

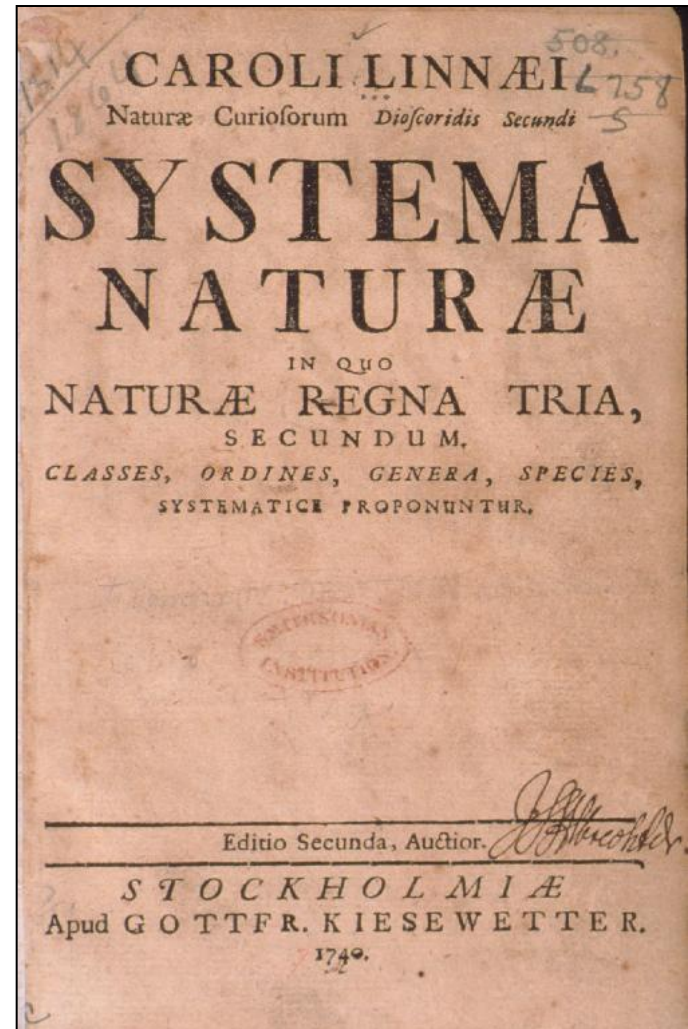
On evolution and sequences

Bent Petersen

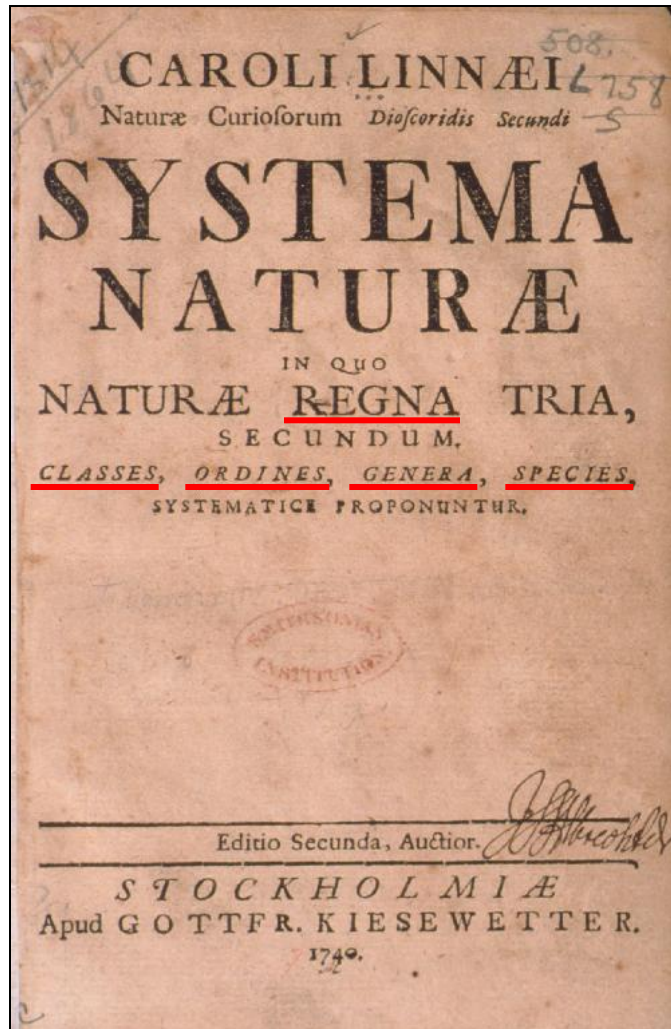
