The Molecular Evolutionary Perspective

Presented by:

Fatchiyah

JB UB

Natural selection is evolutionary process

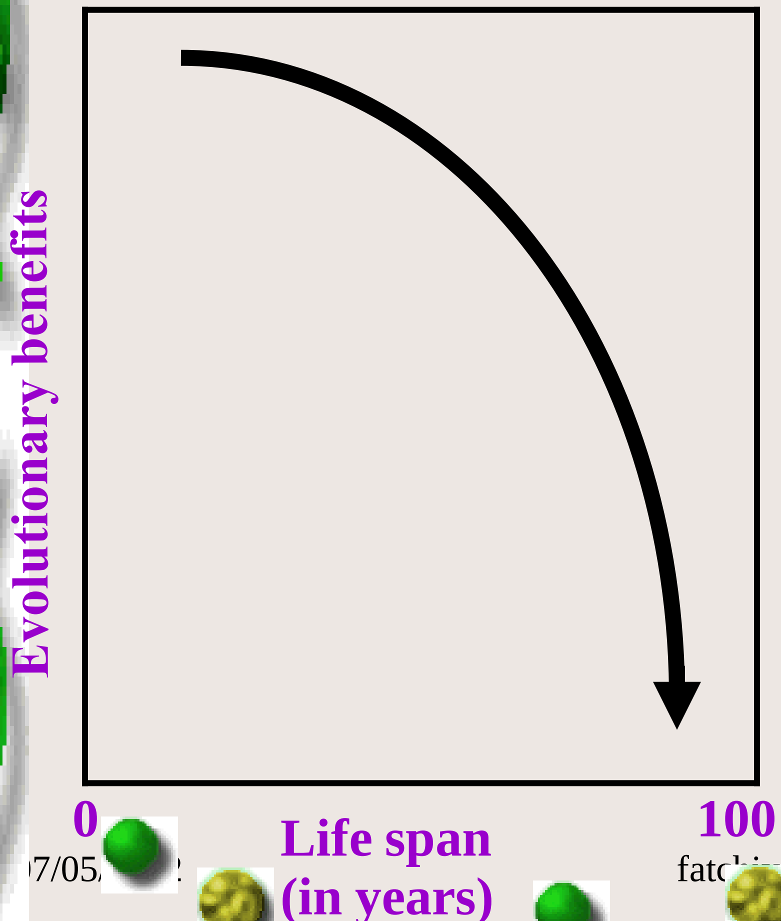
- Based on Darwin's theory
- Best-adapted members of species survive to reproduce
- Survival characteristics passed on in genes
- Ideas explain behavior in evolutionary psychology approach
- David Buss: evolution shapes our physical features and how we make life decisions

Evolutionary developmental psychology

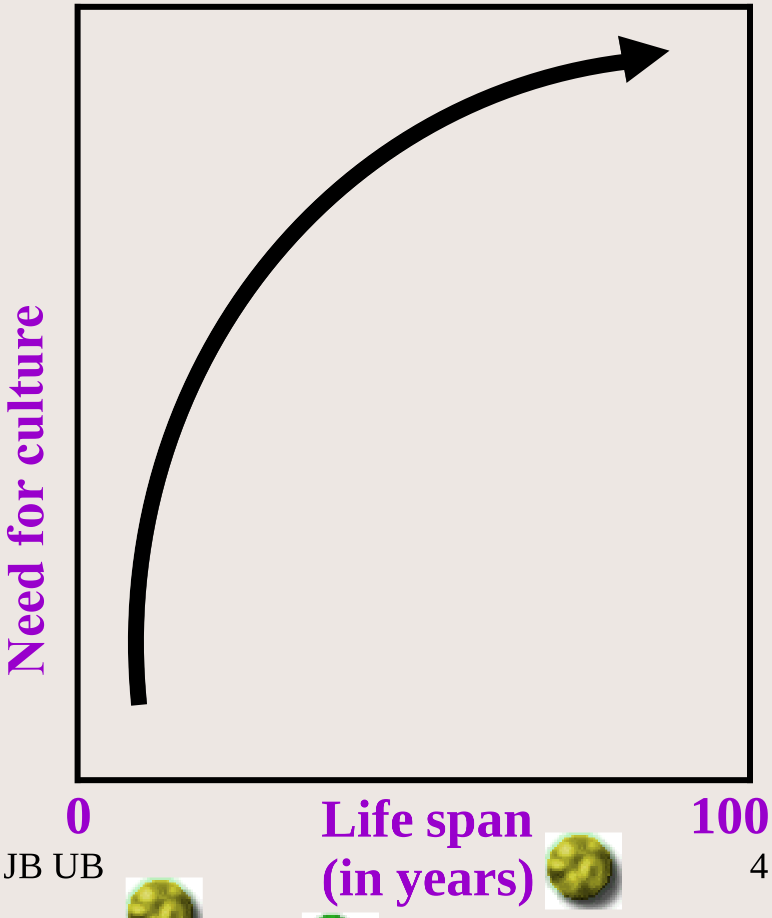
- Extended juvenile period allows brain to develop and learn complexity of social interactions
- Many aspects of childhood are preparation for adulthood evolving over time
- Some childhood characteristics promote adaptation during development before reaching adulthood
- Many evolved psychological mechanisms are domain-specific or specific to environmental needs
- Evolved mechanisms are not always adaptive in contemporary society

Baltes' View of Evolution and Culture Across the Life Span

Evolutionary selection benefits decrease with age



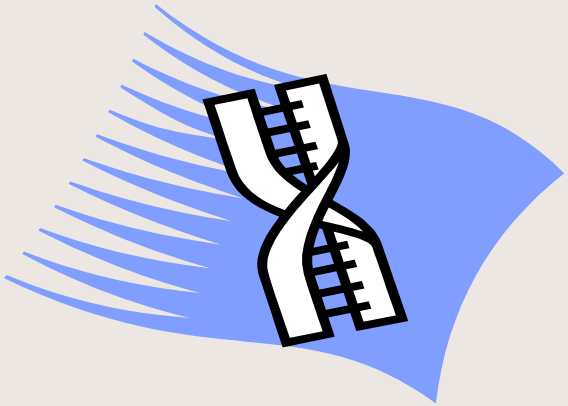
Need for culture increases with age



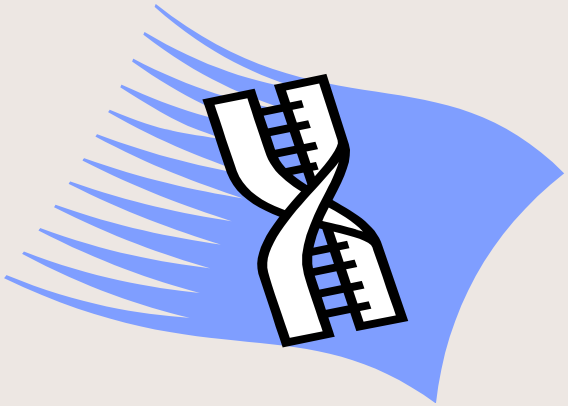
- **Currently:**
  - **There is great interest in evolutionary explanations of aging**
  - **Natural selection has not weeded out harmful conditions or diseases and nonadaptive characteristics associated with reproduction**
  - **Evolutionary psychology approach has its limitations and weaknesses, and its critics**

Molecular Evolution

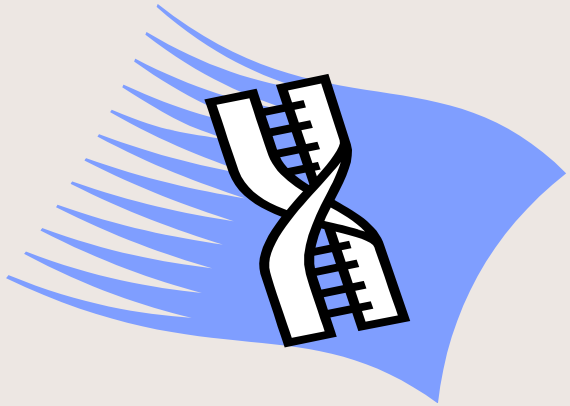
- **Study of how genes and proteins evolve and how are organisms related based on their DNA sequence**



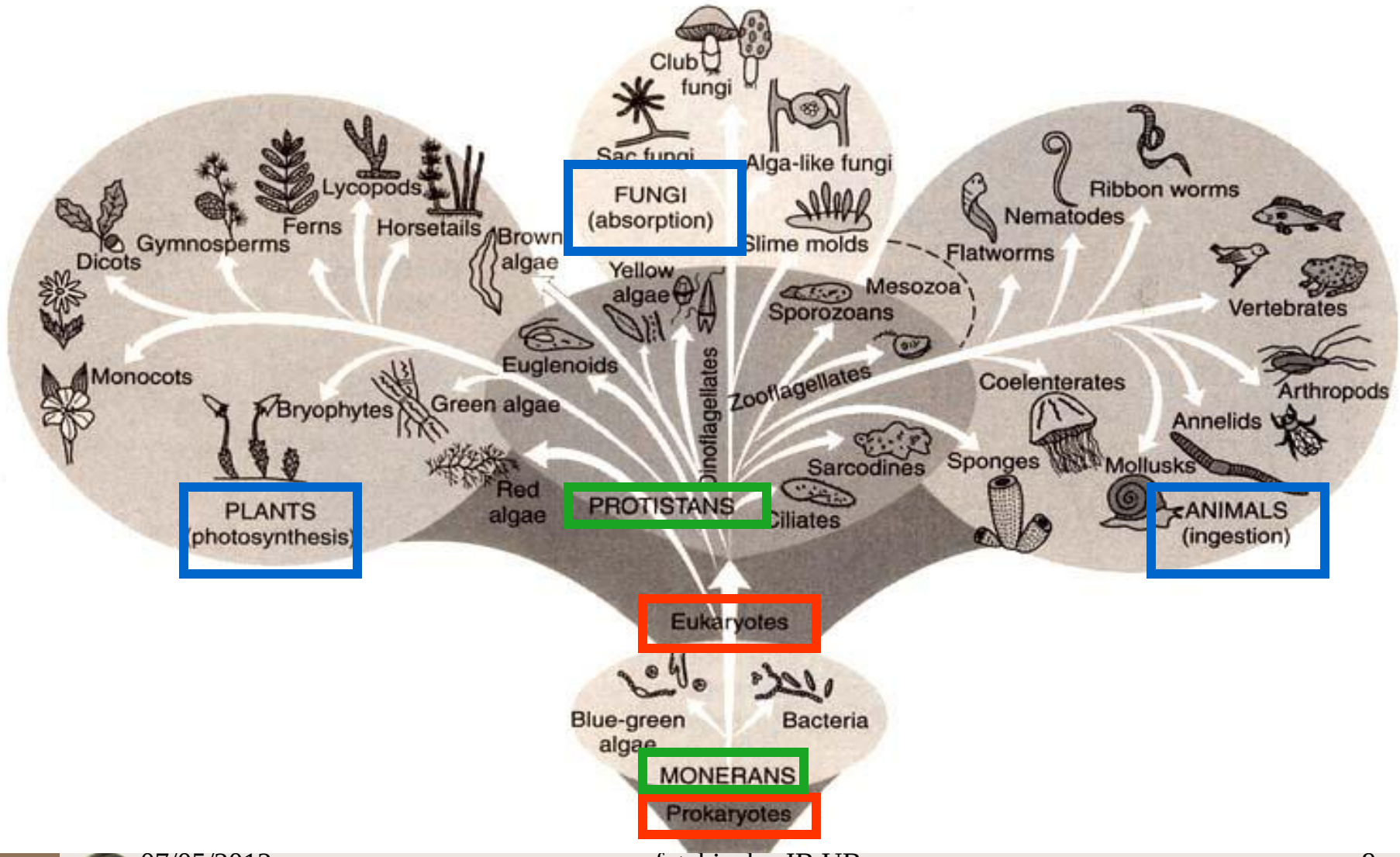
- **Molecular evolution therefore is the determination and comparative study of DNA and deduced amino acid sequences.**



