

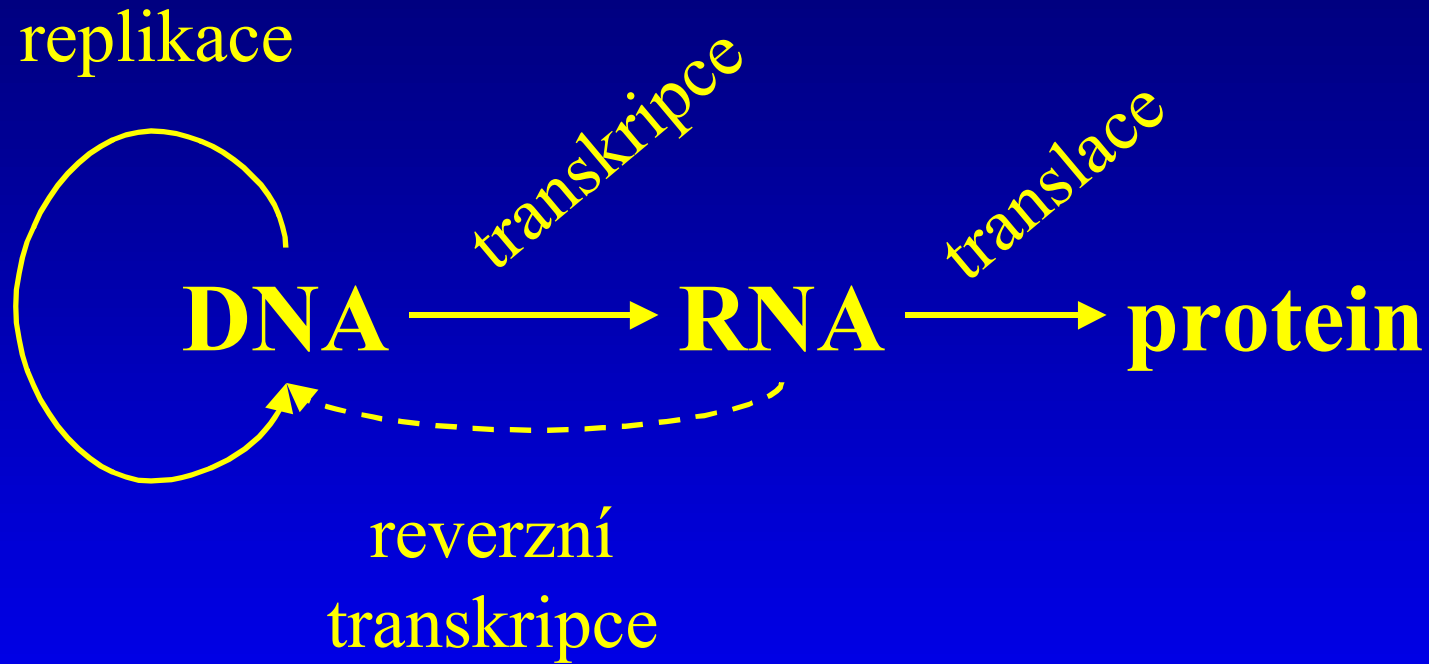
O původu života na Zemi

Václav Pačes

Ústav molekulární genetiky

Akademie věd ČR

centrální dogma



informace —————→ **funkce**

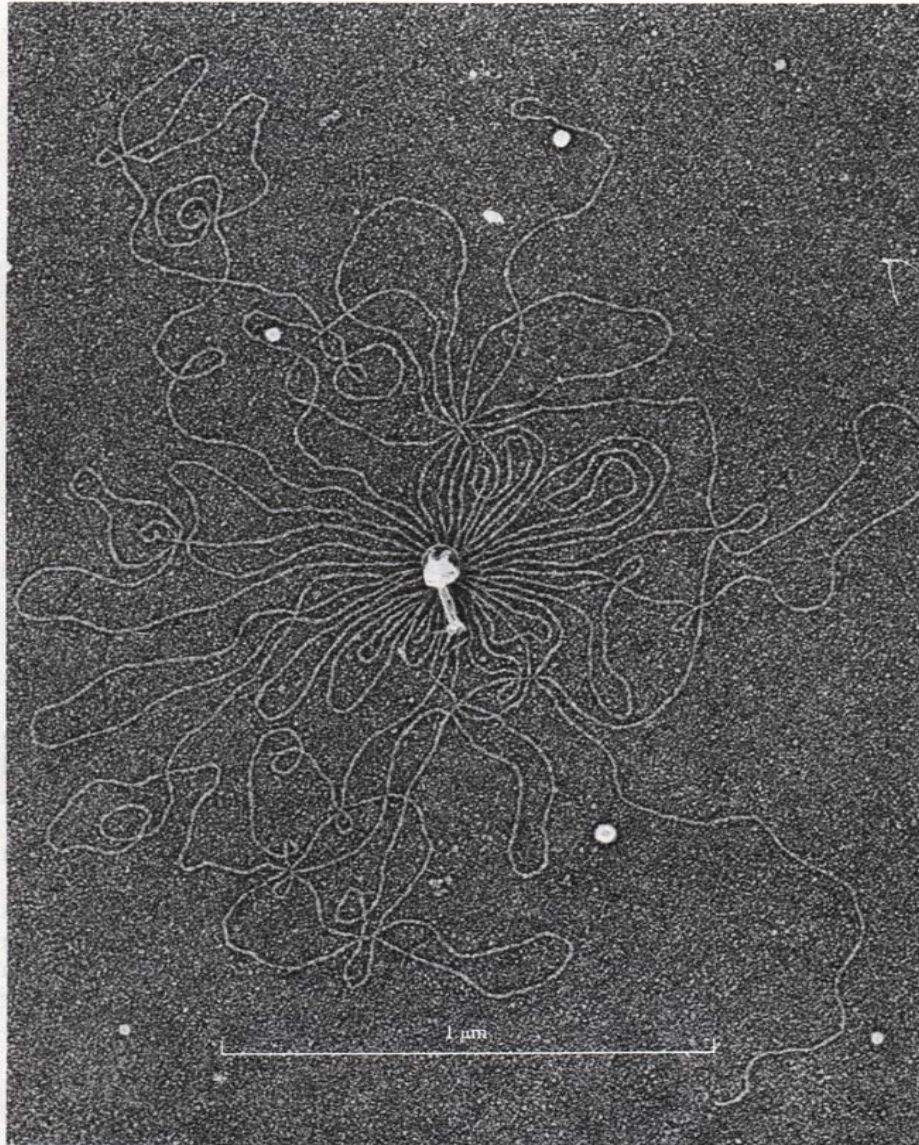
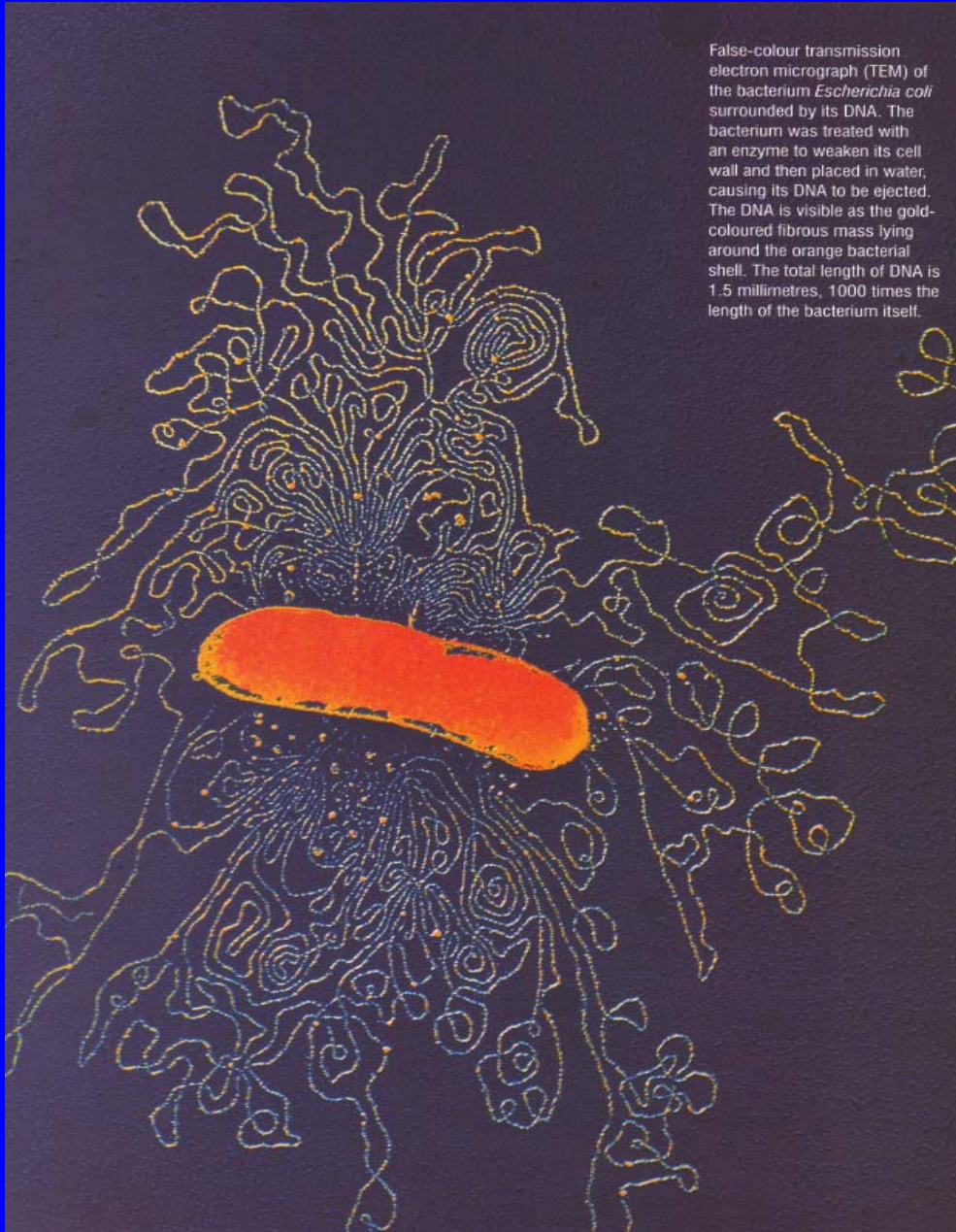