Classification: Linnaeus



Carl Linnaeus
1707-1778



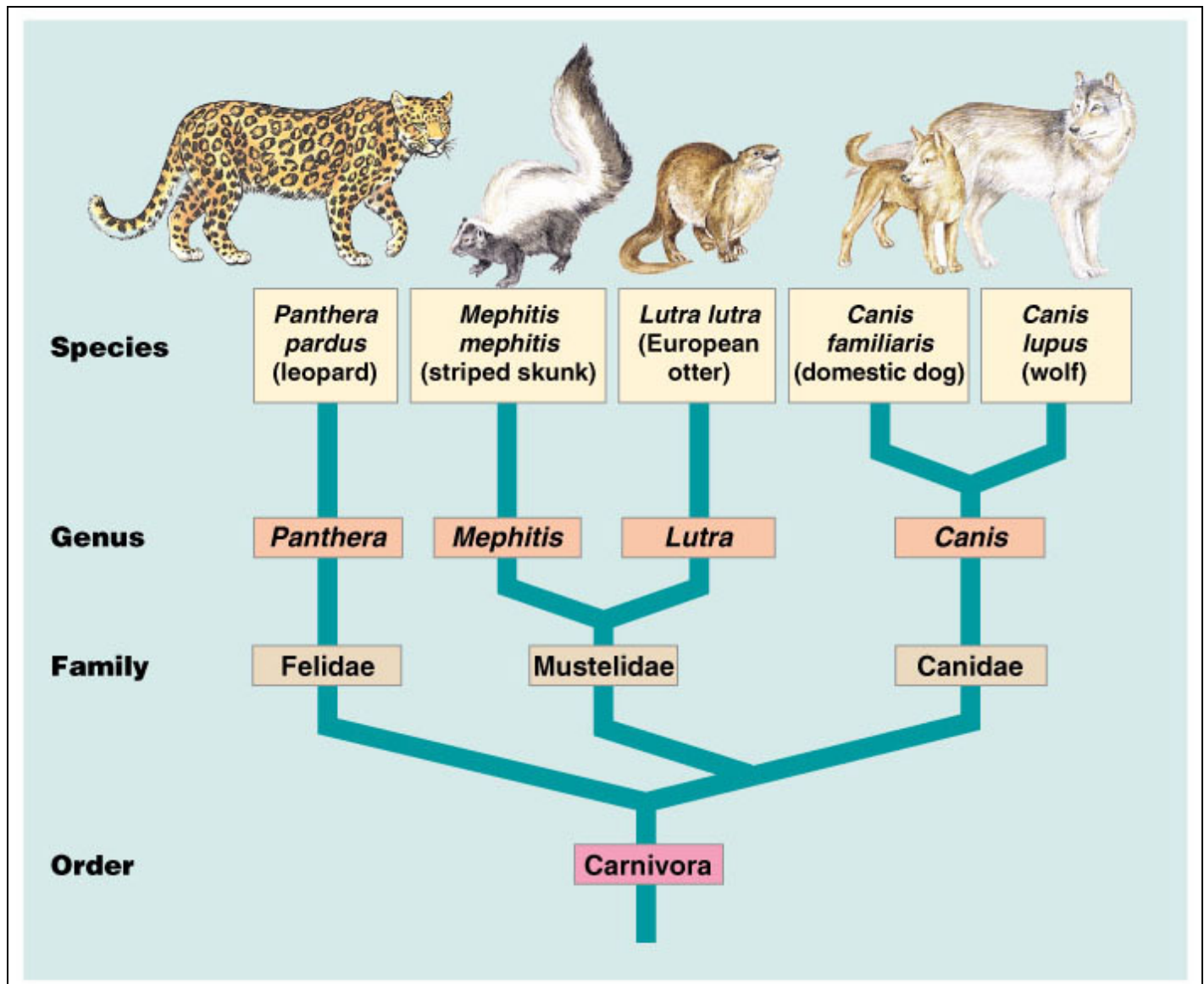