- **Sequences from different organisms or populations are matched or aligned**



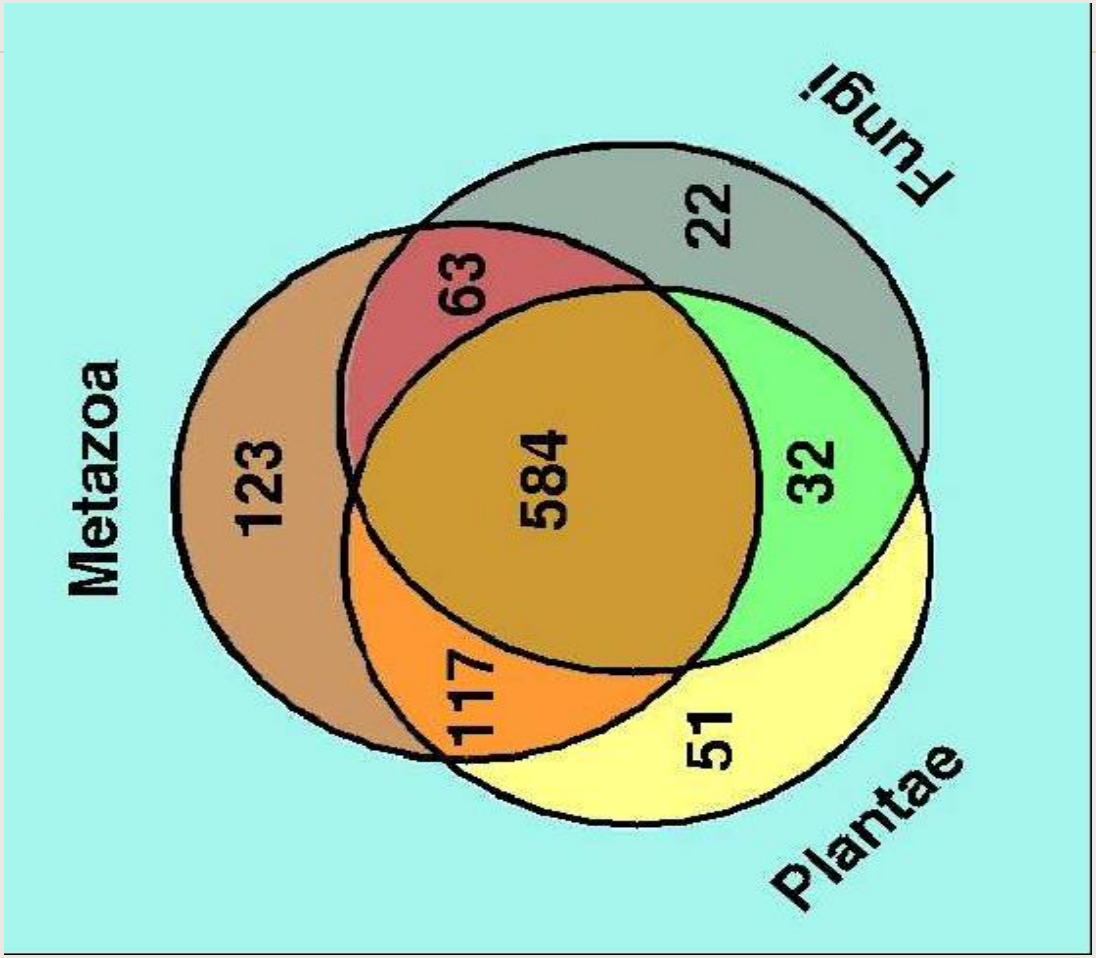
The Five-Kingdoms Classification

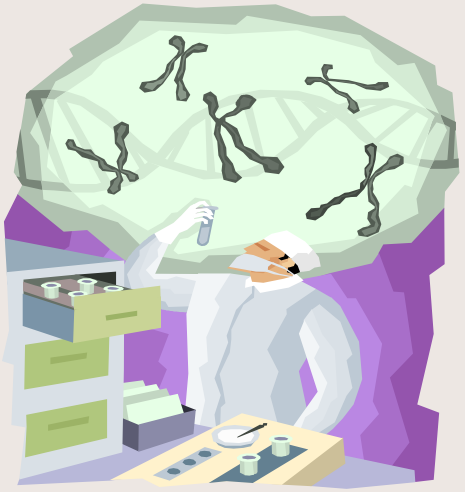


Is it true or not?

How molecular evolution did?