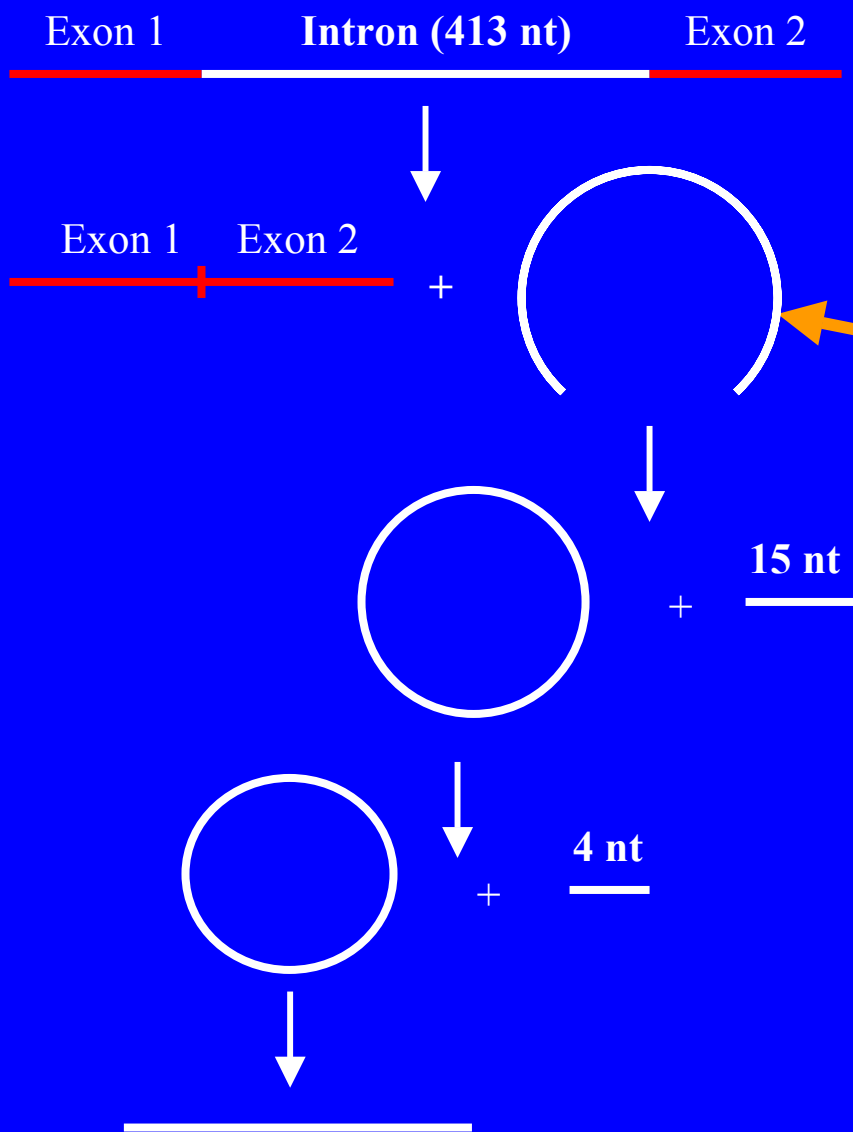
FIGURE 10-6
Electron micrograph of the DNA molecule of T-even phage released from the phage head by osmotic shock. Center: The phage ghost. Bottom right and top center: The two ends of the DNA molecule. [From A. K. Kleinschmidt, D. Lang, D. Jacherts, and R. K. Zahn, *Biochim. Biophys. Acta* **61**, 857 (1962).]



False-colour transmission electron micrograph (TEM) of the bacterium *Escherichia coli* surrounded by its DNA. The bacterium was treated with an enzyme to weaken its cell wall and then placed in water, causing its DNA to be ejected. The DNA is visible as the gold-coloured fibrous mass lying around the orange bacterial shell. The total length of DNA is 1.5 millimetres, 1000 times the length of the bacterium itself.

Life Without the Double Helix

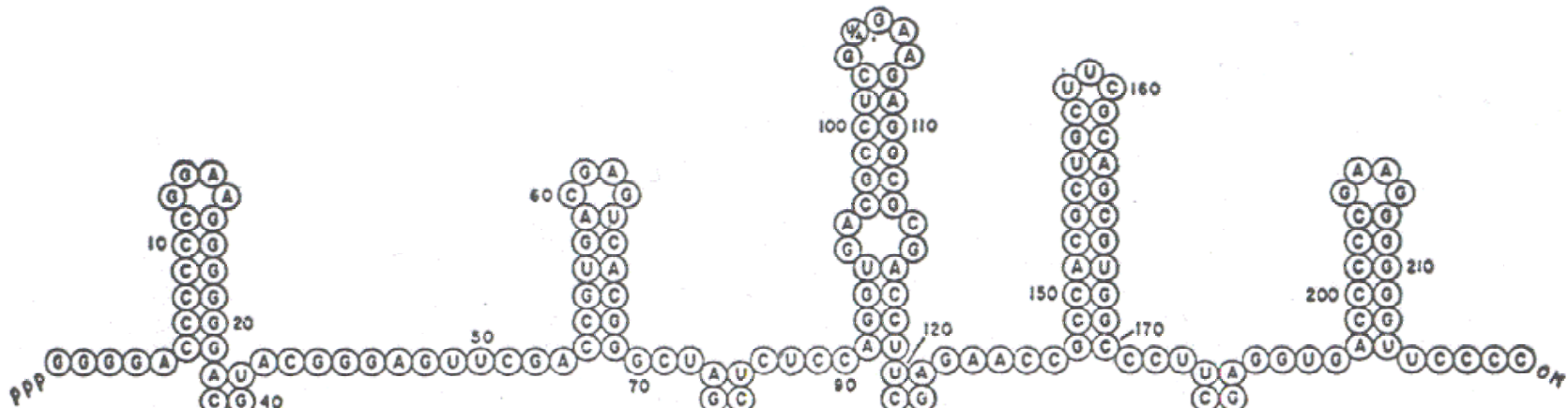
DNA replication. Coloured Transmission Electron Micrograph (TEM) of human DNA from a HeLa cancer cell, showing a stage of DNA replication. The strand of DNA is coloured yellow. It has formed into a Y-shaped molecule termed a replication fork, where the DNA has unwound into two single strands. Normally, DNA consists of two tightly wound spiral strands. During replication, a "bubble" region forms which enlarges to form a replication fork. It is here that daughter strands form as the parent DNA acts as a template for the construction of a new matching strand. In this way the sequence of bases (or genetic information) along the DNA molecule is replicated.



