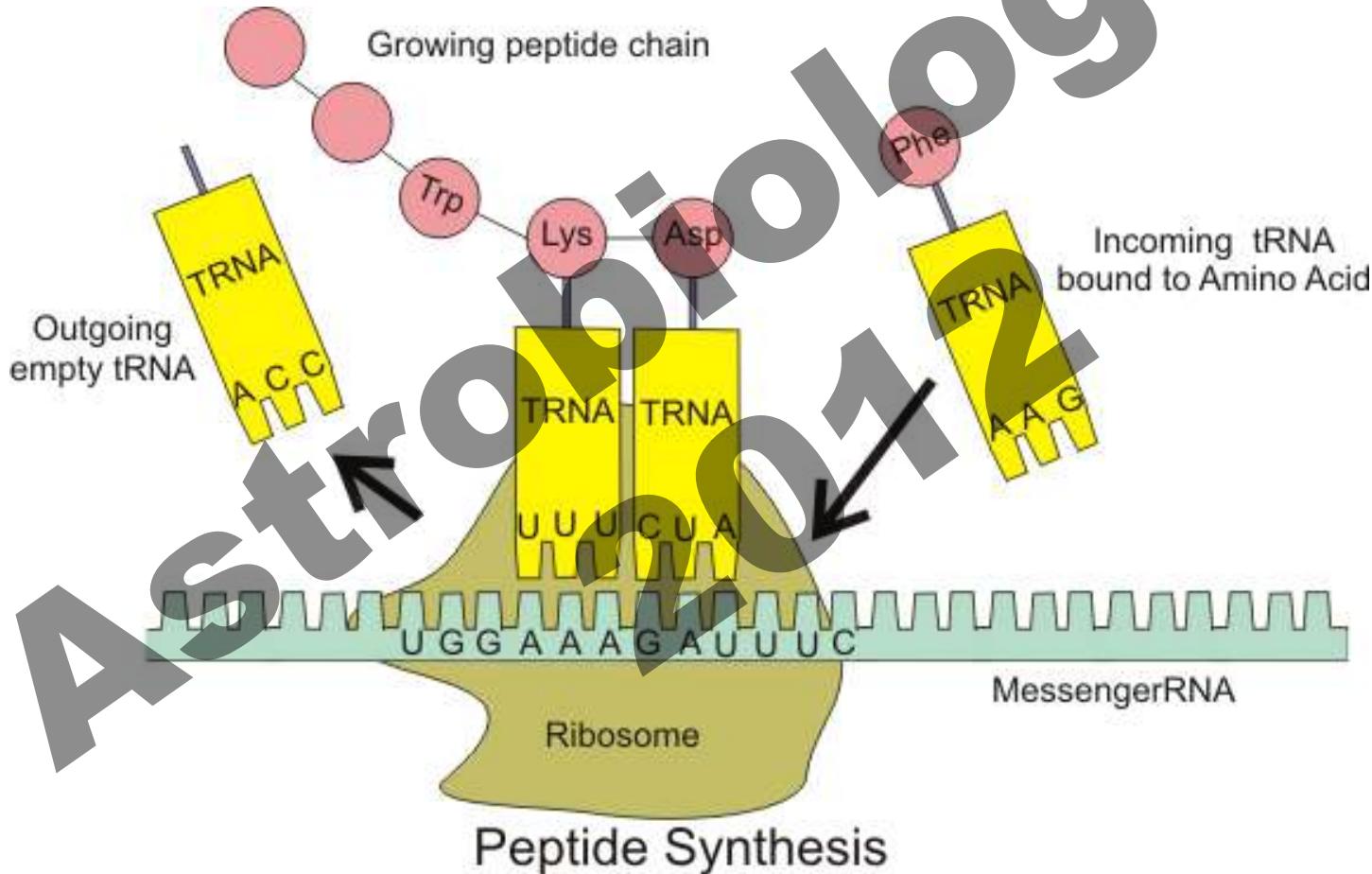
## **2. Gde?**

- „warm little pond“ (Darwin → Oparin + Holdejn)
- duboki hidroermalni izvori (npr. Wächtershäuser)
- drugde u svemiru (npr. Hojl – samo gde drugde?)
- radioaktivne plaže (! – Z. Adam, 2007)

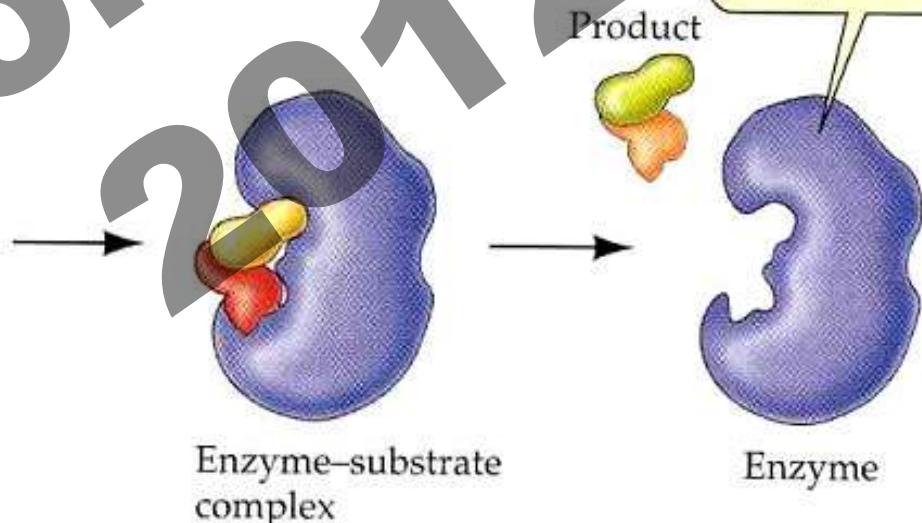
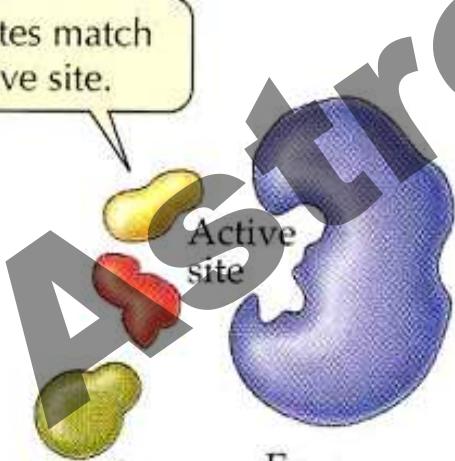
## **3. Metabolizam ili nasleđivanje prvo?**

- metabolizam! (Oparin-Holdejn, Fox)
- nasleđivanje! (npr. Leslie Orgel)
- dilema je lažna (RNK-svet, npr. Cech, Szostak)

# NAJVAŽNIJI PROCES U ŽIVOTU...



# KLJUČNA ULOGA ENZIMA



At adequate substrate level, the maximum reaction rate is determined by enzyme saturation