Gene Similarity Distribution



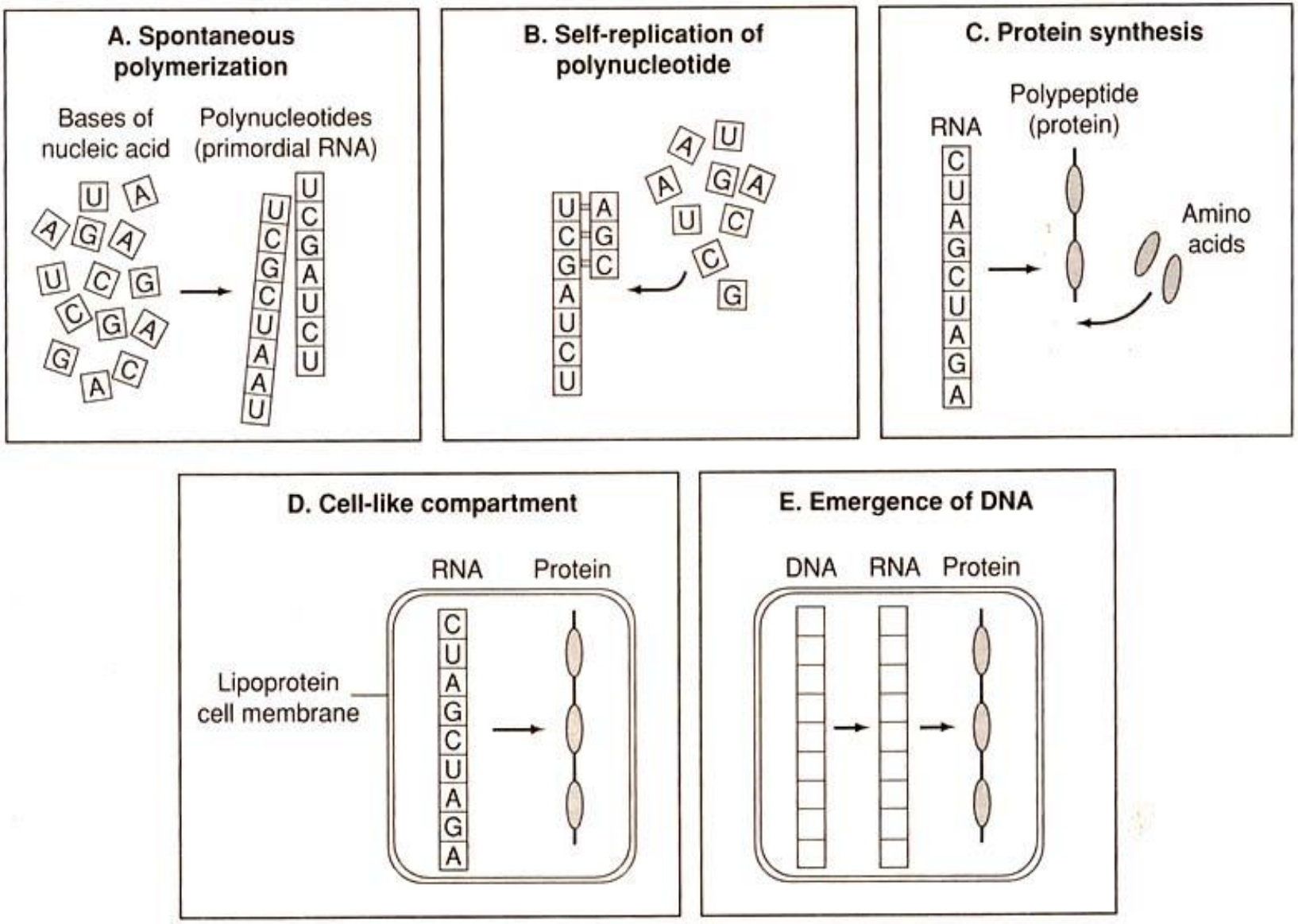


Selective gene losses contribute to species formation

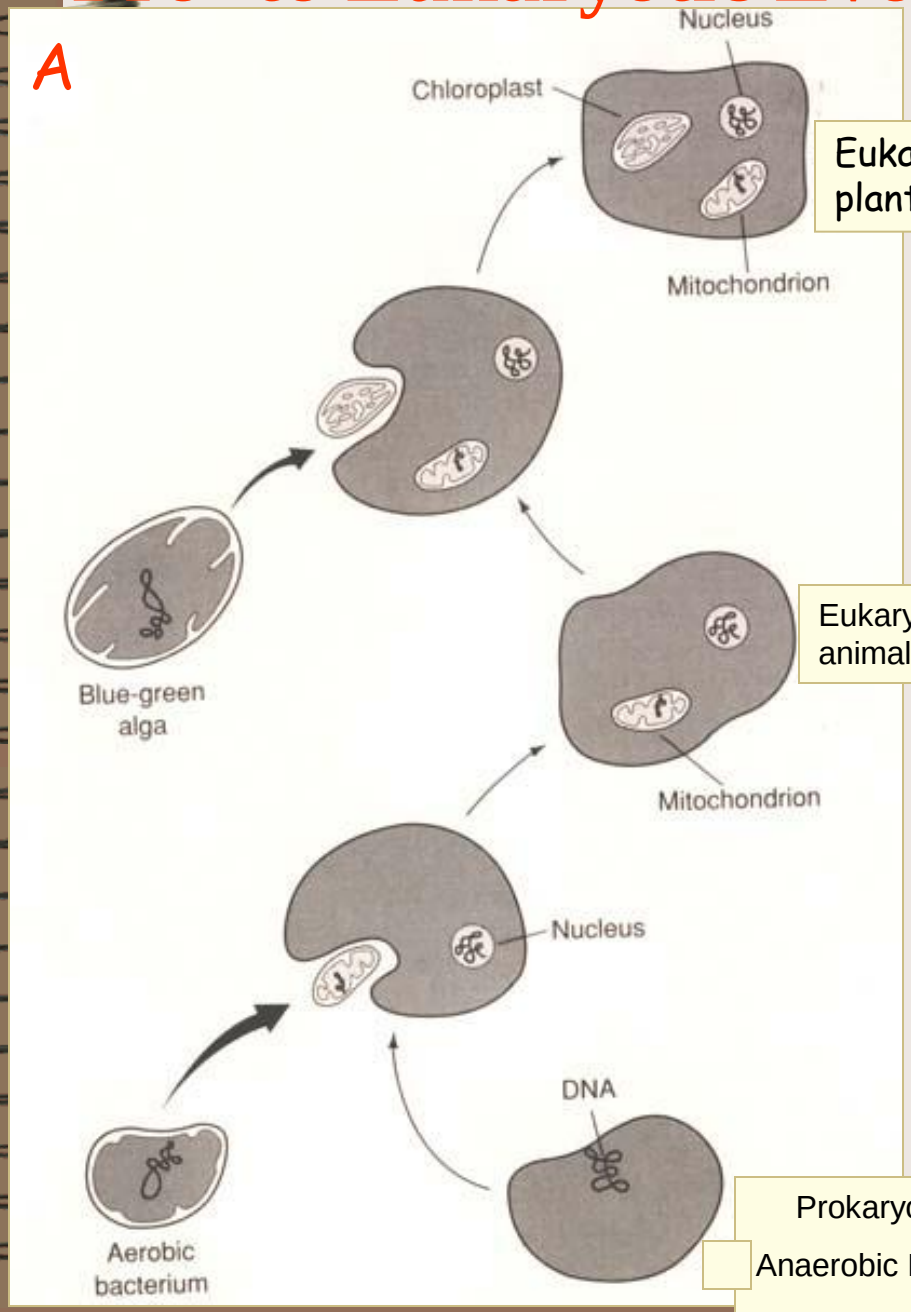
Postulated stages in the origin of living cells

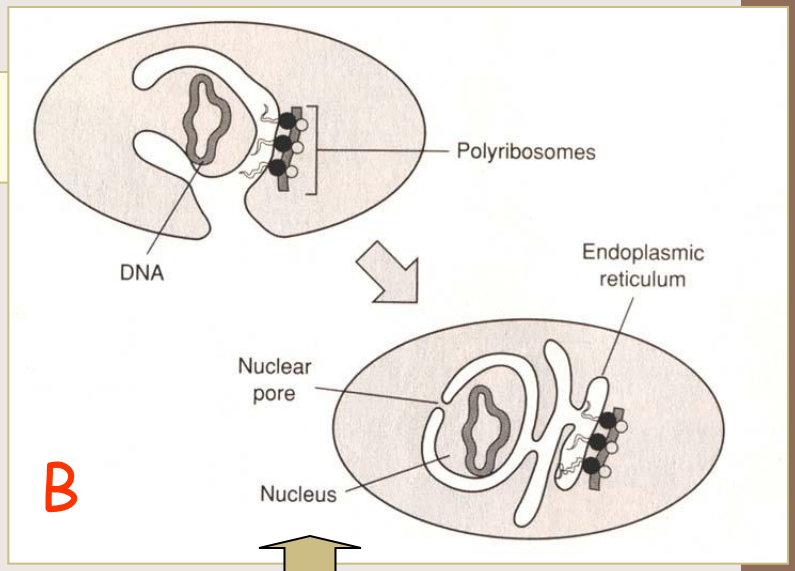
- ✓RNA itself can act as catalyst
- ✓RNA molecules have enzymatic properties, as template
- ✓RNA guided the primordial synthesis of protein
- ✓Nucleotides of RNA (not DNA) were probably the first carriers of genetics information

Life's beginning



Pro- to Eukaryotic Evolution through Symbiosis





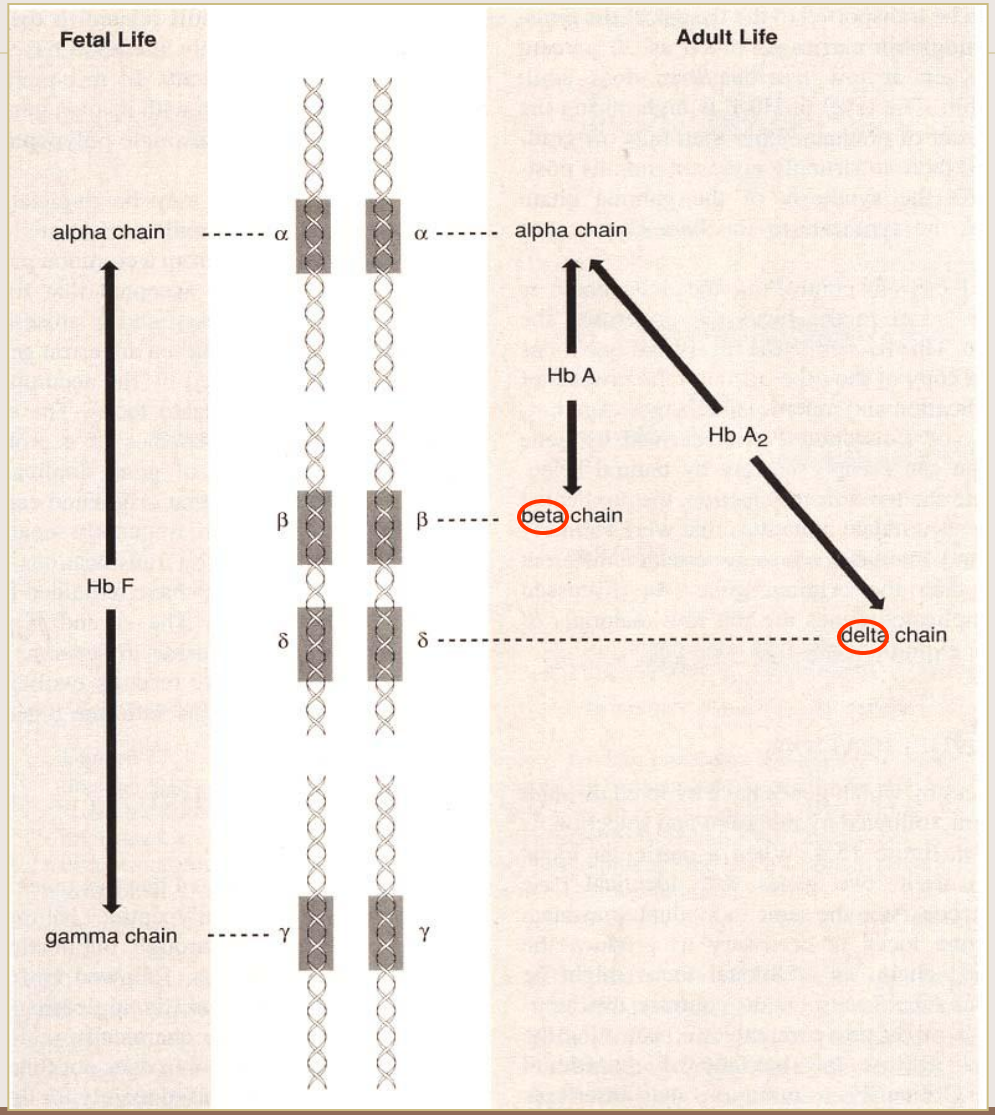
Hypothetical the origin of nucleolus and endoplasmic reticulum