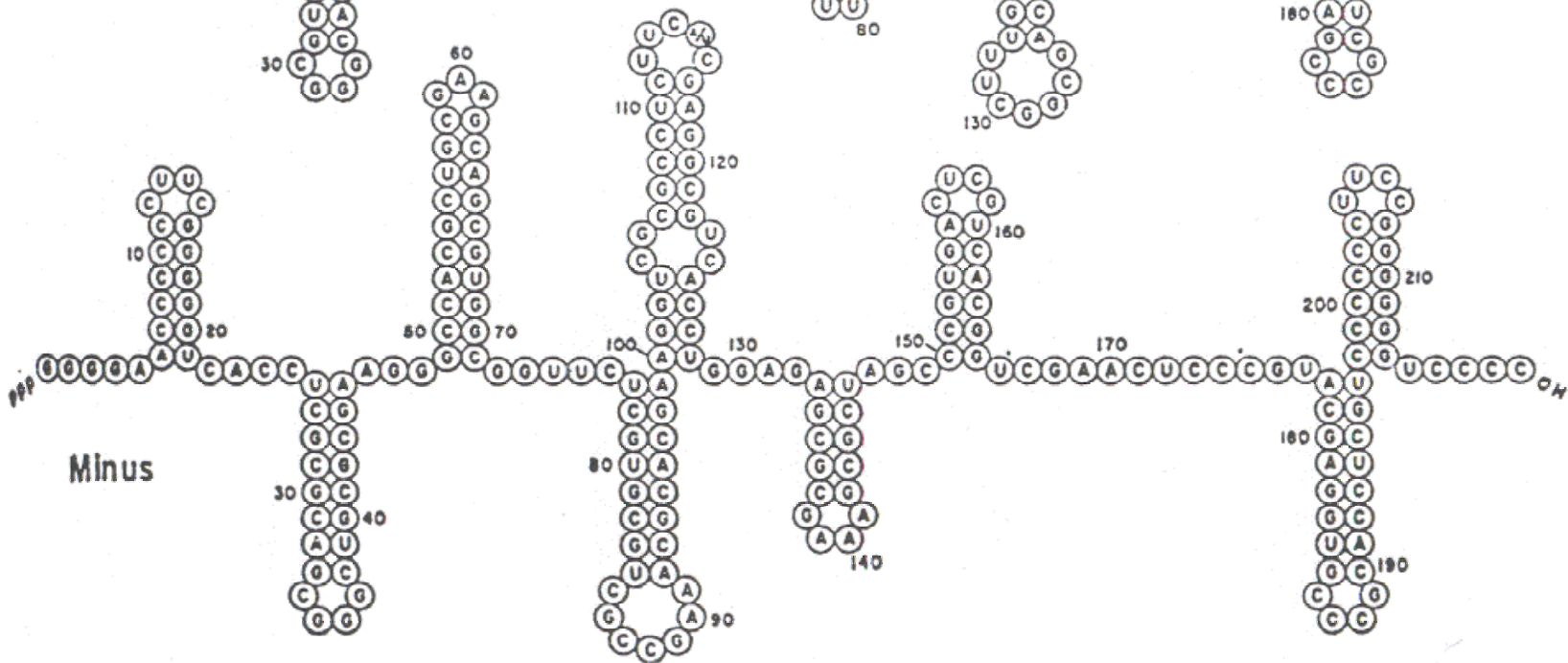
Genome of RNA-bacteriophage Q β



Plus



Minus

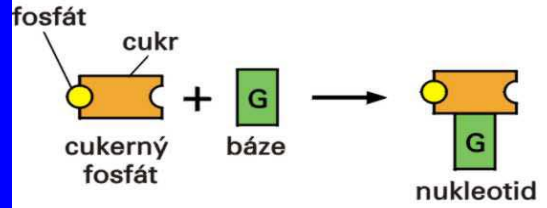


Příklady genomových projektů

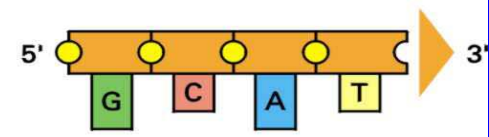
| Organismus | Species | Velikost genomu (miliony bp) | | Počet genů |
|----------------------------|-----------------------------------|---------------------------------|------|------------|
| PROKARYOTA | | | | |
| Actinobakterie | <i>Mycobacterium tuberculosis</i> | 4,4 | | 4397 |
| Chlamydie | <i>Chlamydia pneumoniae</i> | 1,1 | | 1000 |
| Cyanobakterie | <i>Synechocystis species</i> | 3,6 | | 3215 |
| Gram-positivní bakterie | <i>Bacillus subtilis</i> | 4,2 | | 4221 |
| | <i>Mycoplasma genitalium</i> | 0,5 | | 503 |
| Kyslík redukující bakterie | <i>Aquifex aeolicus</i> | 1,5 | | 1572 |
| Proteobakterie | <i>Escherichia coli</i> | 4,6 | | 4397 |
| | <i>Haemophilus influenzae</i> | 1,8 | | 1791 |
| | <i>Helicobacter pylori</i> | 1,7 | | 1609 |
| | <i>Rickettsia prowazekii</i> | 1,1 | | 834 |
| | <i>Deinococcus radiodurans</i> | 3,2 | | 3000 |
| Radioresistentní bakterie | | | | |
| Spirochety | <i>Borrelia burgdorferi</i> | 0,9 | | 1279 |
| | <i>Treptonema pallidum</i> | 1,1 | | 1082 |
| Archea | <i>methanococcus jannaschii</i> | 1,6 | | 1813 |
| EUKARYOTA | | | | |
| | | Počet chromosomů | | |
| Kvasinka | <i>Saccharomyces cerevisiae</i> | 16 | 12 | 6548 |
| Hlístice | <i>Caenorhabditis elegans</i> | 6 | 97 | 19000 |
| Hmyz | <i>Drosophila melanogaster</i> | 6 | 137 | 13500 |
| Rostlina | <i>Arabidopsis thaliana</i> | 5 | 116 | 25545 |
| Ryba | <i>Fugu rubripes</i> | 22 | 400 | 25000 |
| Člověk | <i>Homo sapiens</i> | 23 | 3000 | 30000 |