Reaction rate with enzyme catalysis

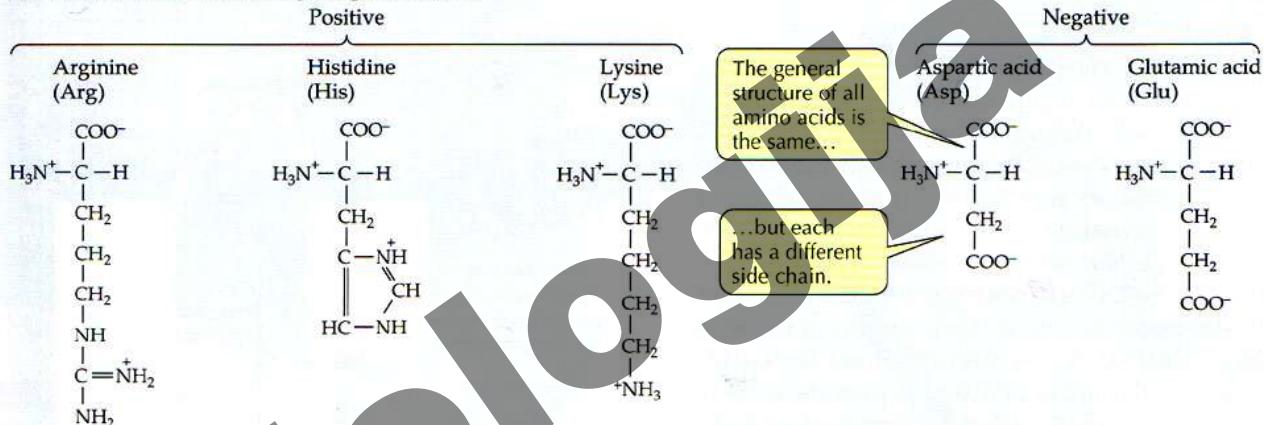
Reaction rate without enzyme catalysis

Substrate concentration

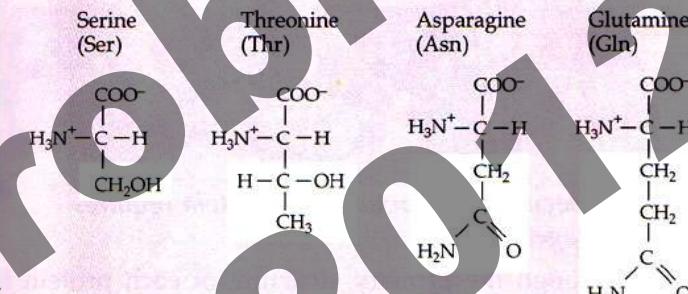
The breakdown of the enzyme–substrate complex yields the product. The enzyme is now available to catalyze another reaction.

TABLE 3.1 Twenty amino acids found in proteins

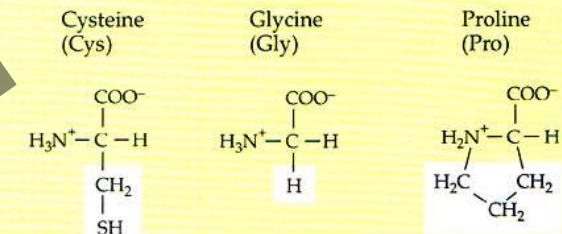
A. Amino acids with electrically charged side chains



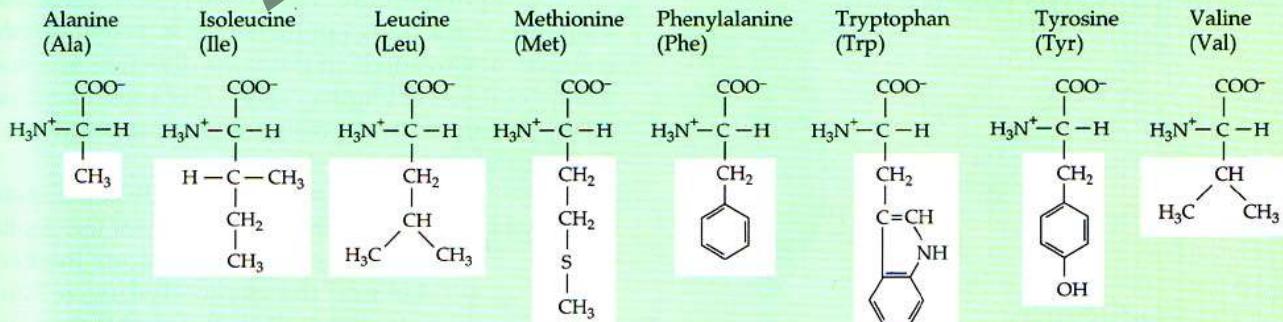
B. Amino acids with polar but uncharged side chains



C. Special cases



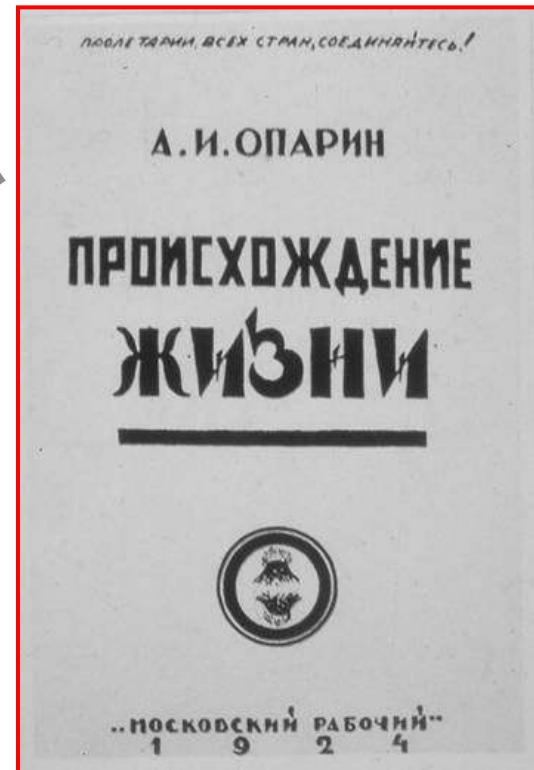
D. Amino acids with hydrophobic side chains



- 4 slova genetskog coda (A, G, C, T), u rečima dužine 3...
- G. Gamow: kodoni označavaju različite aminokiseline

# OPARIN-HOLDEJN, NASTAVAK

- Sidney Fox (1912-1998), nastavljač Miller-Urey eksperimenata
- Fox-Harada eksperiment (1964): proizvodnja amino-kiselina interakcijom primordijalne atmosfere sa vulkanskom lavom i silikonskim gelovima
- **Termalna kopolimerizacija** (zahтева 140-180°C)
- Sklapanje **protenoida** (mol. težine par hiljada)
- Protenoidi se mogu navesti da se spakuju u **mikrosfere**
- Fox: mikrosfere su preteče ćelija!