Not clear

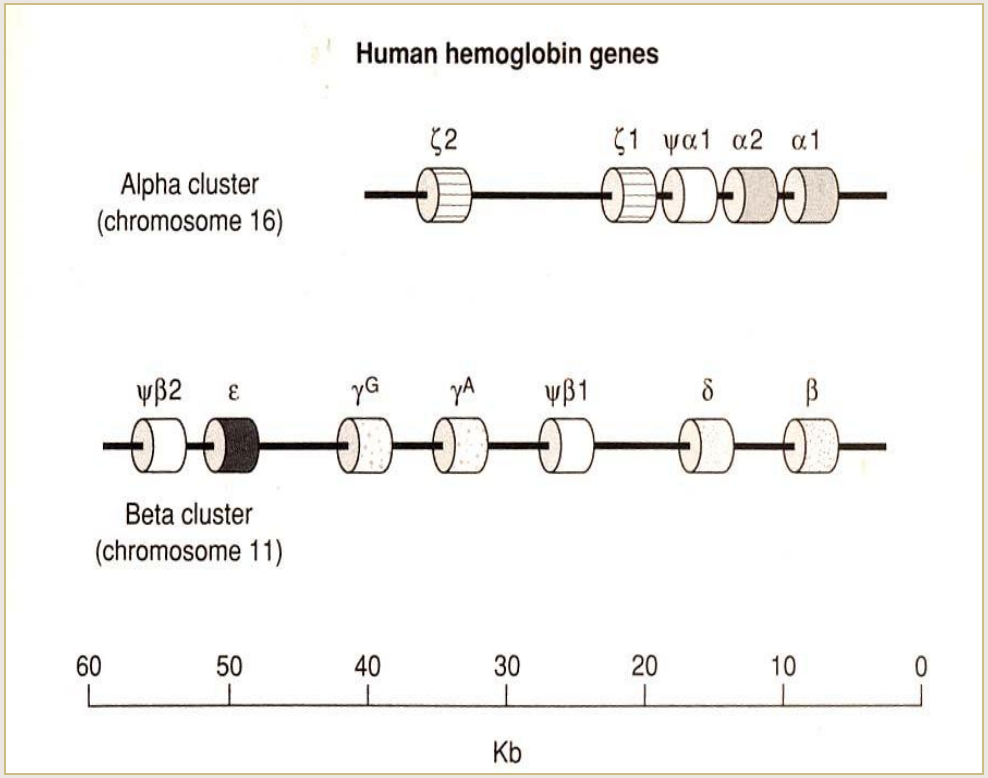
B

Genetics control of Hemoglobin by four loci

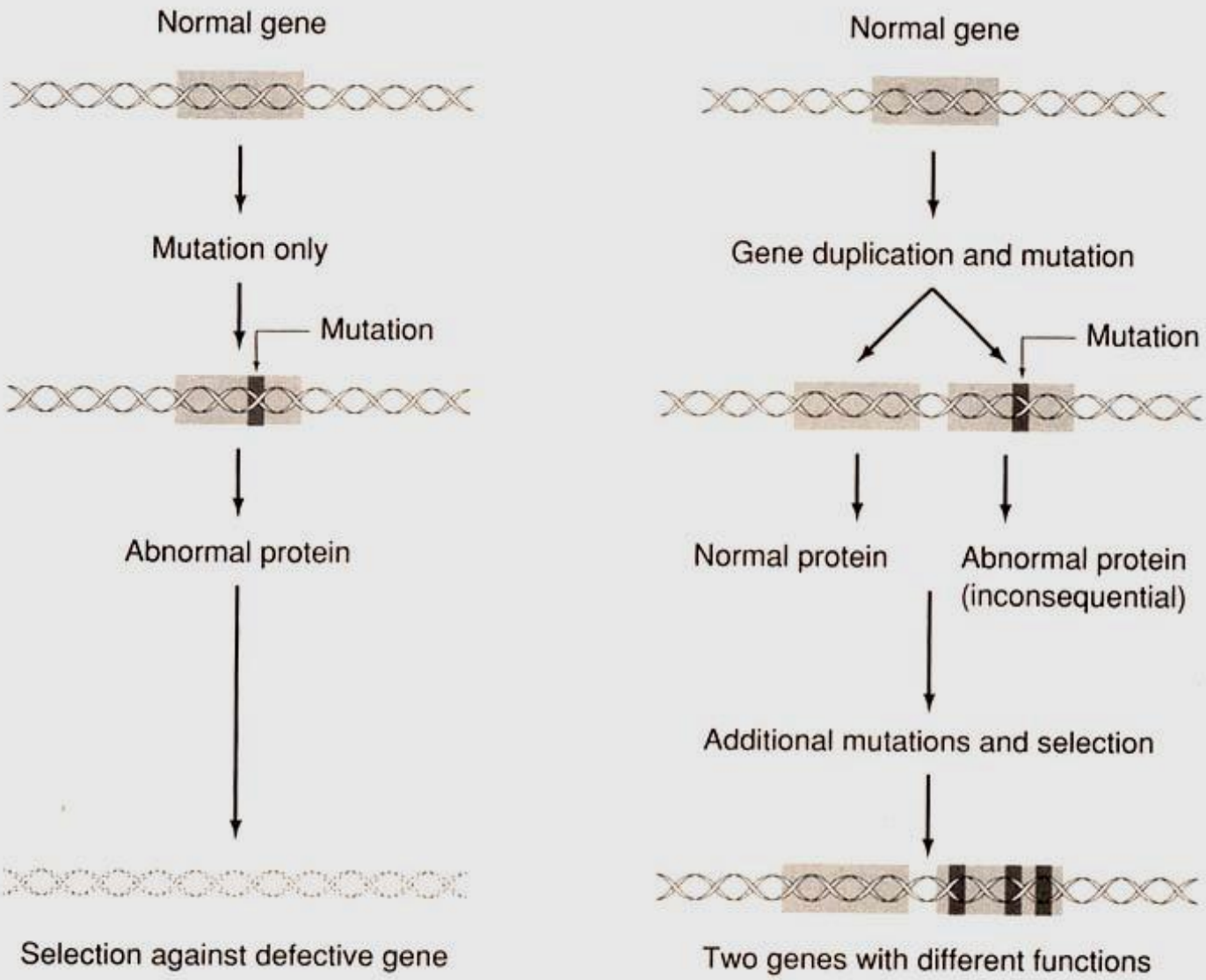
Human Hb is one ideal model for molecular events that have occurred during evolution →The beta and delta locus are closely in the same chromosome



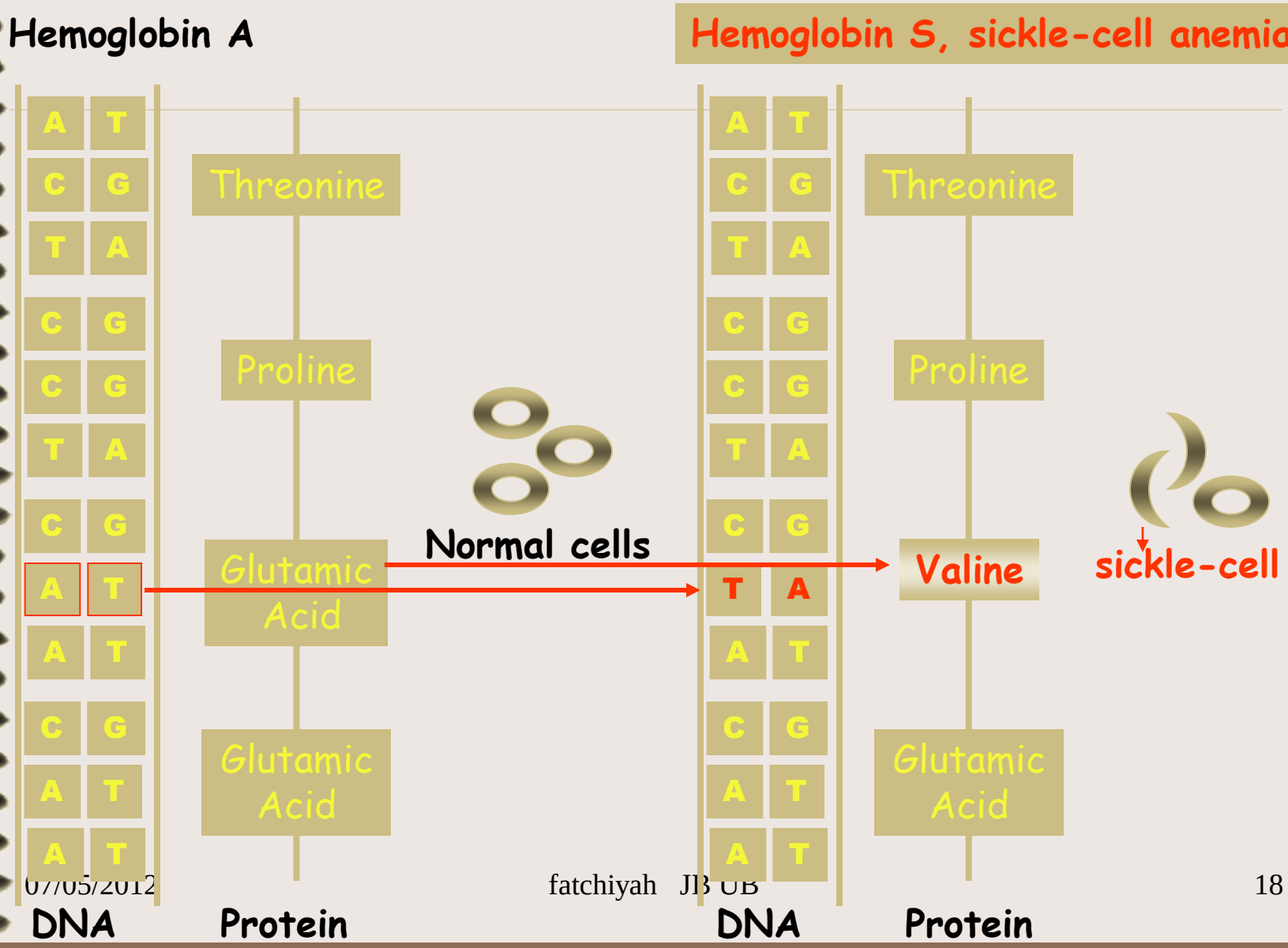
Two different hemoglobin genes from different chromosomes