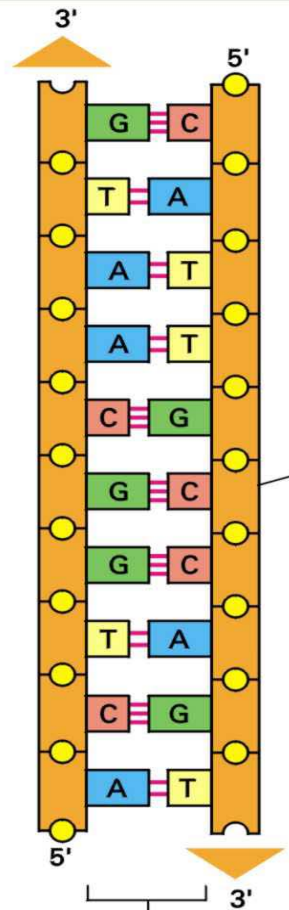
stavební kameny DNA



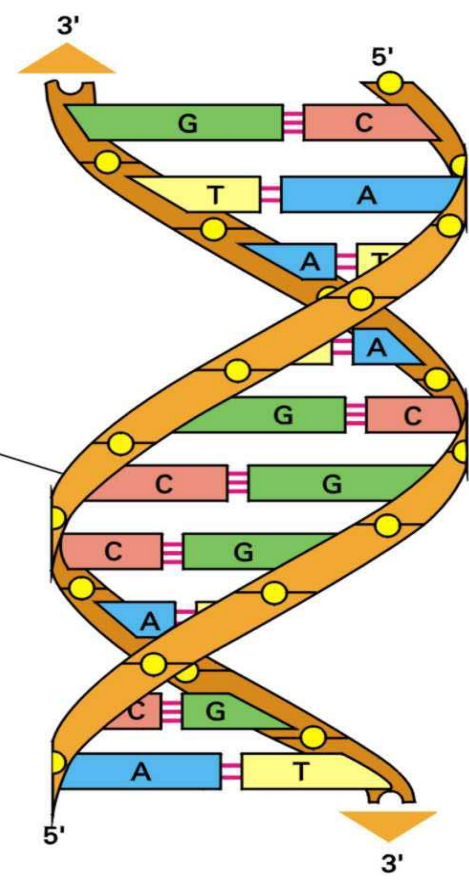
řetězec DNA



dvouřetězcová DNA

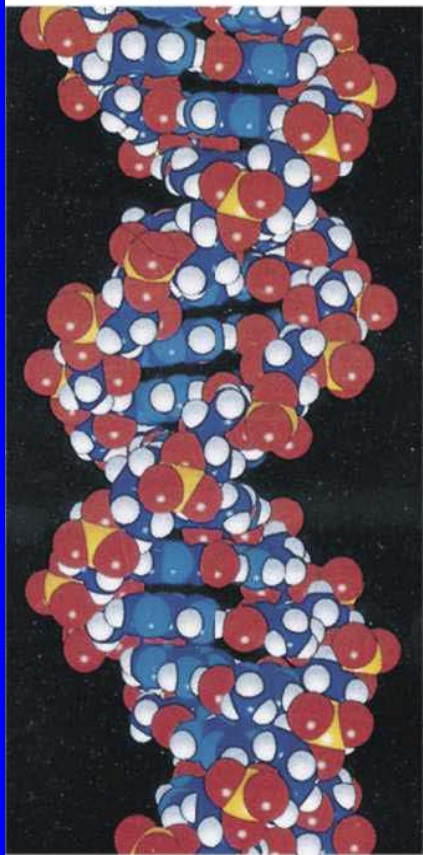


dvojšroubovice DNA



kostra cukerného fosfátu

páry bází vázaných vodíkovými můstky



2 nm

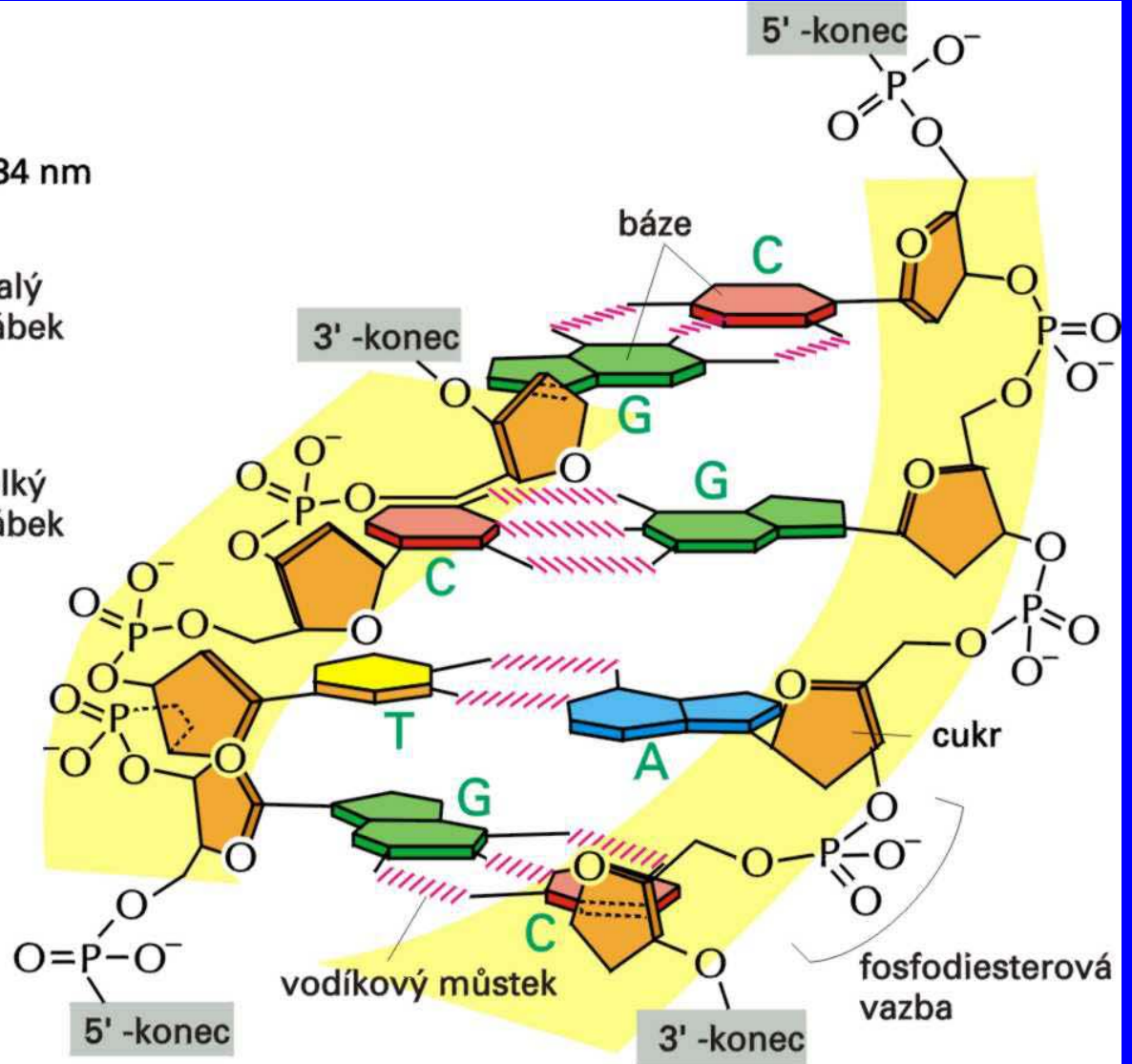
2 nm

(A)

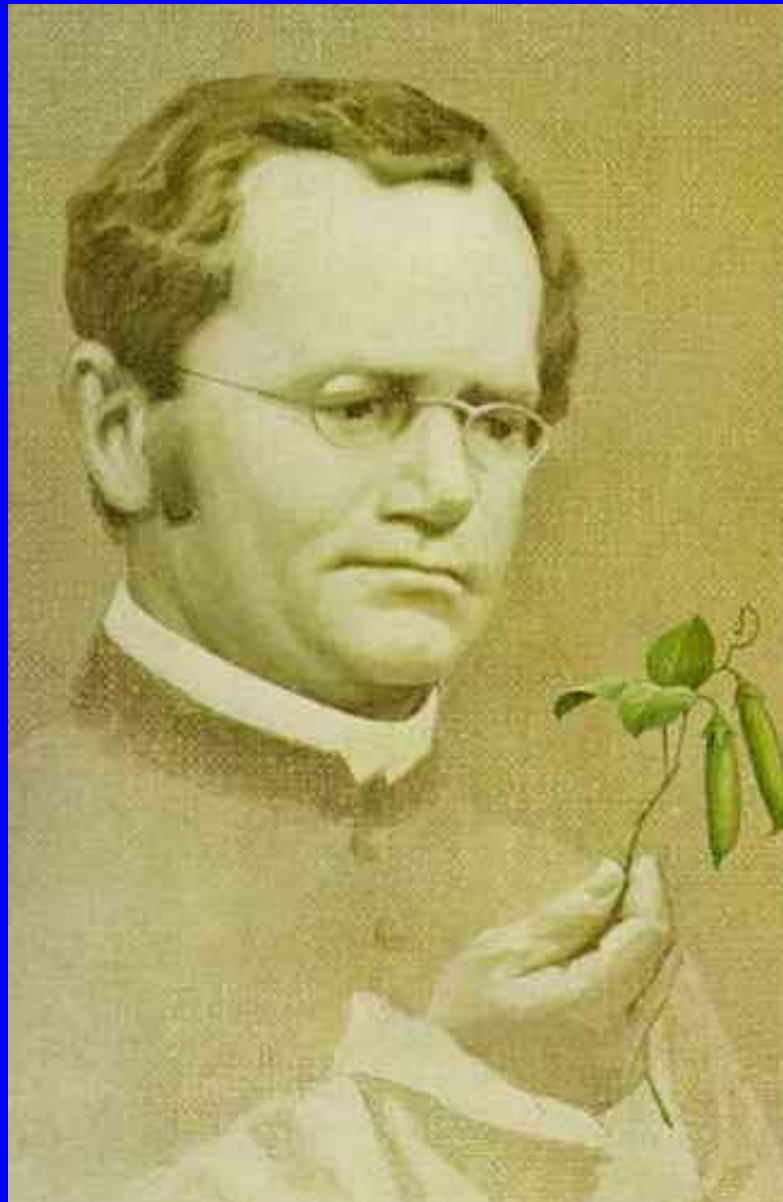
0,34 nm

malý
žlábek

velký
žlábek

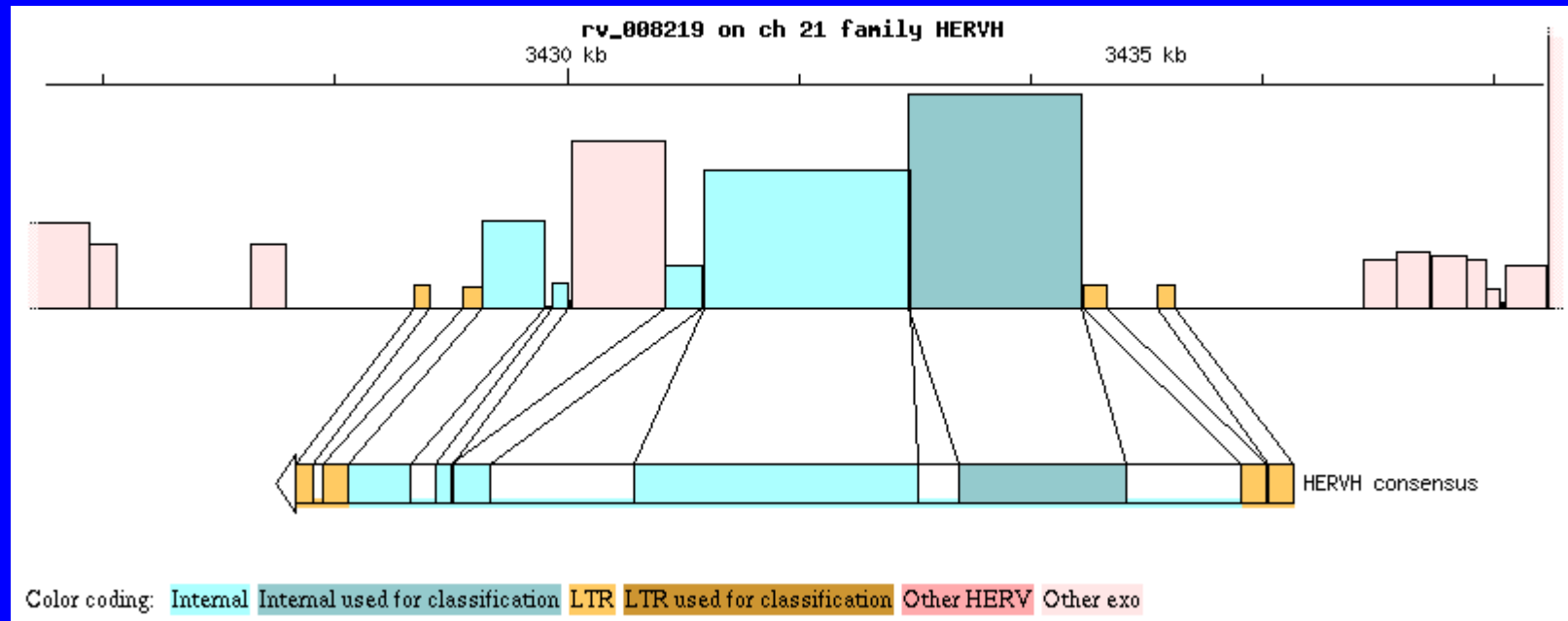


(B)