# PAR NOVIJIH ELABORACIJA

- Uloga mehurića u primordijalnoj supi
- Autokataliza!
- Plovućac i „splavovi“
- Uloga radioaktivnosti?
- Uloga kosmičkih zraka?



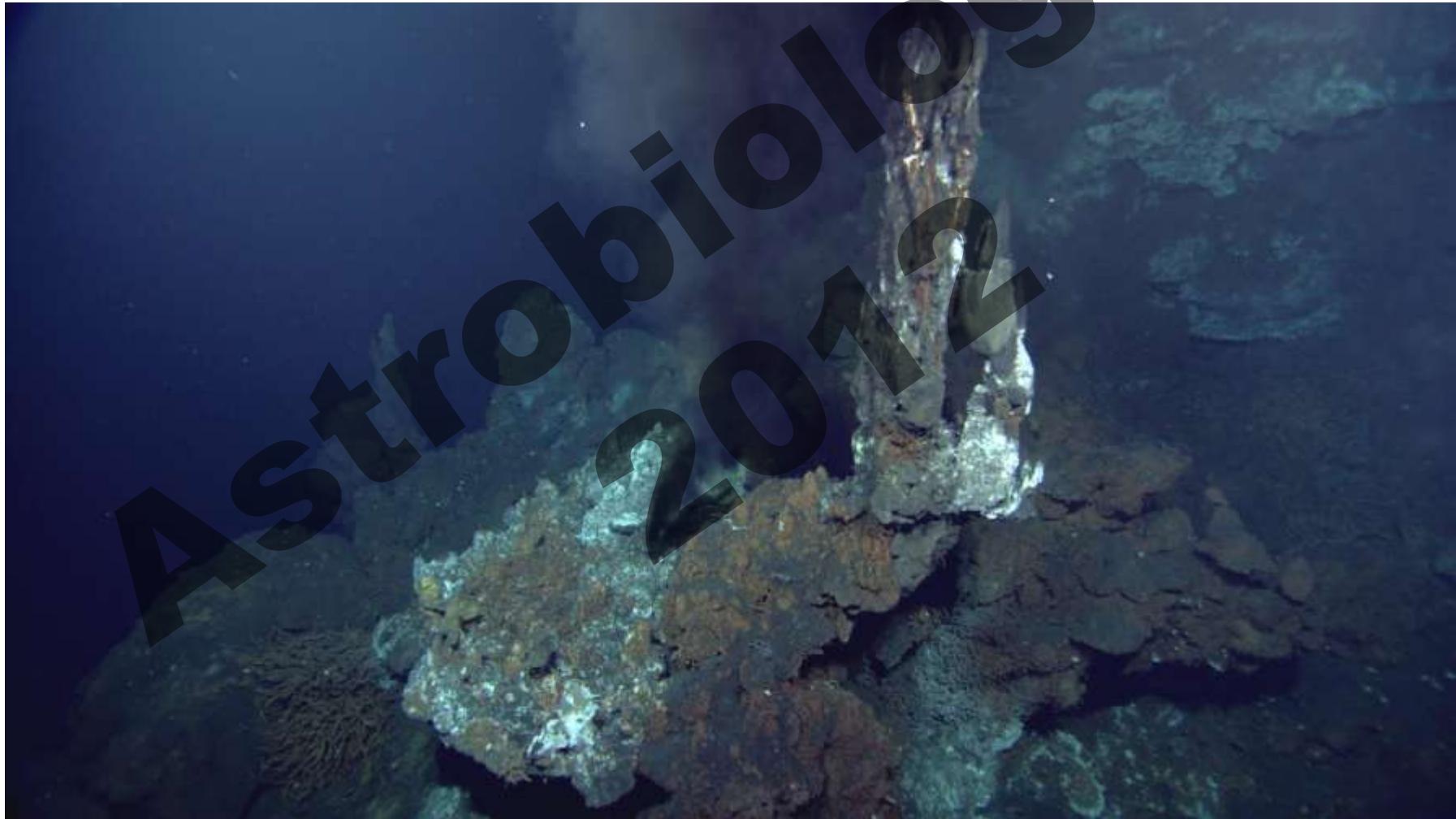
# WÄCHTERSHÄUSEROVA ALTERNATIVA

- Günter Wächtershäuser (1990): hemosinteza na visokoj T i visokom P
- Hidroermalni izvori na rubovima ploča
- $\text{FeS} + \text{H}_2\text{S} \rightarrow \text{FeS}_2 + 2\text{H}^+ + 2\text{e}^-$
- „gvozdeno-sumporni svet“
- $\Rightarrow$  prvi oblici života bili su **ekstremofili**
- Eksperimenti za sad postigli samo dipeptide i tripeptide