Selective advantage of gene duplication

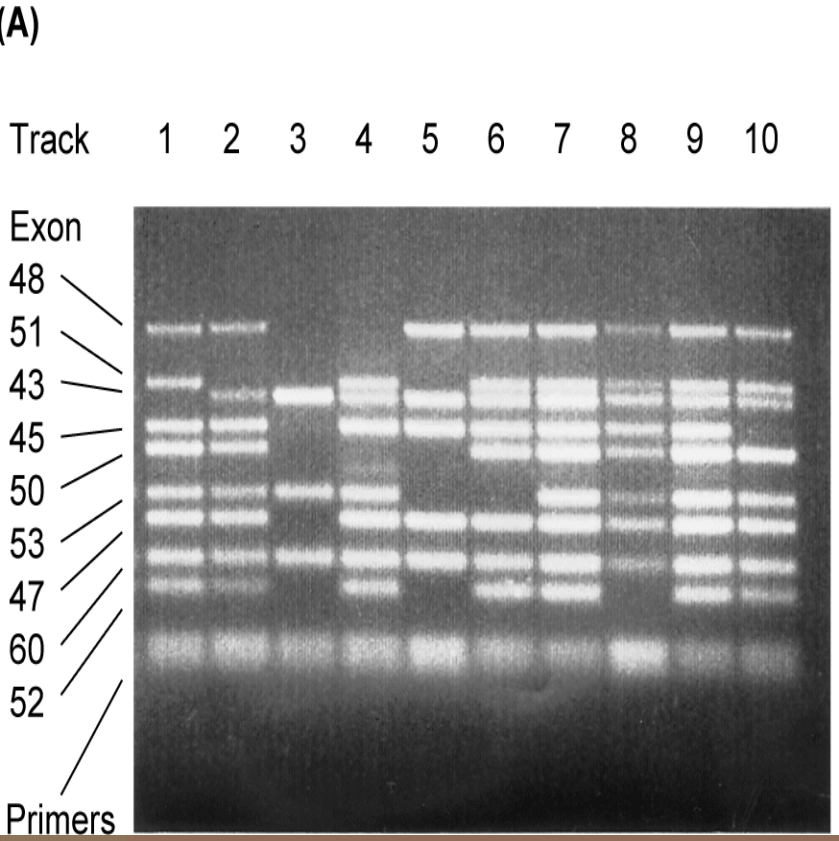


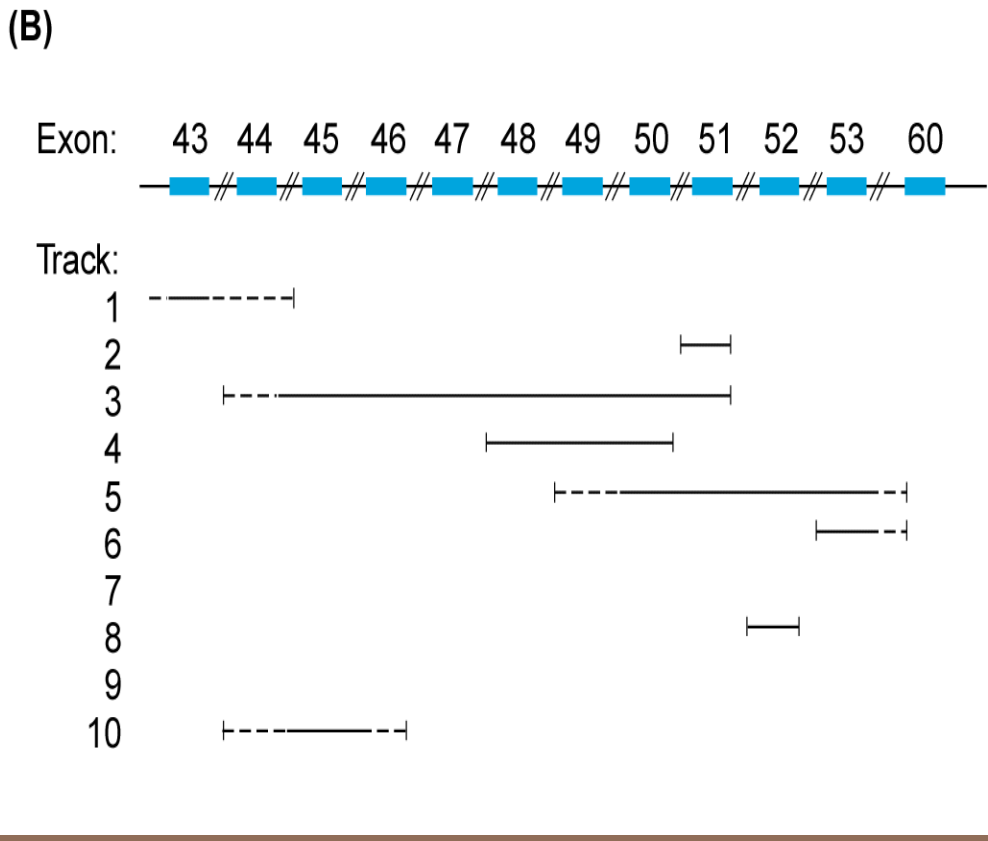
Molecular Mechanism of Mutations



Multiplex Mutation of Thalasemia

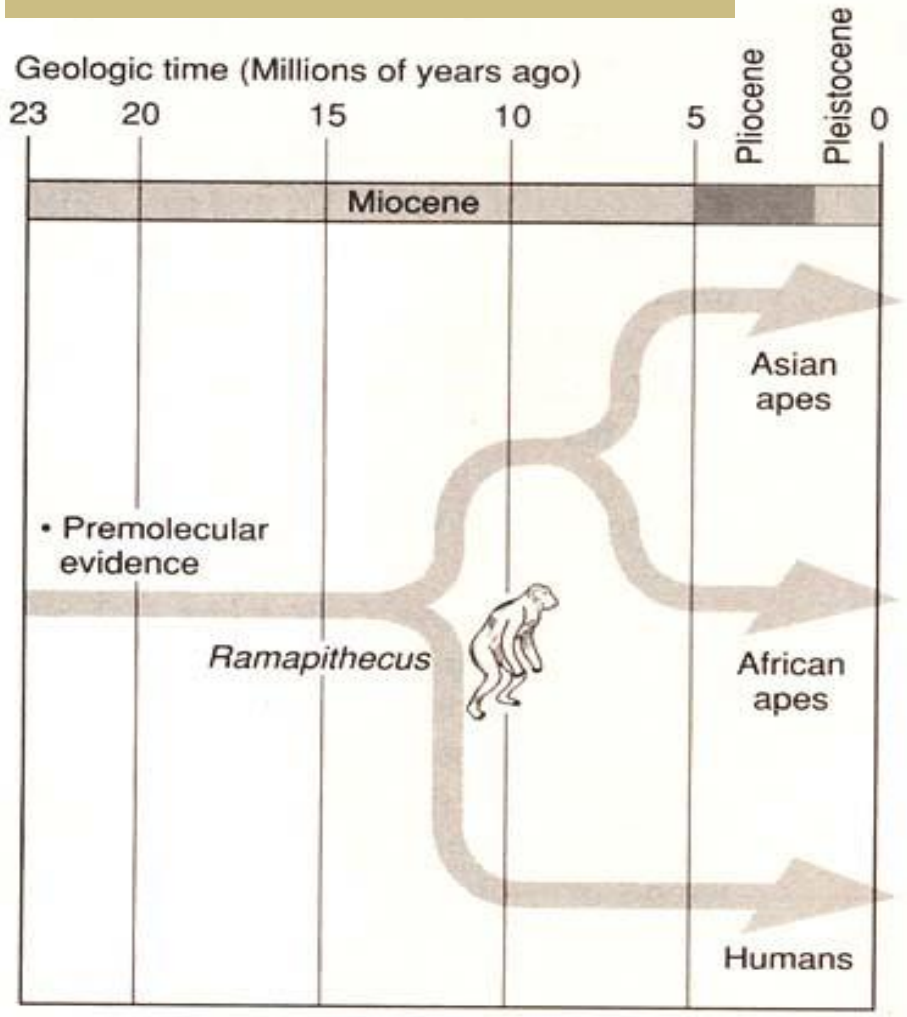
- Diagnostic applications by PCR reactions can be devised in which several targets are amplified simultaneously