Classification: Linnaeus



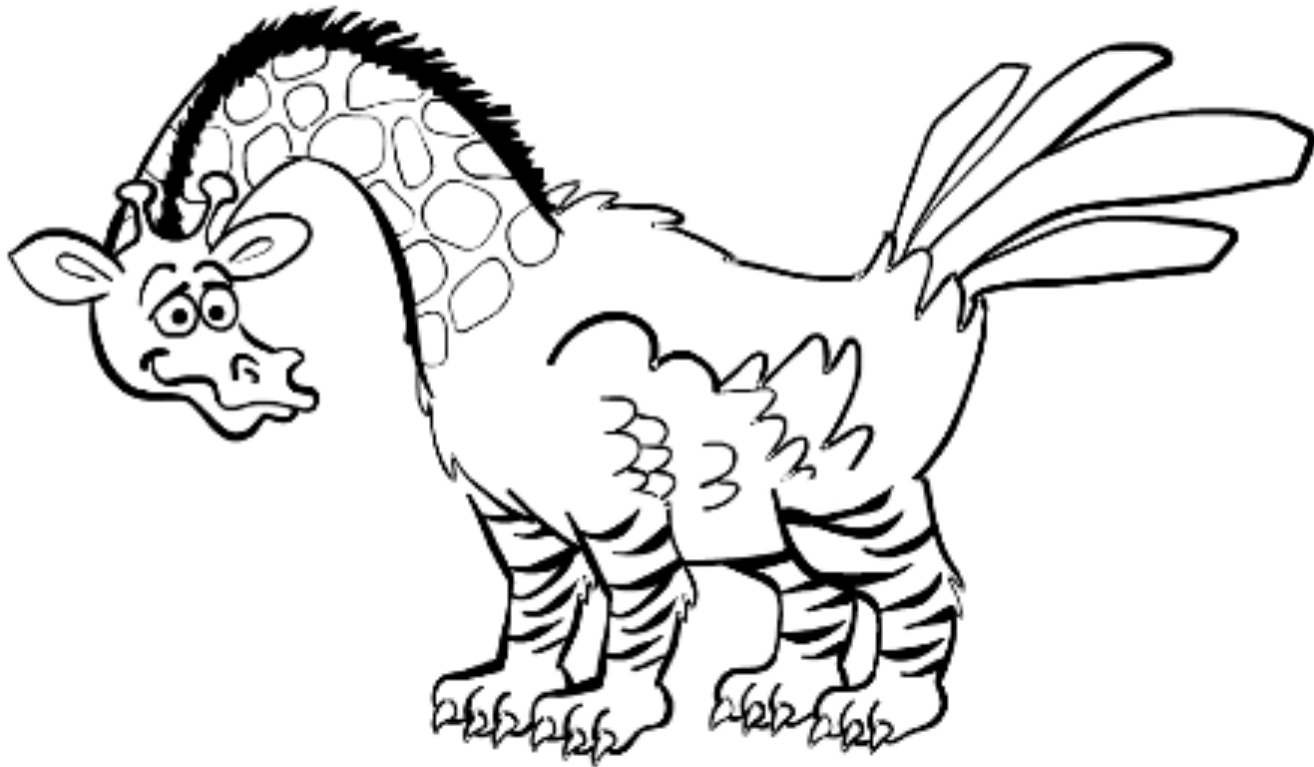
- Hierarchical system
 - Kingdom
 - Phylum
 - Class
 - Order