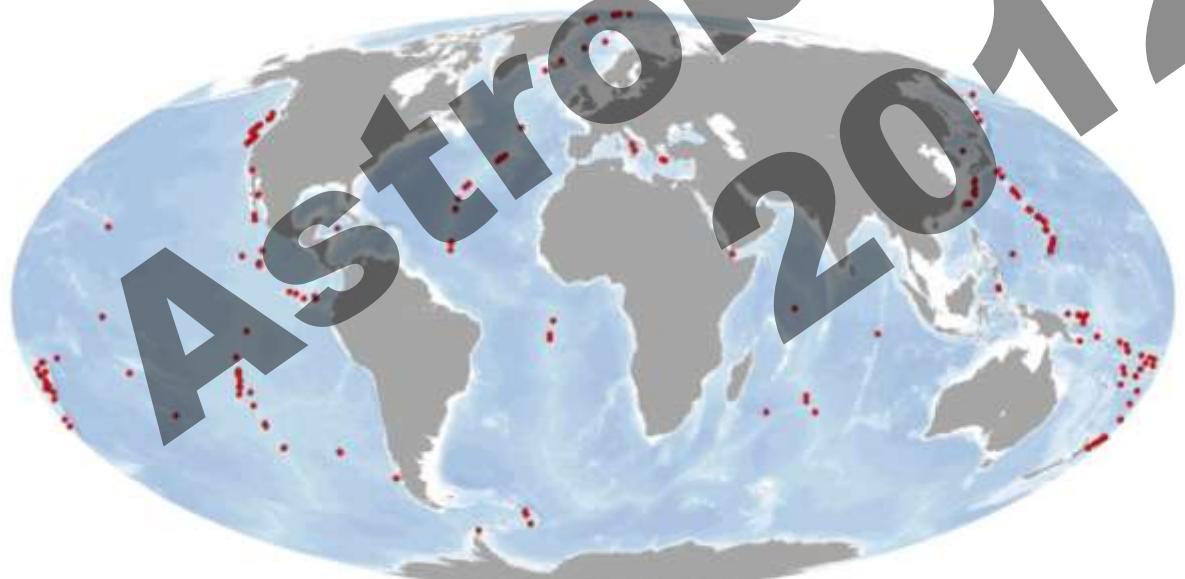
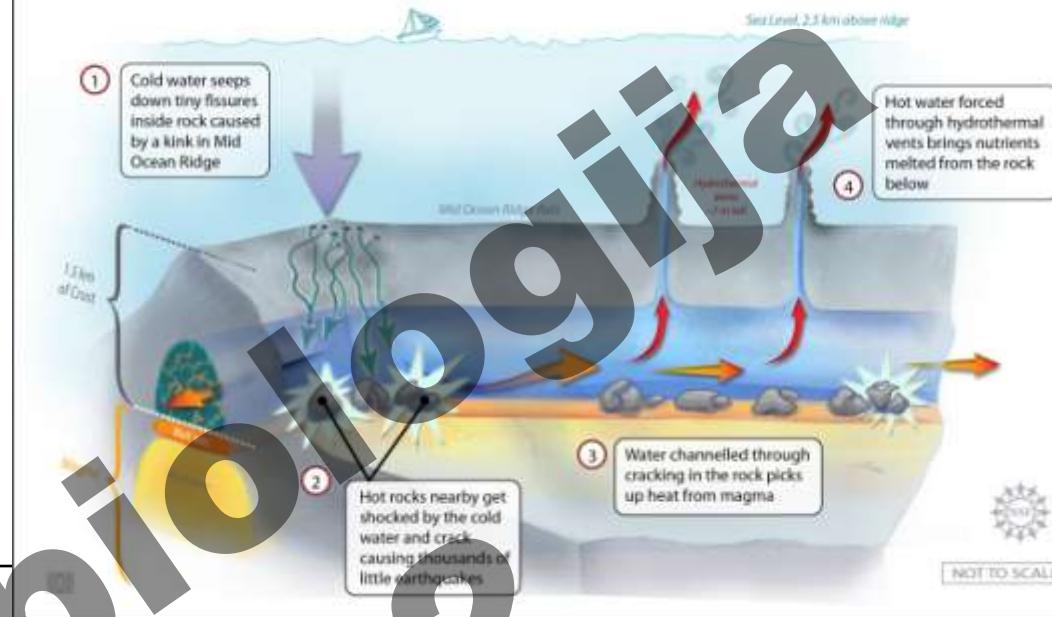


# **“CRNI PUŠAČI” (*BLACK SMOKERS*)**

**Astrobiologija  
2012**



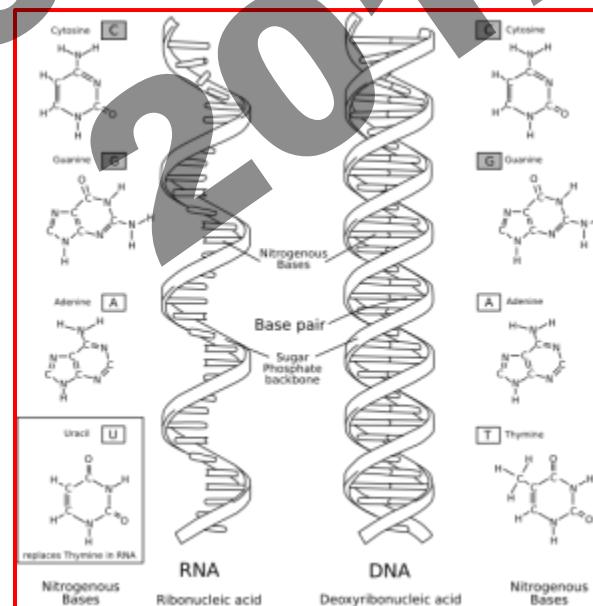
## NEW MODEL FOR WATER DYNAMICS OF DEEP-SEA HYDROTHERMAL VENTS



Astrobiology 2012

# RNK-SVET

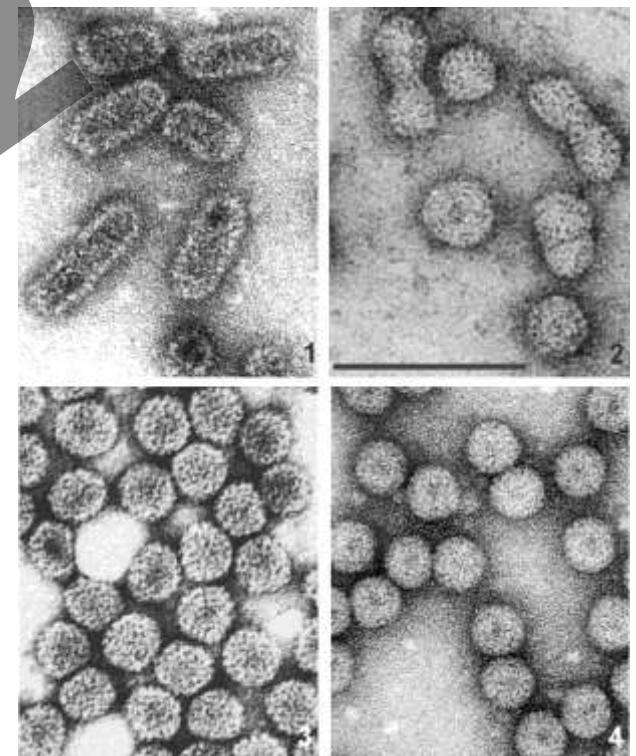
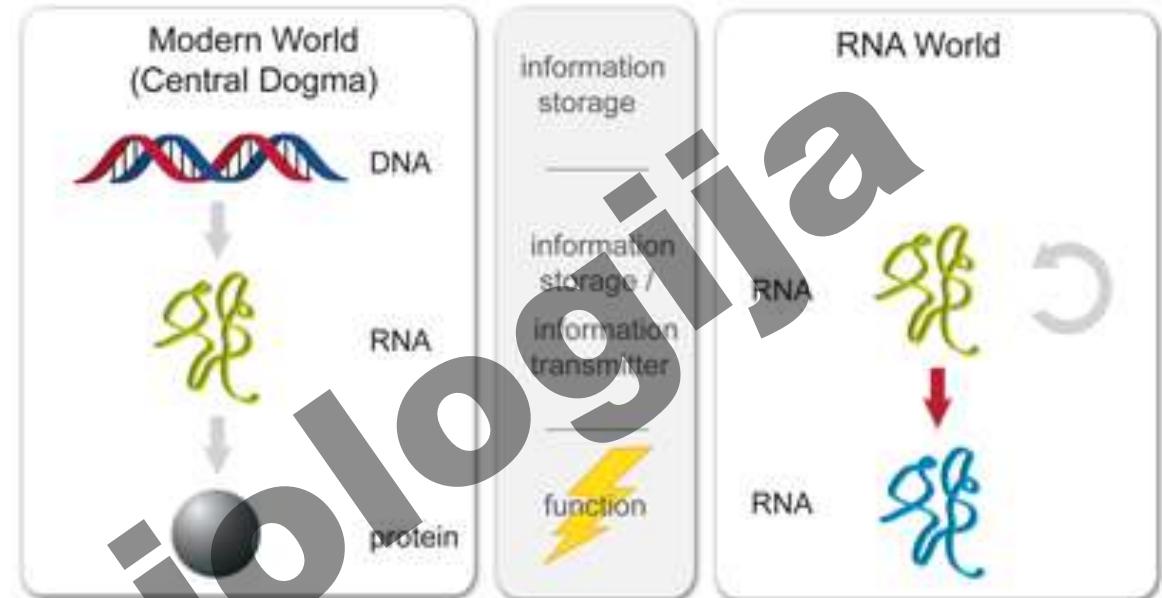
- Prve ideje: Frencis Krik, Lesli Orgel (1968)
- Tomas Čeh (1982): RNK kao **katalizator** (ribozim)
- Dvostruka funkcija RNK!
- Prevazilazi dilemu metabolizam ili nasleđe
- rRNK – ključna katalitička mesta na ribozomima
- → “živi fosil“ RNK-sveta!