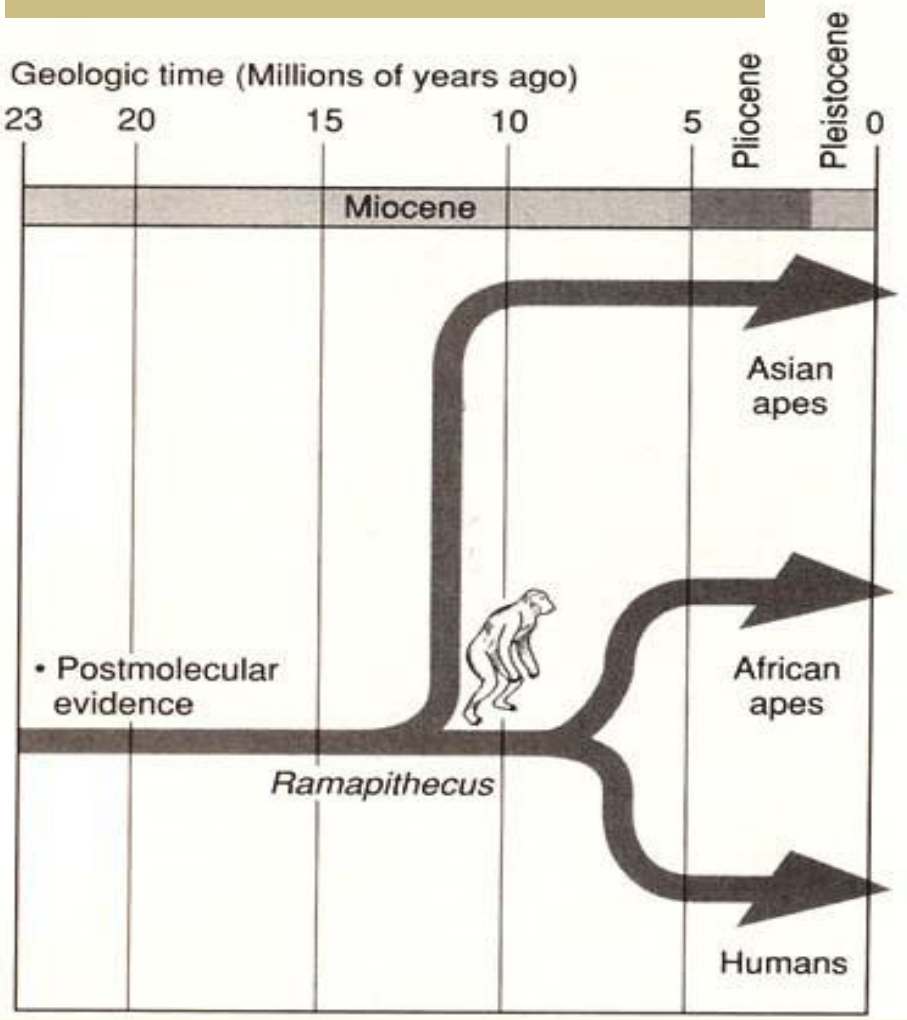


Divergence time between Human and African Apes

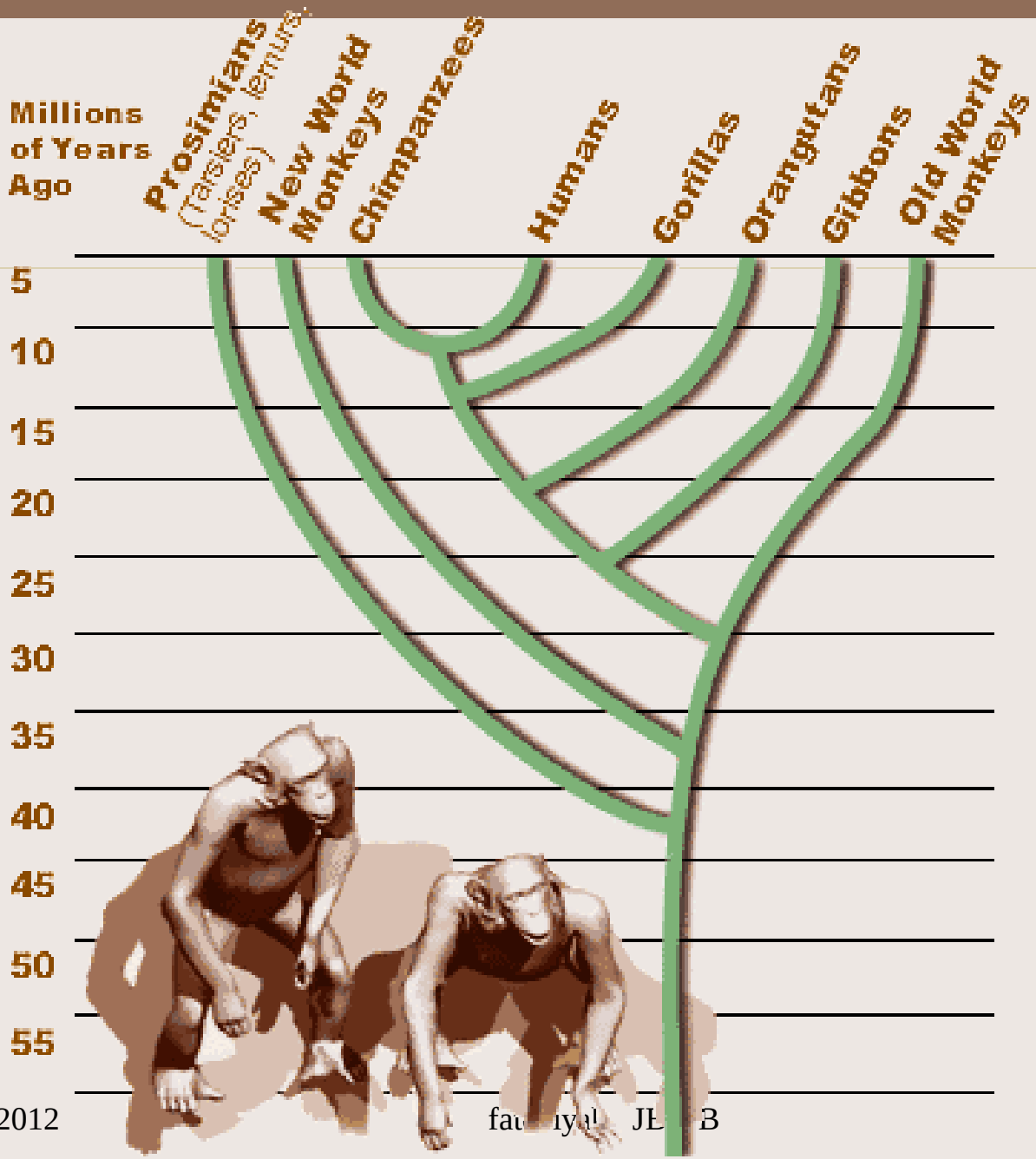
Pre-molecular Evidence



Post-molecular Evidence



Note: Asian apes is orangutan; African apes is chimpanzee and gorilla



Primates

http://members.aol.com/darwinpage/trees.htm

Molecular Genetics

- the functions of various nucleic acids used in Proof Reading & Correction.
- You may expect to see some changes to Protein Synthesis!
- The Amino Acid Chart may change from previous years

Molecular Genetics

- We have traditionally discussed the two main forms of point mutations:
    1. substitutions
    2. frame shift mutations

- However, silent, mis-sense and non-sense seem to be new terminology used for types of substitution (Point Mutations).

Genetics: Implications

- There is not clear-cut definition of genetic engineering
- Genetic markers – 2 types
  - Linked marker
  - Gene-Specific Marker
- The ethical issues surrounding the treatment of genetic disorders could be a potential level 3 question.

DNA sequence alignment of some of the sequence of the Human and mouse PDGF receptor

```
agacctcaaaaggtgtccacgtgagctgccgcccacgctgctggggaacagttccgaaga
|||||||||||||||||||| | ||| | ||||| | ||||||| |||||| | ||
agacctcaaaaggtgtccacgaaaactgtcacccacacccttggggaatagttccaagga

ggagagccagctggagactaacgtgacgtactgggaggaggagcaggagtttgaggtggt
|||||||||||| || || || ||||| | ||||||||| || ||||| | ||||||||
ggagagccagctagaaacgaatgtgactttctgggaggaagatcaggaatacgaggtggt

gagcacactgcgtctgcagcacgtggatcggccactgtcggtgcgctgcacgctgcgcaa
|||||||||||| |||| |||||||||| ||||||||| || ||||||| ||||| ||
gagcacactgcgcctgcgccacgtggatcagccactgtccgtacgctgcatgctgcagaa

cgctgtgggccaggacacgcaggaggtcatcgtggtgccacactccttgccctttaaggt
| | |||| || |||||||||||| |||||| ||||| |||||||||| || ||
ctccatgggtggagattcgcaggaggtcaccgtggtcccacattccttgcccttcaaagt

ggtggtgatctcagccatcctggccctggtggtgctcaccatcatctcccttatcatcct
|||||||||||||||||||||||| | ||||| || ||| ||||||| || ||||||||
ggtggtgatctcagccatcctggccttagtggtccttaccgtcatctctctcatcatcct
```

Comparison of some of the amino acid sequence from Human and mouse PDGF receptors. Note indels.

- LKRCPRELPPTLLGNSSEEESQLETNVTYWEEEQEFEVVSTLRLQHVDRPLSVRCTLRNA
- LKRCPR+L PT LGNSS+EESQLETNVT+WEE+QE+EVVSTLRL+HVD+PLSVRC L+N+
- LKRCPRKLSPTPLGNSSKEESQLETNVTFWEEDQEYEVVSTLRLRHVDQPLSVRCMLQNS

- VGQDTQEVIVVPHSLPFKXXXXXXXXXXXXXXXXXXXXXXMLWQKKPRYEIRWKVIESVS
- +G D+QEV VVPHSLPFK MLWQKKPRYEIRWKVIESVS
- MGGDSQEVTVVPHSLPFKVVVISAILALVVLTVISLIILIMLWQKKPRYEIRWKVIESVS

- SDGHEYIYVDPMQLPYDSTWELPRDQLVLGRTLGSGAFGQVVEATAHGLSHSQATMKVAV
- SDGHEYIYVDP+QLPYDSTWELPRDQLVLGRTLGSGAFGQVVEATAHGLSHSQATMKVAV
- SDGHEYIYVDPVQLPYDSTWELPRDQLVLGRTLGSGAFGQVVEATAHGLSHSQATMKVAV

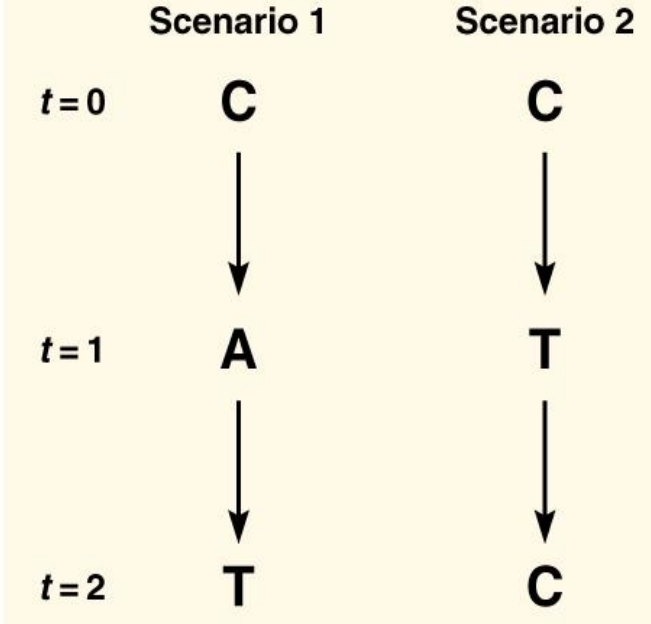
- Which is better (amino acid sequence or DNA sequence) to study function? Which is better to study evolution?

Molecular Evolution

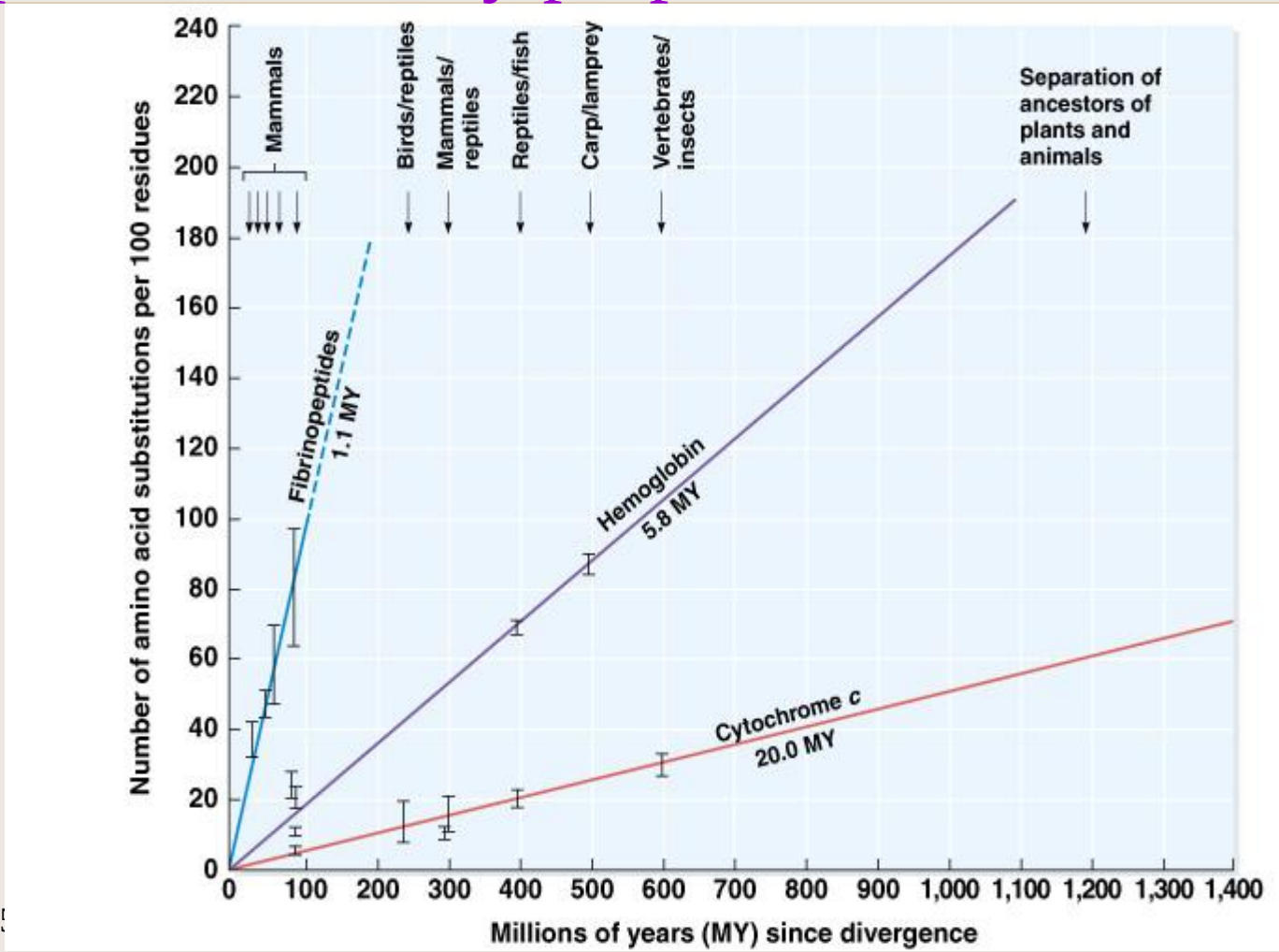
- ✓ Can there be a rate calculated for the changes that occur within a sequence. In other words how fast do changes occur within a gene.
- ✓ Rate equation number of changes per unit time
- ✓ How are number of changes estimated?