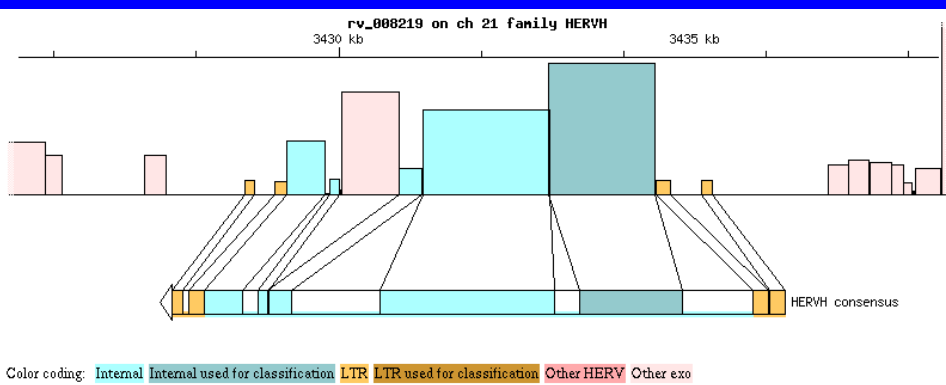
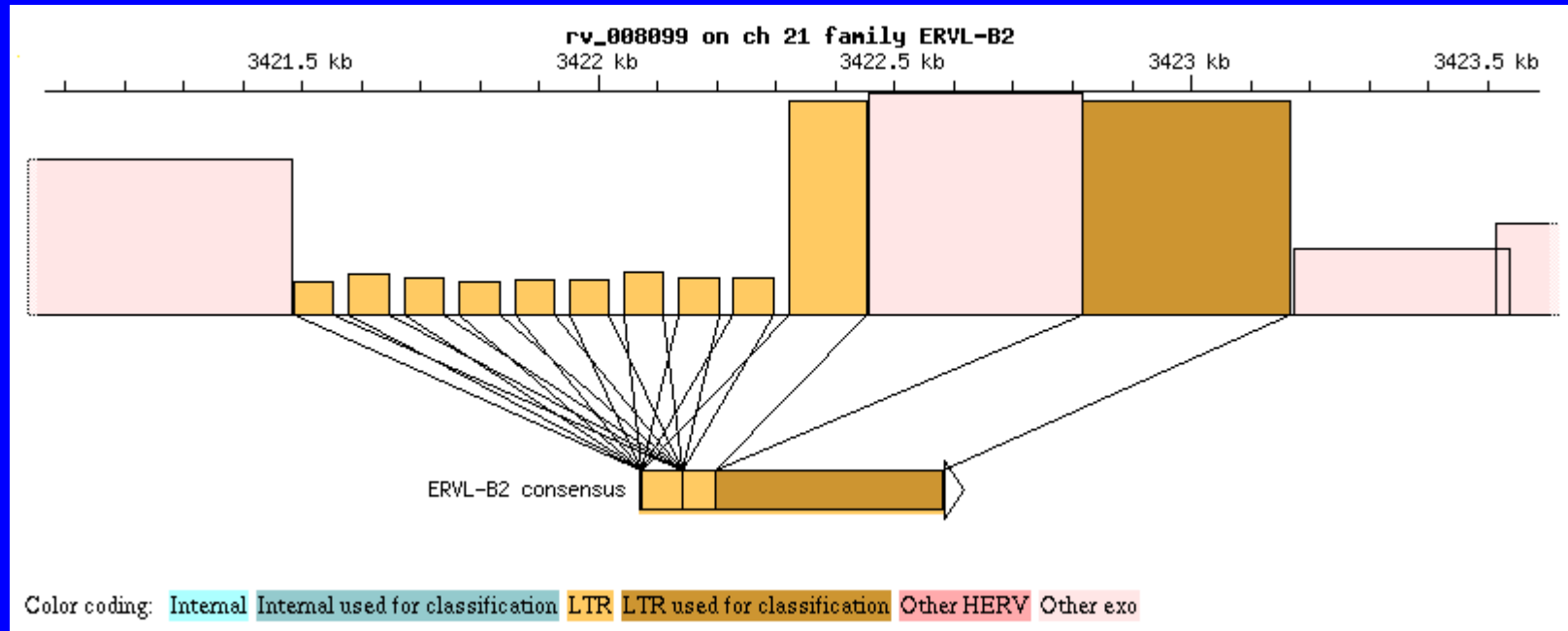
HERV

Human Endogenous Retroviruses (Example of HERV H)



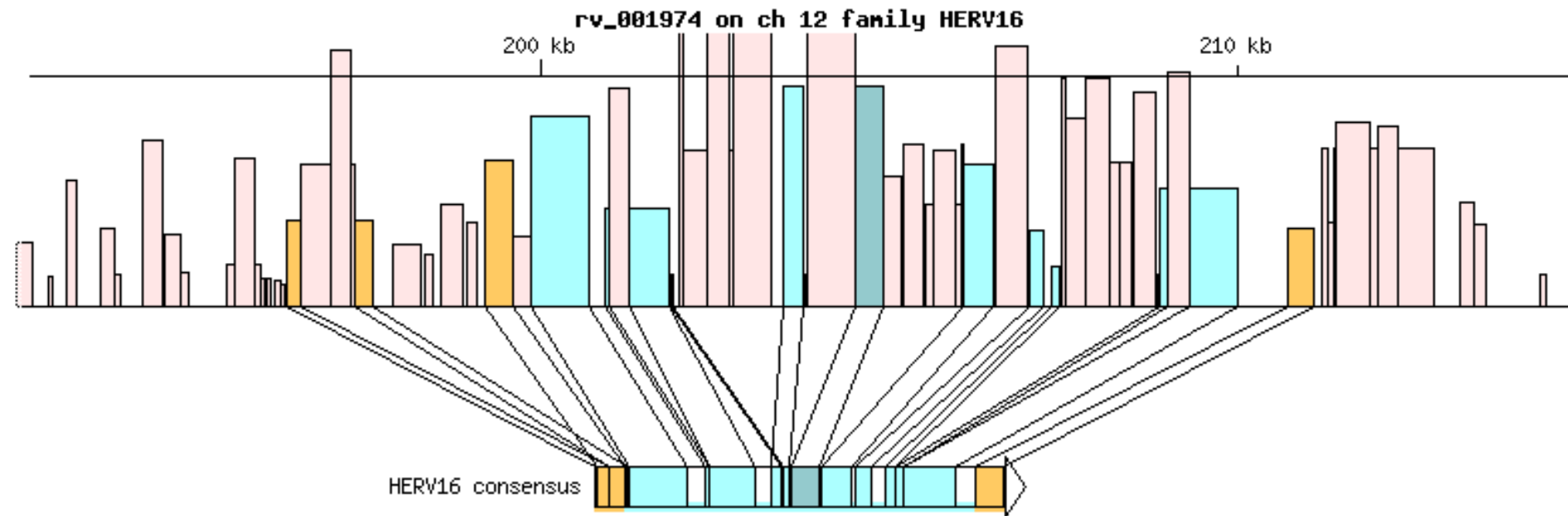
HERV

Human Endogenous Retroviruses (Example of HERV L)