(*Life as we know it*)



- **Sličnost RNK-sveta današnjim svetom virusa!**
- Zbog krhkosti RNK koda, genom je morao biti mali...
- Horizontalni transfer gena
- 2011: 'RNAlzyme' sa 93 baze („slova“)
- 2012: *IRAS 16293-2422* – glikolaldehid (ključni sastojak RNK)



# (HIPER)CIKLIČNO POBOLJŠAVANJE (EIGEN 1971-1977)

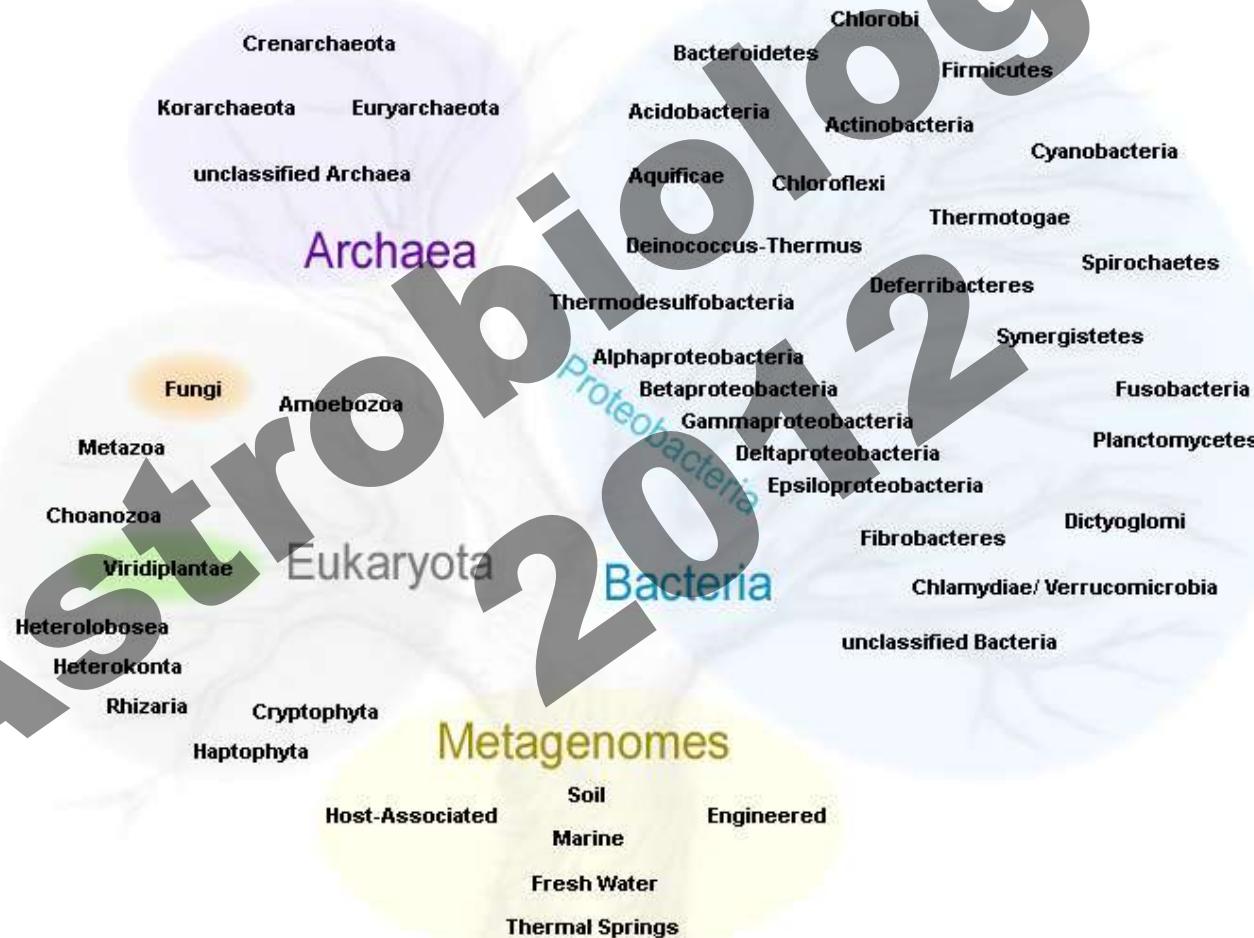
Eigenov  
ciklus



# ŠTA JE SVE NASTALO BIOGENEZOM I EVOLUCIJOM?

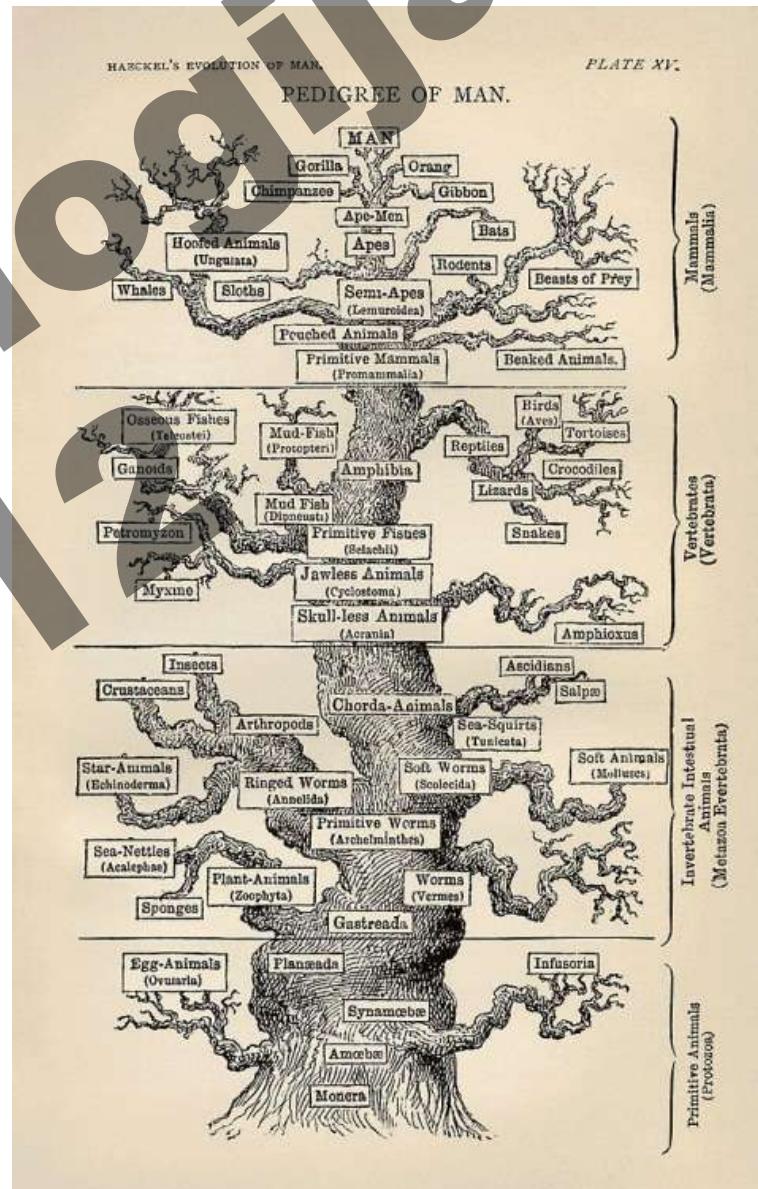
The diagram illustrates the phylogenetic tree of life, showing the relationships between Archaea, Bacteria, and Eukaryota. The tree is rooted at the bottom and branches upwards. Major groups are labeled on the left and right sides.

- Archaea:** Crenarchaeota, Korarchaeota, Euryarchaeota, unclassified Archaea.