- **Estimations trying to take into account changes that may have occurred that don't result in a net change.**

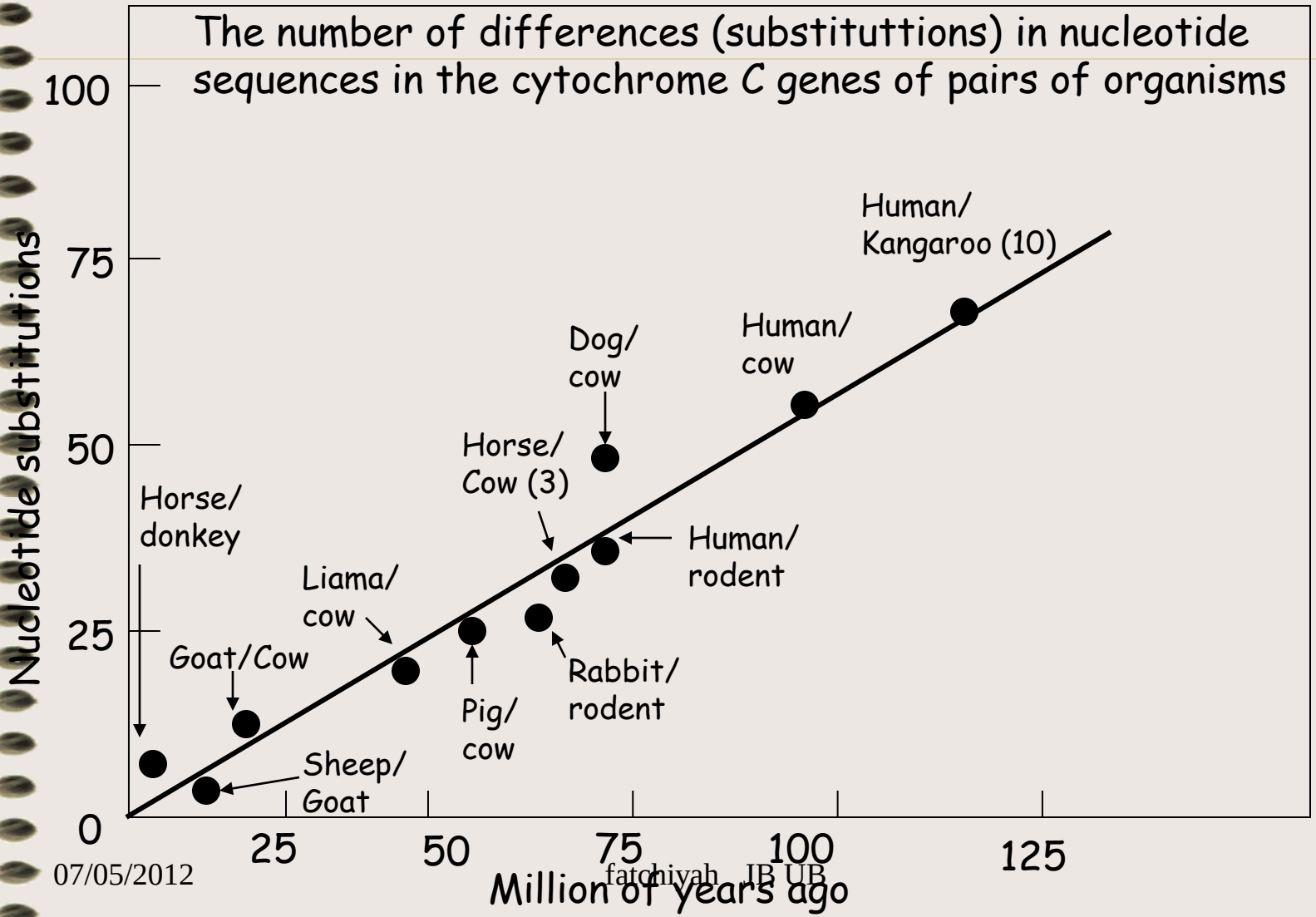
- ❑ Rates of change can be estimated
- ❑ Are rates the same for all DNA?
- ❑ Are mutation rates the same
- ❑ For all synonymous possibilities?
- ❑ For all proteins?
- ❑ For all amino acids?
- ❑ For organelles?



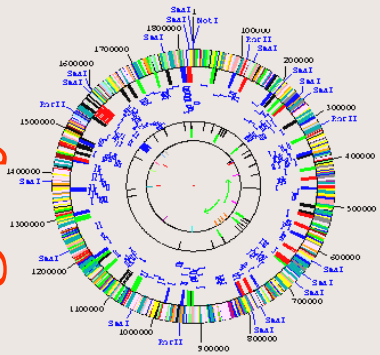
- Molecular clocks
- changes in homologous proteins between species is directly proportional to time

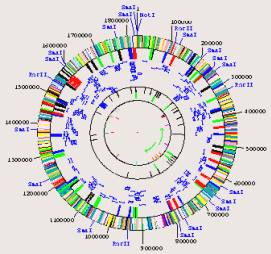


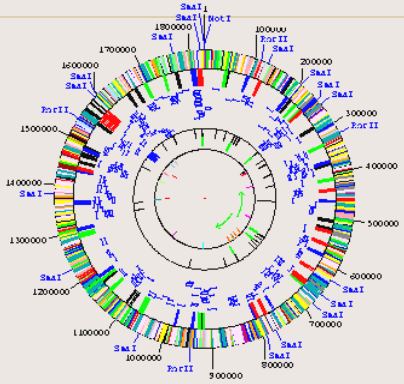
Molecular Clock of Cytochrome C is an ancient and evolutionarily conservative molecule



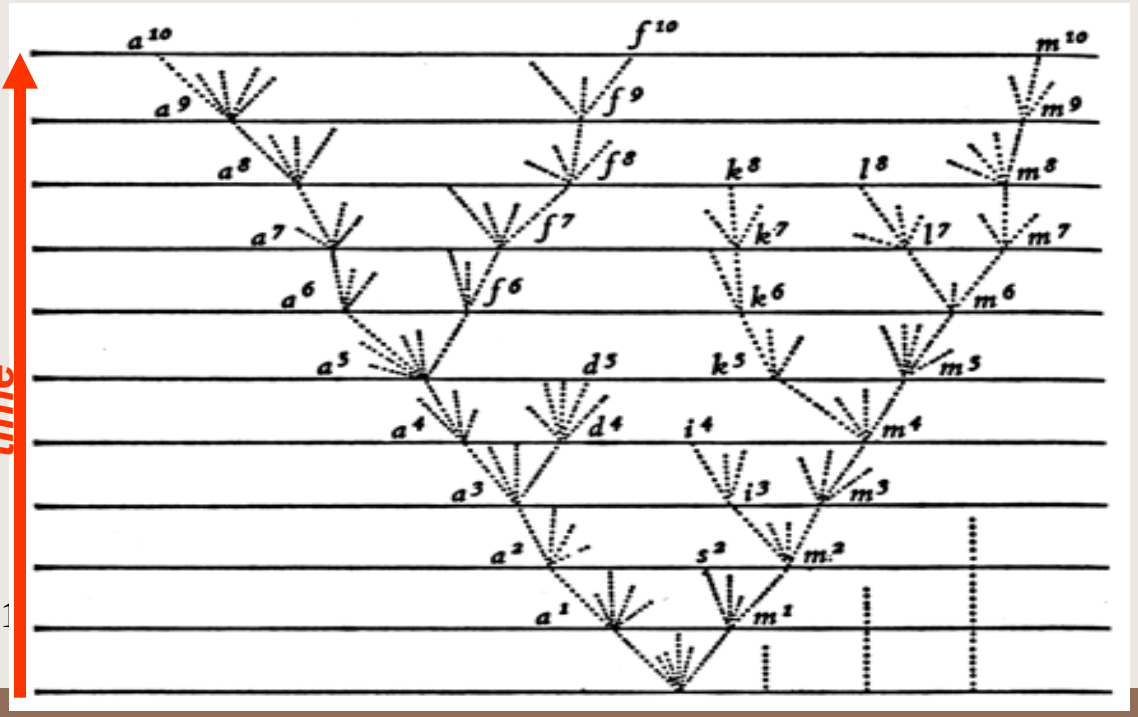
To a first (and often quite good) approximation, gene families have arisen by descent with modification *via* a hierarchy of increasingly distant common ancestors