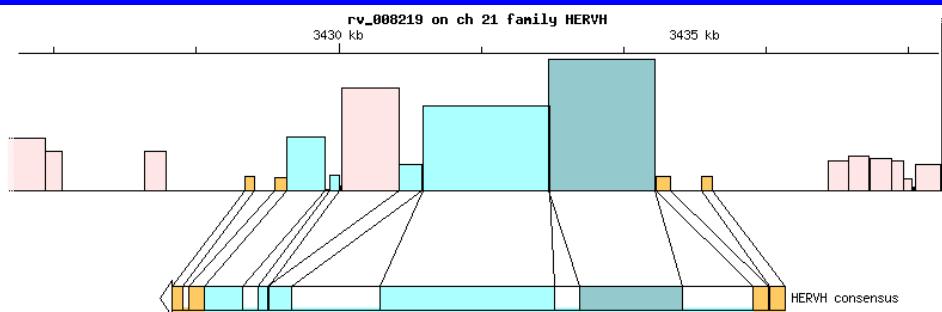


HERV

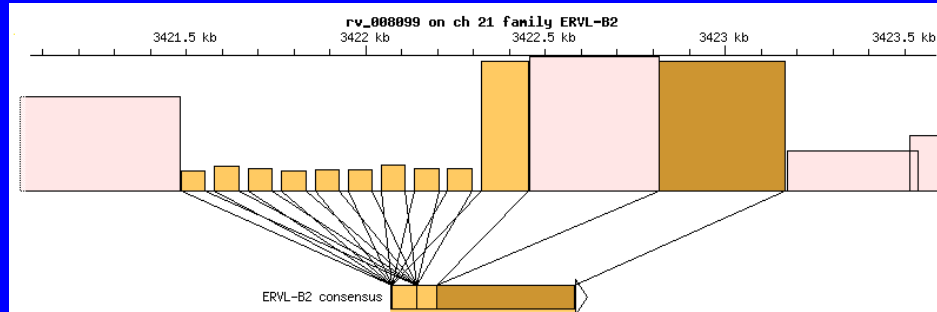
Human Endogenous Retroviruses (Example of HERV 16)



Color coding: Internal Internal used for classification LTR LTR used for classification Other HERV Other exo

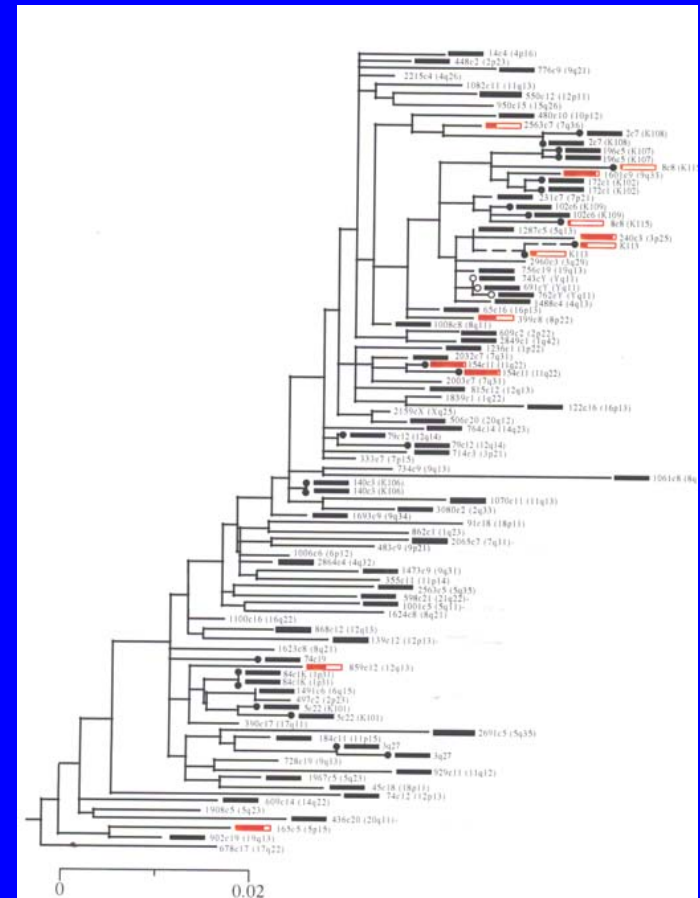
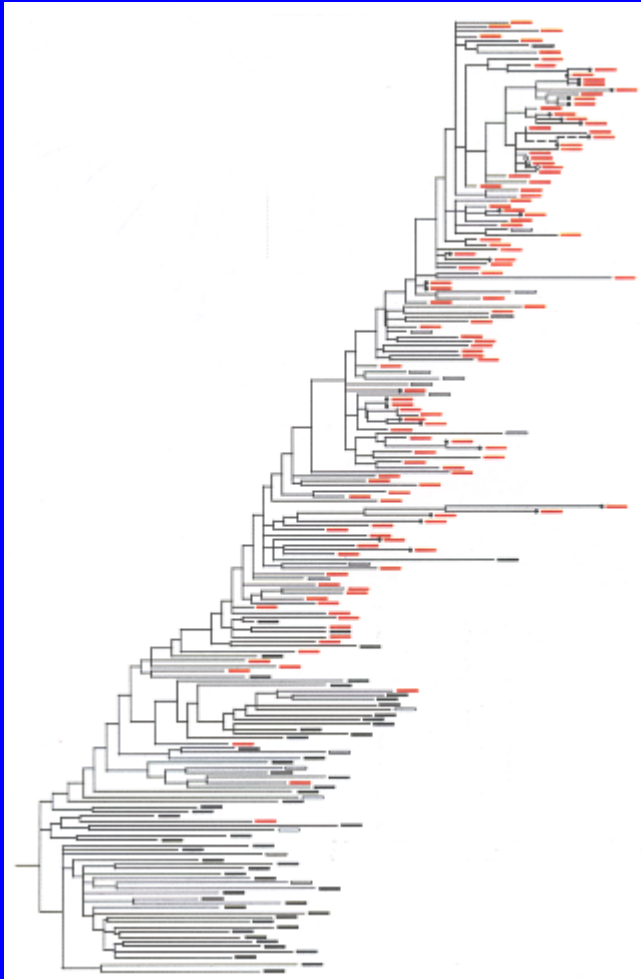


Color coding: Internal Internal used for classification LTR LTR used for classification Other HERV Other exo

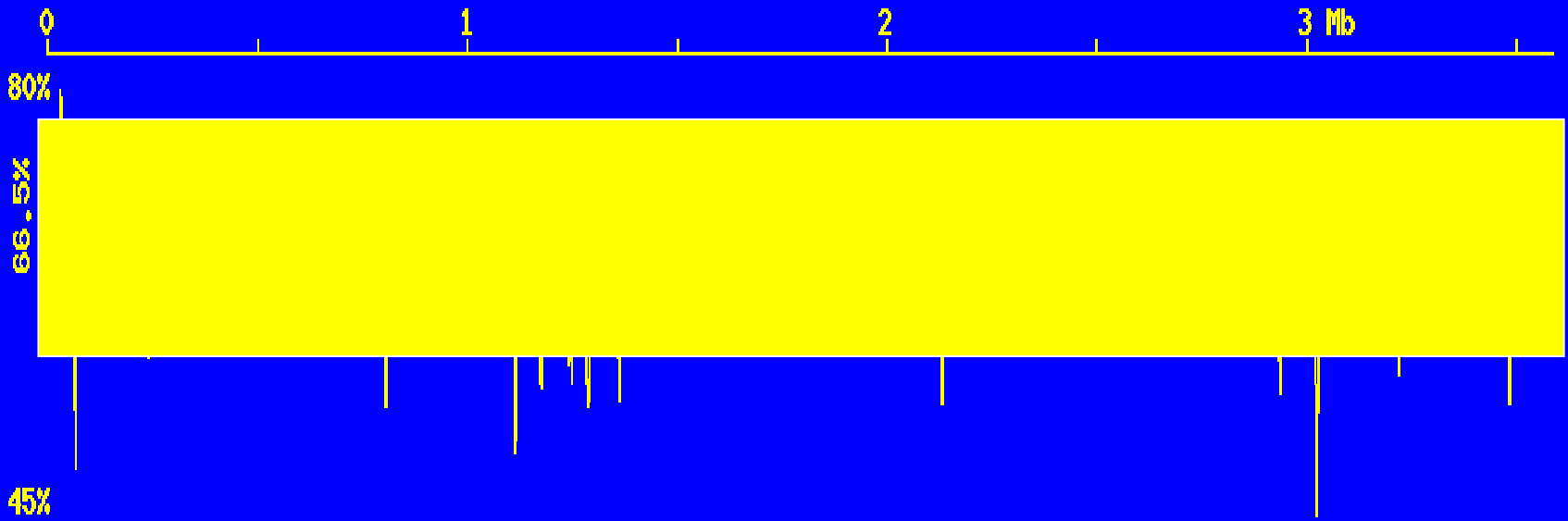


Color coding: Internal Internal used for classification LTR LTR used for classification Other HERV Other exo

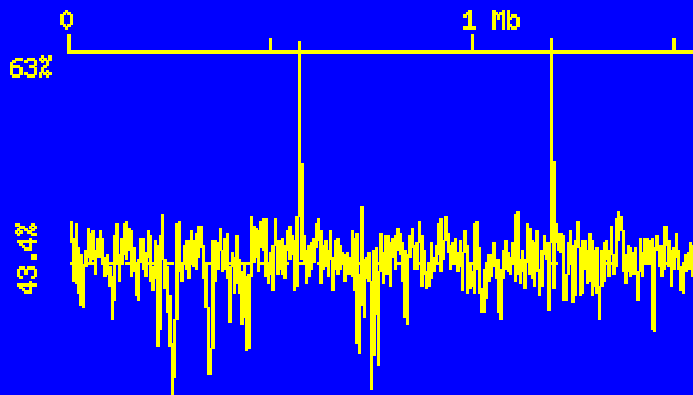
HERVK (HML2)