- Bacteria:** Chlorobi, Bacteroidetes, Firmicutes, Acidobacteria, Actinobacteria, Cyanobacteria, Chloroflexi, Deinococcus-Thermus, Thermodesulfobacteria, Thermotogae, Spirochaetes, Deferrribacteres, Synergistetes, Fusobacteria, Planctomycetes, Dictyoglomi, Chlamydiae/ Verrucomicrobia, Epsilonproteobacteria, Deltaproteobacteria, Gammaproteobacteria, Betaproteobacteria, Alphaproteobacteria, Proteobacteria, Fibrobacteres, Heterolobosea, Viridiplantae, Choanozoa, Metazoa, Amoebozoa, Fungi.
- Eukaryota:** Unlabeled branch leading to Viridiplantae, Choanozoa, Metazoa, Amoebozoa, and Fungi.

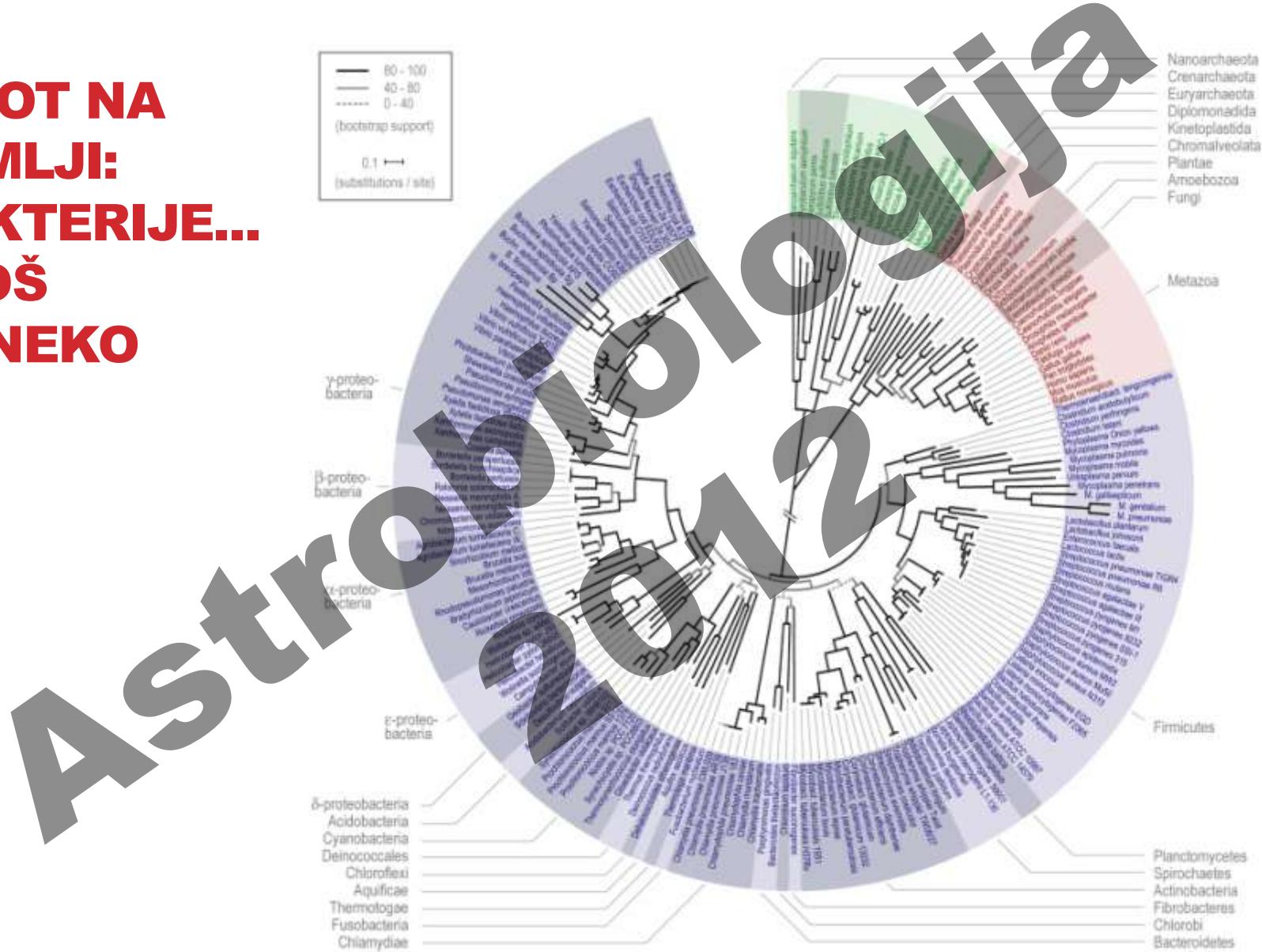


# NEKADA (I NAŽALOST JOŠ PONEGDE)...

- Antropocentrično (i pogrešno) drvo života
- Potpuno kriva slika strukture zemaljske biosfere
- Nema inherentnog „napretka“ u evoluciji...
- Istorija fanerozoika pokazuje, naprotiv, **stop & go** režim („punktuirana ravnoteža“)
- **Stazis**
- Nepotpunost fosilnog zapisa