- Molecular phylogeny

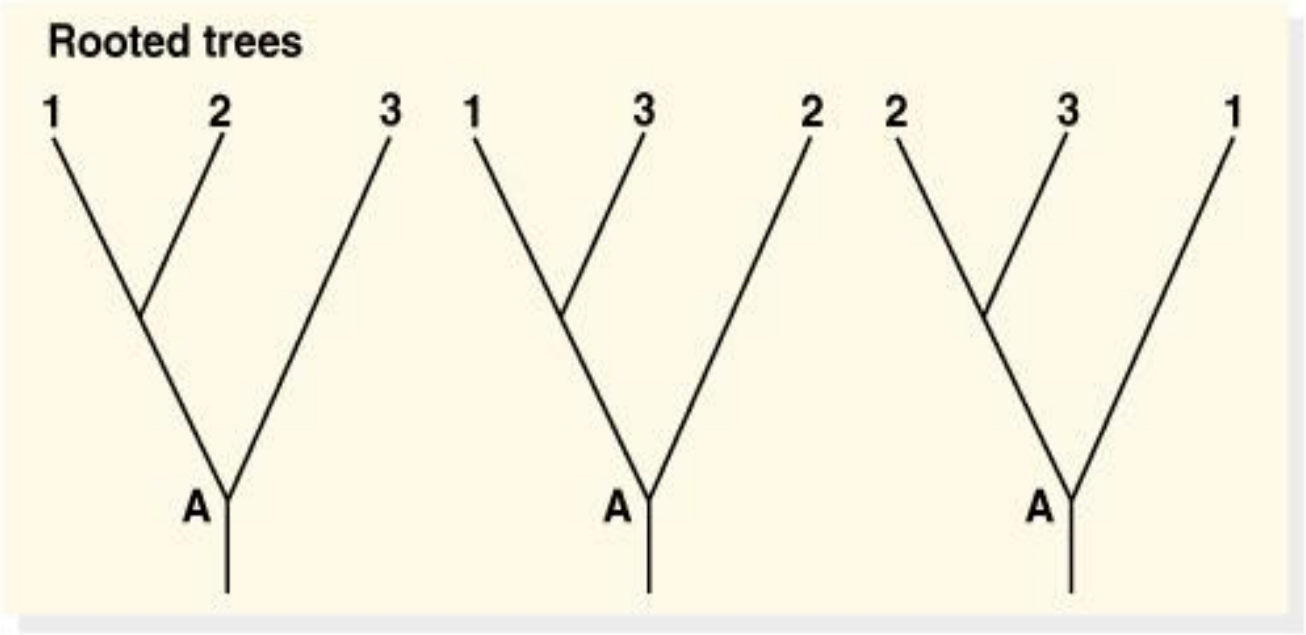


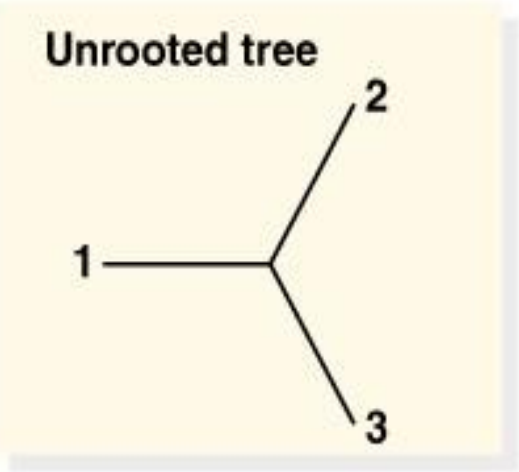
Genomes: TIGR

Tree: Darwin, *Origin of Species*

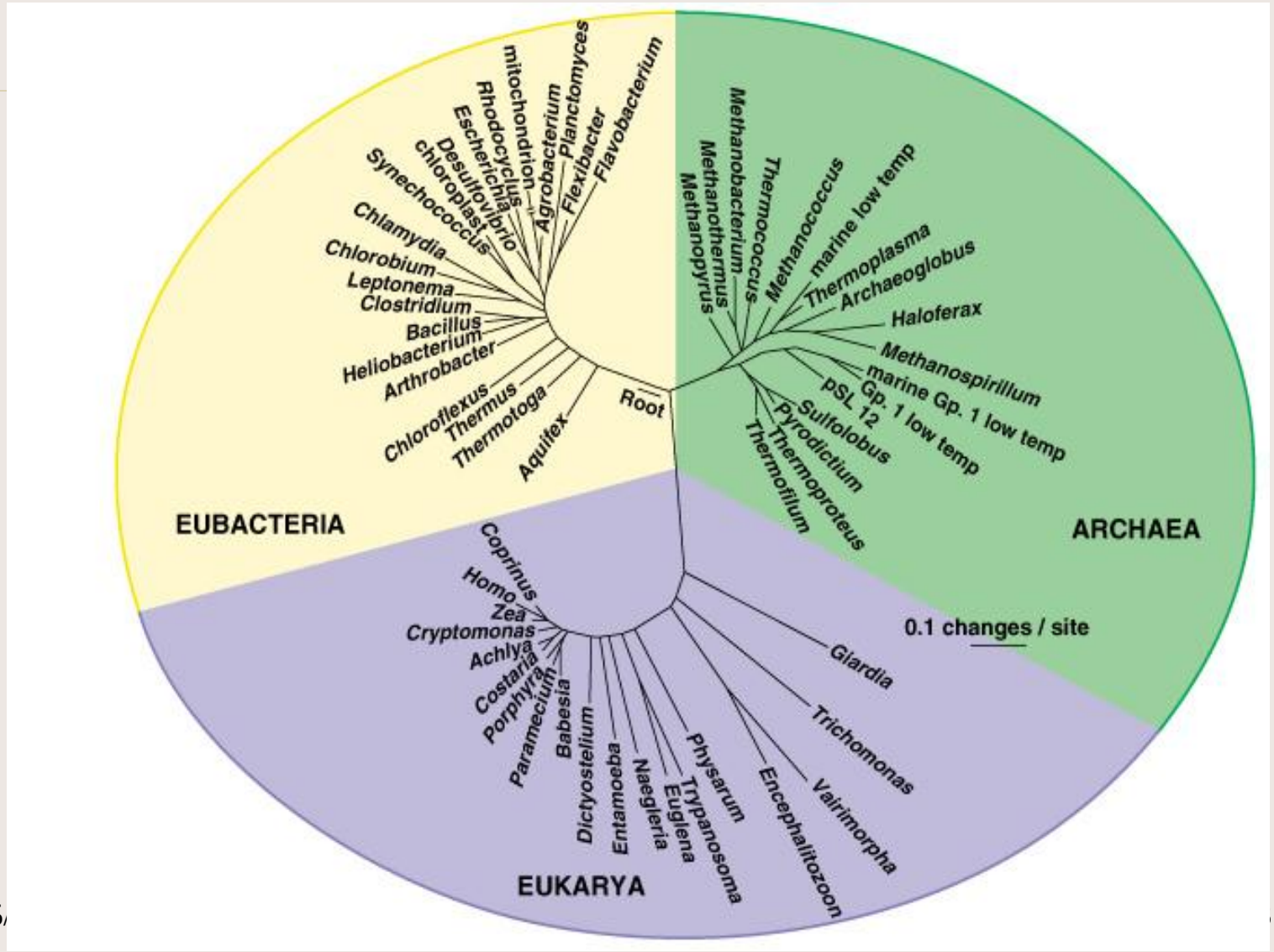
Phylogenetic trees

- Which tree is correct?
- Data matrix- statistical approach
- Parsimony-based – simplest relationship, lowest number of mutations

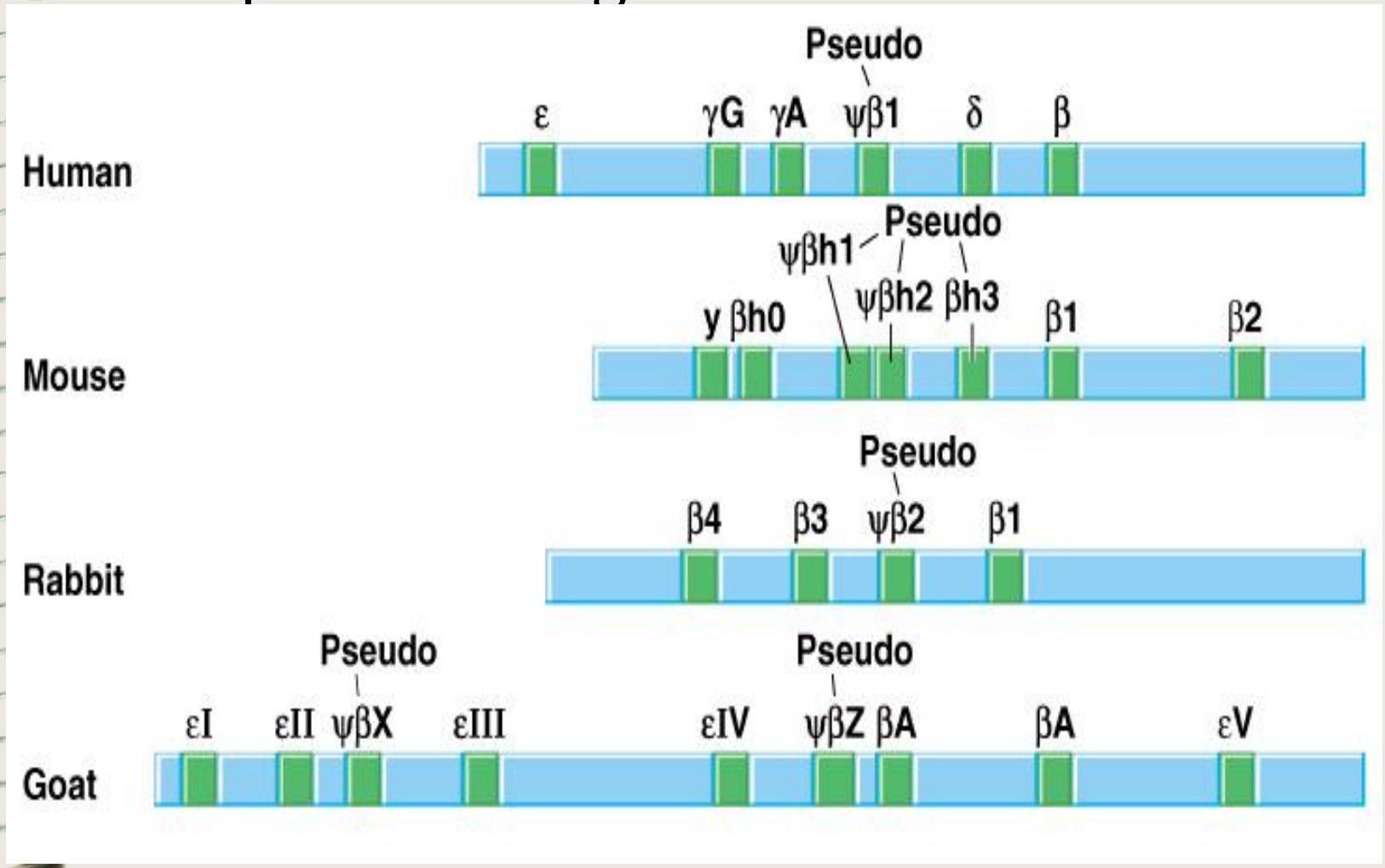




- Bootstrapping


mitochondrion
Agrobacterium
Planctomyces
Flexibacter
Flavobacterium
Rhodocyclus
Escherichia
Desulfovibrio
chloroplast
Synechococcus
Chlamydia
Chlorobium
Leptonema
Clostridium
Bacillus
Heliobacterium
Arthrobacter
Chloroflexus
Thermus
Thermotoga
Aquifex
Root
Methanobacterium
Methanothermus
Methanopyrus
Thermococcus
Methanococcus
marine low temp
Thermoplasma
Archaeoglobus
Haloferax
Methanospirillum
marine Gp. 1 low temp
Gp. 1 low temp
pSL 12
Sulfolobus
Pyrodictium
Thermoproteus
Thermofilum
EUBACTERIA
ARCHAEA
Coprinus
Homo
Zea
Cryptomonas
Achlya
Costaria
Porphyra
Paramecium
Babesia
Dictyostelium
Entamoeba
Naegleria
Euglena
Trypanosoma
Physarum
Encephalitozoon
Vairimorpha
Trichomonas
Giardia
0.1 changes / site
EUKARYA

- How are new genes created while still maintaining the “old” gene.
- Duplication of genes and/or exons



Problem

1. How does the coding DNA can estimate the phenotype of organism?
2. Why the pre-molecular and post molecular evidence are different ?
3. Lets explain the relationship of natural selection of physiologies to evolution process.