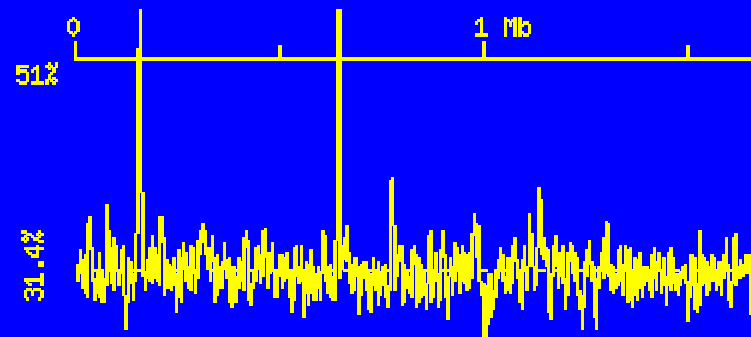
Rhodobacter capsulatus, GC profil

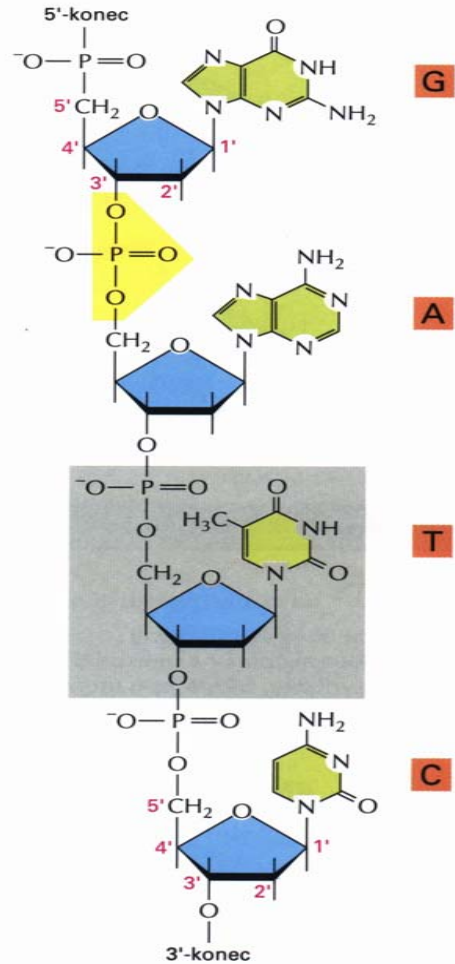


Aquifex

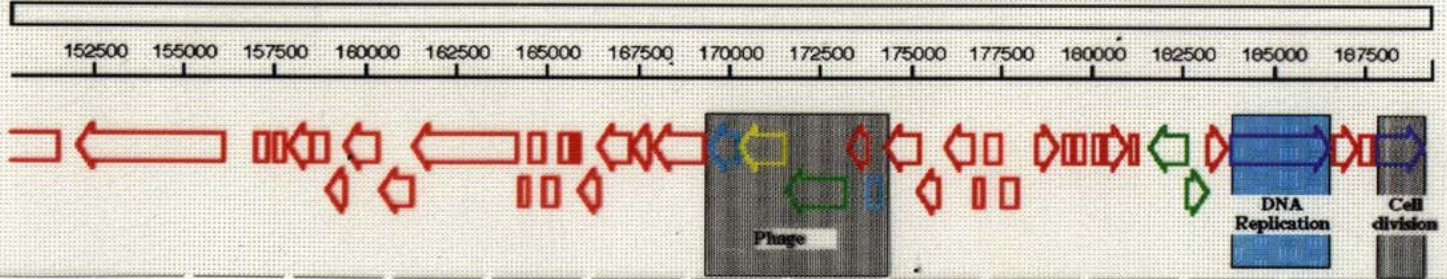
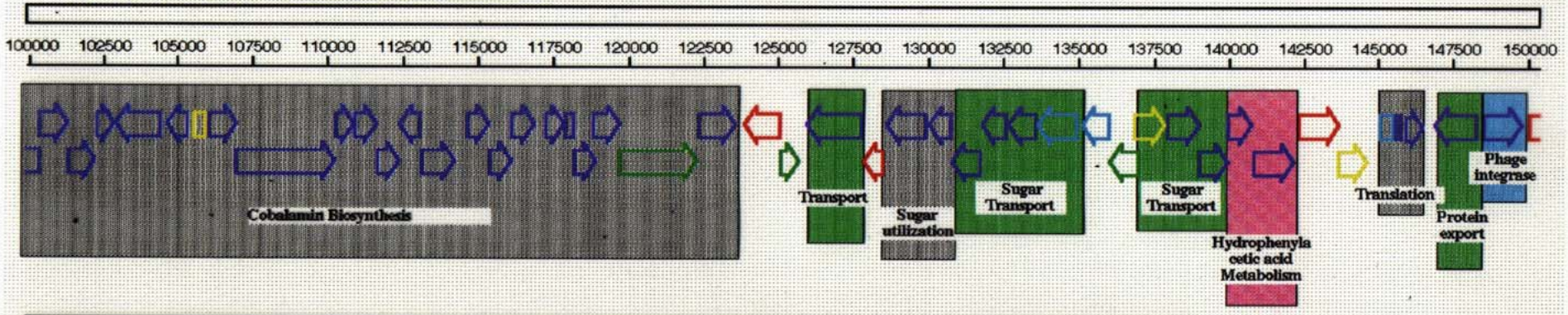
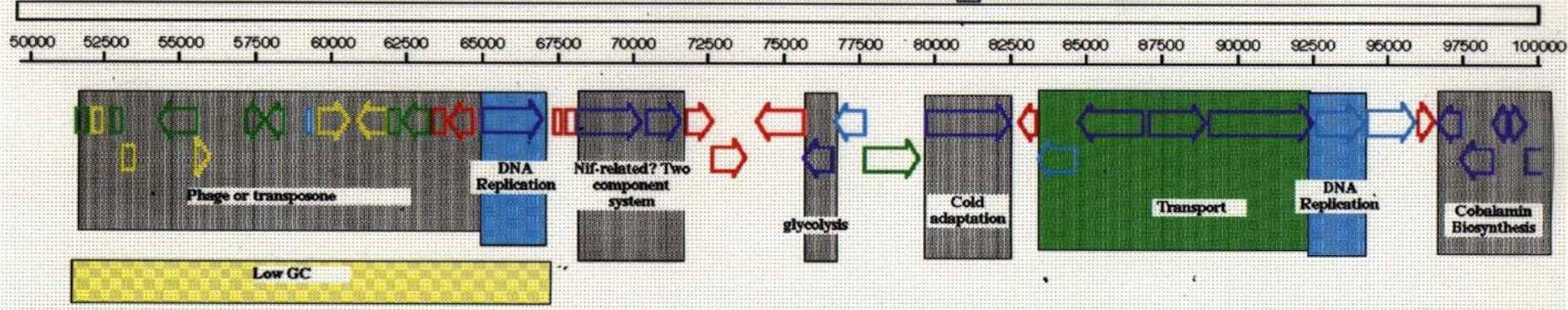
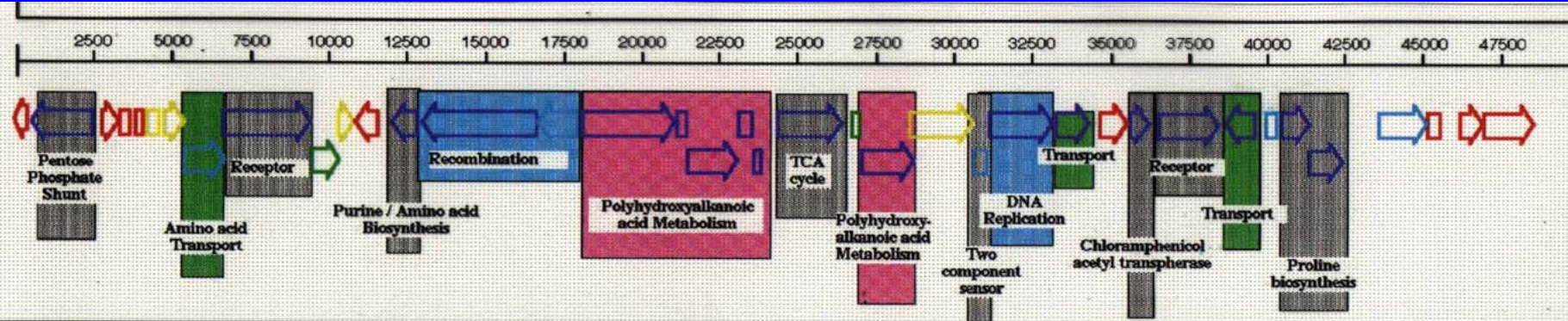


Methanococcus





Otázka 2-7 Co se myslí „polaritou“ poly-peptidového řetězce a „polaritou“ chemické vazby? Jak se tyto dva významy liší?