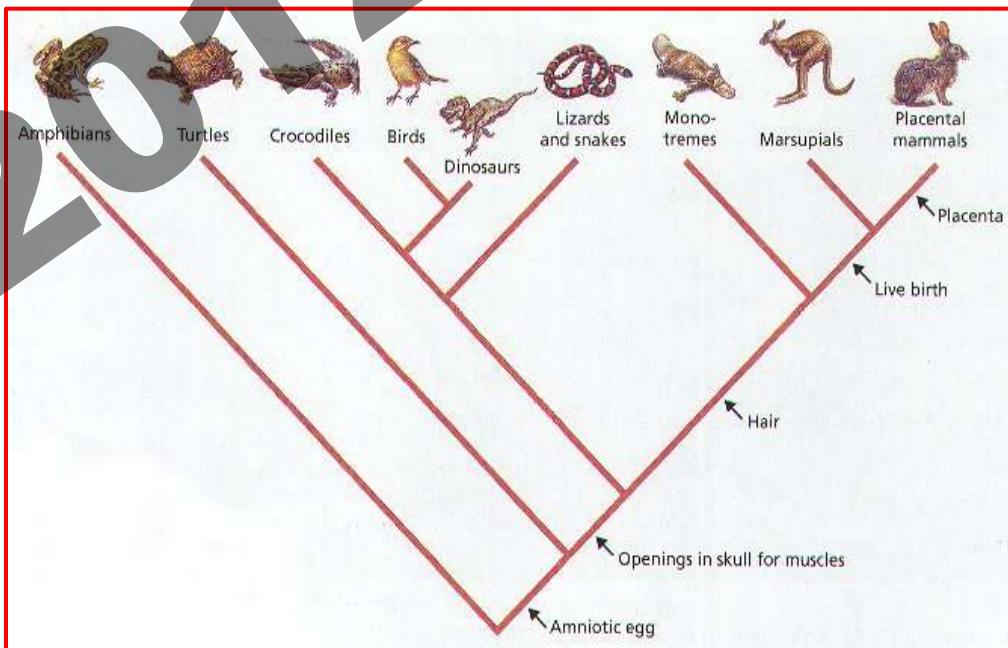
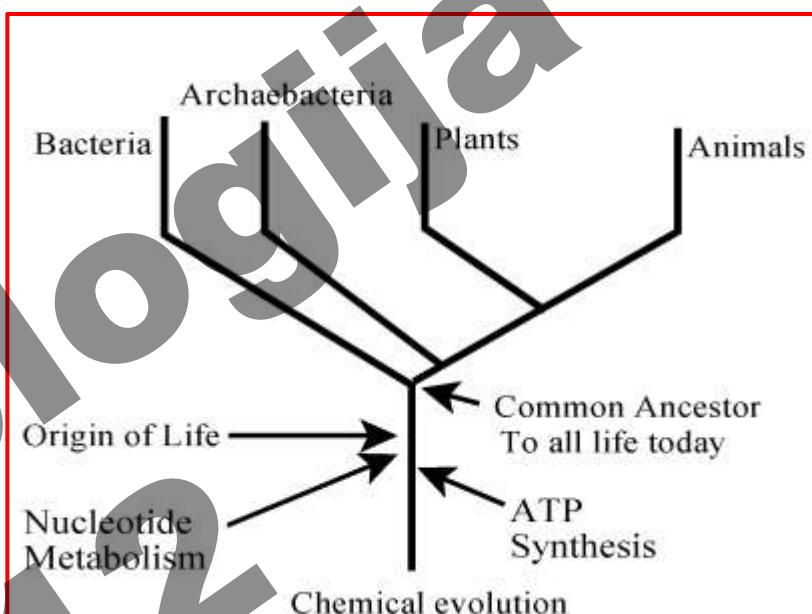


# ŽIVOT NA ZEMLJI: BAKTERIJE... I JOŠ PONEKO



# APPENDIX 1: KLADISTIKA

- Novi sistem filogenetske klasifikacije koji koristi **zajedničke izvedene karaktere** da ustanovi evolucionarne veze
- Kladogram**
- Prepostavke:**
  - Organizmi u grupi potiču od zajedničkog pretka
  - Račvanja: kladogeneza
  - Promene u karakterima dešavaju se u lozama tokom vremena.



# APPENDIX 2: ENDOSIMBIOZA

- Kako je nastala kompleksna struktura eukariotske ćelije?
- Константин Сергеевич Мережковский (1905): hloroplasti liče na cijanobakterije!
- Moderna verzija:  
Lin Margulis (1966)

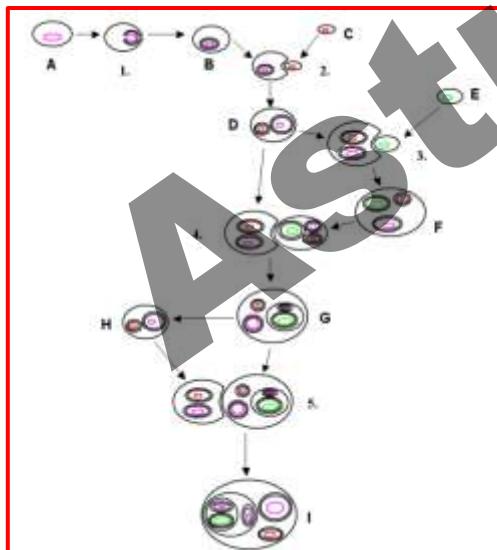
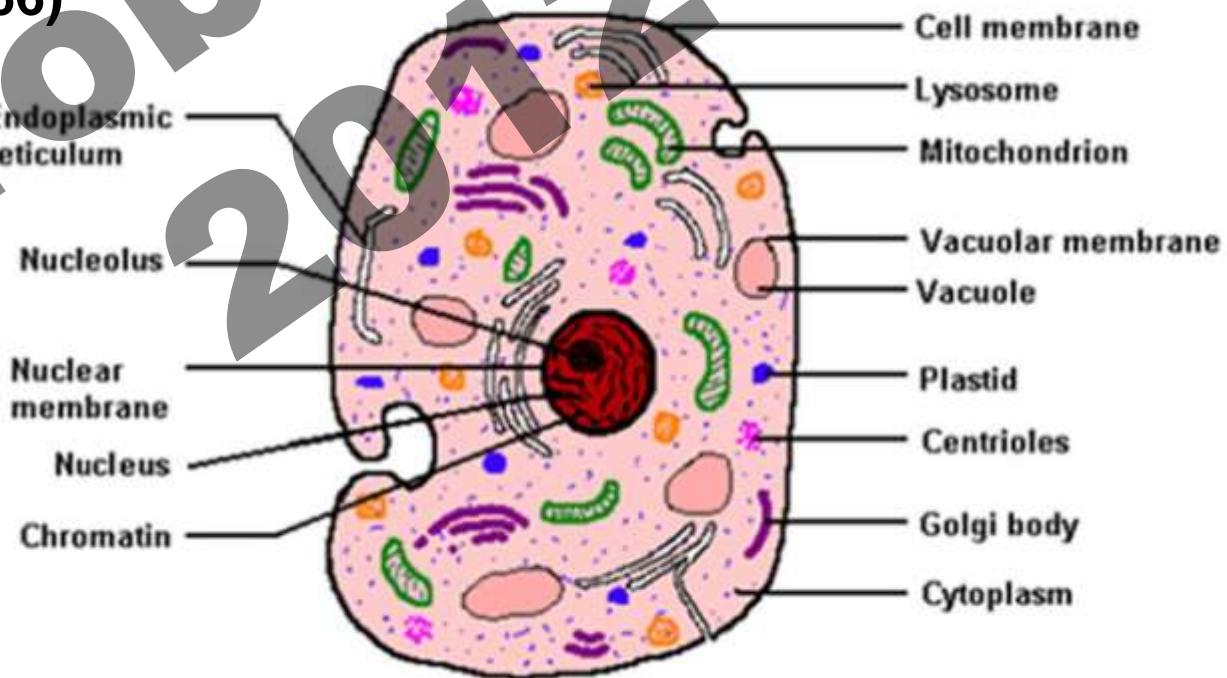
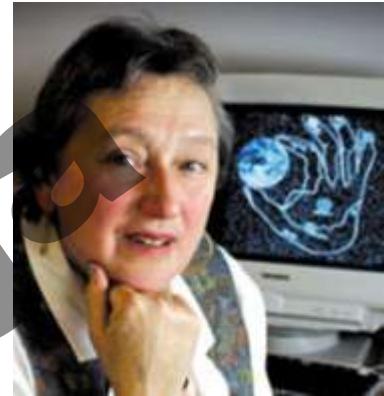
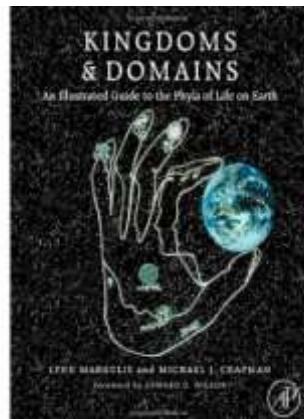


Diagram of Cell

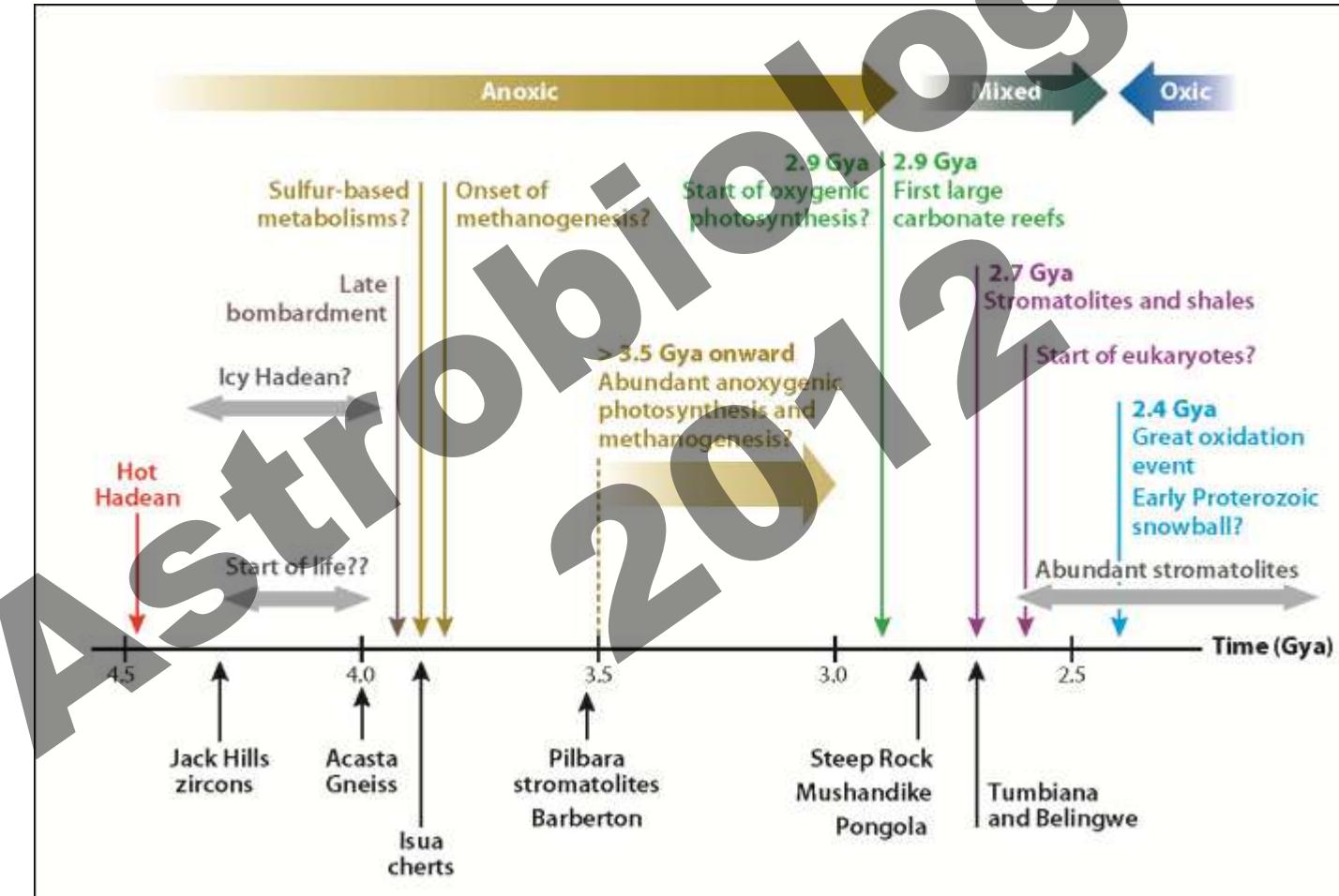


# LIN MARGULIS – HEROINA SAVREMENE BIOLOGIJE

- Lynn Margulis (1938-2011)
- Wunderkind sa čikaškog South Side-a
- Rad sa endosimbiotskom teorijom odbijan... 15 puta (!!!)
- 1980-tih otkrivena razlika nuklearne/mitohondrijalne DNK
- Gaja hipoteza
- Kontroverze...



# A SLEDEĆI PUT...



2006.09.09 09:19:08 UTC  
Real time

Earth  
Distance: 19,703 km  
Radius: 6,378.1 km  
Apparent diameter: 28° 18' 37.8"

...BIĆE PROHLADNO

Astrobiologija  
2012