BIOINFORMATIC LINKS

AT THE INSTITUTE OF MOLECULAR GENETICS AS CR IN PRAGUE

DATABASES

Sequences [45]

- DNA [3]
- Protein [4]
- RNA [5]
- Human Genome [13]
- Eucaryotic Genomes [7]
- Bacterial Genomes [6]
- Repeated sequences [4]

Gene Expression [11]

- Microarray Data [7]
- SAGE Data [2]

Structure [13]

- PDB Classify [8]
- 3D Modelling [1]

Comparative Genomics [17]

- Metabolic Pathways [7]
- Regulatory Pathways [3]
- Taxonomy [4]

Interactions [3]

- Protein-protein [1]

PROGRAMS

Alignment & DB search [16]

- Pairwise Alignment [5]
- Multiple Alignment [10]

DNA Sequence Analysis [13]

- Gene prediction [4]
- Repeated sequences [4]

Protein Analysis [15]

- Folding [1]
- Structure Prediction [7]
- Structure alignment [1]

Phylogenetic Analysis [9]

- Distance Methods [1]
- Parsimony Methods [0]
- Maximum Likelihood Methods [4]
- Tree Inference, Tree Distance [3]
- Bootstrap, Other Tests [0]
- RFLP, RAPD Data Analysis [1]

Visualisation [9]

- Molecular Structures [2]
- Alignment [4]

OTHER LINKS

Courses [10]

- Math&Stat [2]

Link Pages [25]

Unsorted [4]

- Distributed applications [2]

Multifunctional Servers [3]

Search Engines [2]

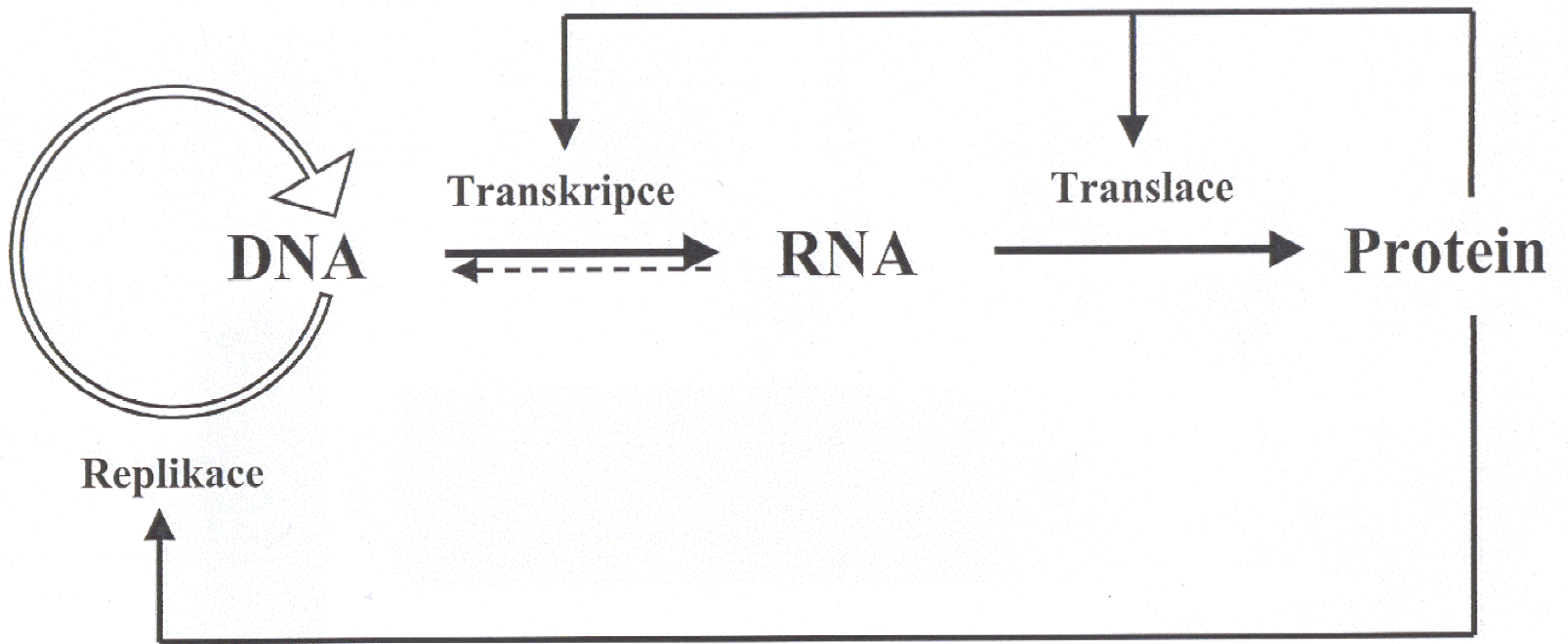
Literature [12]

- Preprints [2]
- Journals [6]

Our Favorite Prague Pubs [2]

New Inserted Links

Link Search



Lidský genom v číslech

Doposud bylo přečteno 3,1647 miliardy nukleotidů.

Průměrný gen je 3 tisíce nukleotidů dlouhý, nejdelší gen (dystrophin) je 2,4 miliónů nukleotidů dlouhý.

Celkový počet genů je odhadován na 30 000 až 35 000.

Pouze méně než 2% genomu kóduje nějaký protein.

Funkce více než 50% identifikovaných genů je zatím neznámá.

DNA je z více než 99,9% totožná u všech lidí.

Repetitivní elementy které nekódují nic ("junk DNA") tvoří více než 50% lidského genomu.

Aplikace molekulární genetiky

1. Transgenní organizmy

Mikroorganismy produkující důležité proteiny (enzymy, hormony..)

Vyšší organizmy produkující důležité proteiny (např. v mléce)

Zlepšené organizmy (pro zemědělství, bioremediace)

2. Diagnostika (prenatalní, infekce...)

3. Kriminalistika, soudnictví (identifikace osob na základě DNA)

4. Genová terapie

Somatické buňky

Zárodečné buňky

„Positivní“ genové inženýrství

5. Proteinové inženýrství

Lidský genom – etické aspekty

- Důvěrnost dat
- Patentování genů
- Genová terapie (somatické buňky vs. zárodečné buňky)
- „Pozitivní“ genové inženýrství

Lidské buňky – etické aspekty

- Klonování
- Embryonální kmenové buňky

On the origin of life on Earth

Václav Pačes

Institute of Molecular Genetics

Academy of Sciences

About Origin of Life on Earth

Václav Pačes

Institute of Molecular Genetics

Academy of Sciences of the Czech Republic

Completed Genome Projects

| Category | Species | Genome size (Mb) | Genes |
|--------------------------|-----------------------------------|--------------------|-------|
| PROKARYOTES | | | |
| Actinobacteria | <i>Mycobacterium tuberculosis</i> | 4,4 | 4397 |
| Chlamydia | <i>Chlamydia pneumoniae</i> | 1,1 | 1000 |
| Cyanobacteria | <i>Synechocystis species</i> | 3,6 | 3215 |
| Gram-positive bacteria | <i>Bacillus subtilis</i> | 4,2 | 4221 |
| | <i>Mycoplasma genitalium</i> | 0,5 | 503 |
| Oxygen-reducing bacteria | <i>Aquifex aeolicus</i> | 1,5 | 1572 |
| Proteobacteria | <i>Escherichia coli</i> | 4,6 | 4397 |
| | <i>Haemophilus influenzae</i> | 1,8 | 1791 |
| | <i>Helicobacter pylori</i> | 1,7 | 1609 |
| | <i>Rickettsia prowazekii</i> | 1,1 | 834 |
| Radioresistent bacteria | <i>Deinococcus radiodurans</i> | 3,2 | 3000 |
| Spirochete | <i>Borrelia burgdorferi</i> | 0,9 | 1279 |
| | <i>Treptonema pallidum</i> | 1,1 | 1082 |
| Archea | <i>methanococcus jannaschii</i> | 1,6 | 1813 |
| EUKARYOTES | | | |
| | | Chromosomes | |
| Fungi | <i>Saccharomyces cerevisiae</i> | 16 | 12 |
| Nematode | <i>Caenorhabditis elegans</i> | 6 | 97 |
| Insect | <i>Drosophila melanogaster</i> | 6 | 137 |
| Plants | <i>Arabidopsis thaliana</i> | 5 | 116 |
| Fish | <i>Fugu rubripes</i> | 22 | 400 |
| Human | <i>Homo sapiens</i> | 23 | 3000 |
| | | | 6548 |

Sylabus

- » Co je život: klinická smrt, spóry, krystaly, viry
- » reprodukce
- » metabolismus
- » změna – evoluce
- » snižování entropie (samoorganizace, *vis vitalis*, uzavřený x otevřen systém)
- » Dva názory:
- » víra ve stvoření
- » soulad s přírodními zákony na Zemi (bylo nebo nebylo dost času? - panspermie)
- » Centrální dogma mol. biol.: slepice nebo vejce? Dualita
- » Obrázky: DNA v reálu
- » Cech a Altman (tRNA, rRNA)
- » Spiegelman a Q β
- » Genomové projekty – *Mycoplasma*, člověk
- » Monod: La chance et la necessitae, frozen accident, statistická termodynamika, jsme možná jediní ve Vesmíru