 - Genus
 - Species

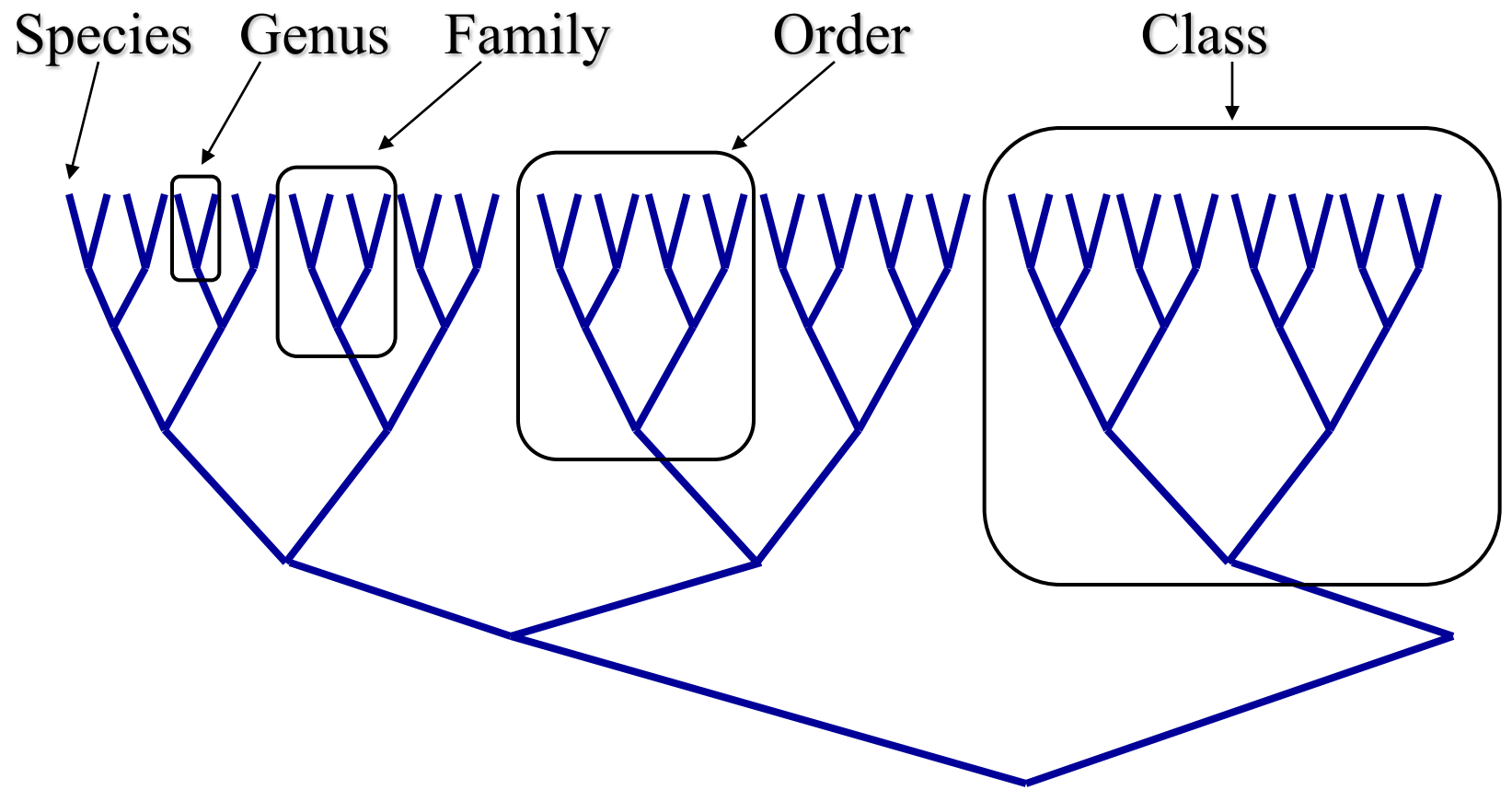
Classification depicted as a tree



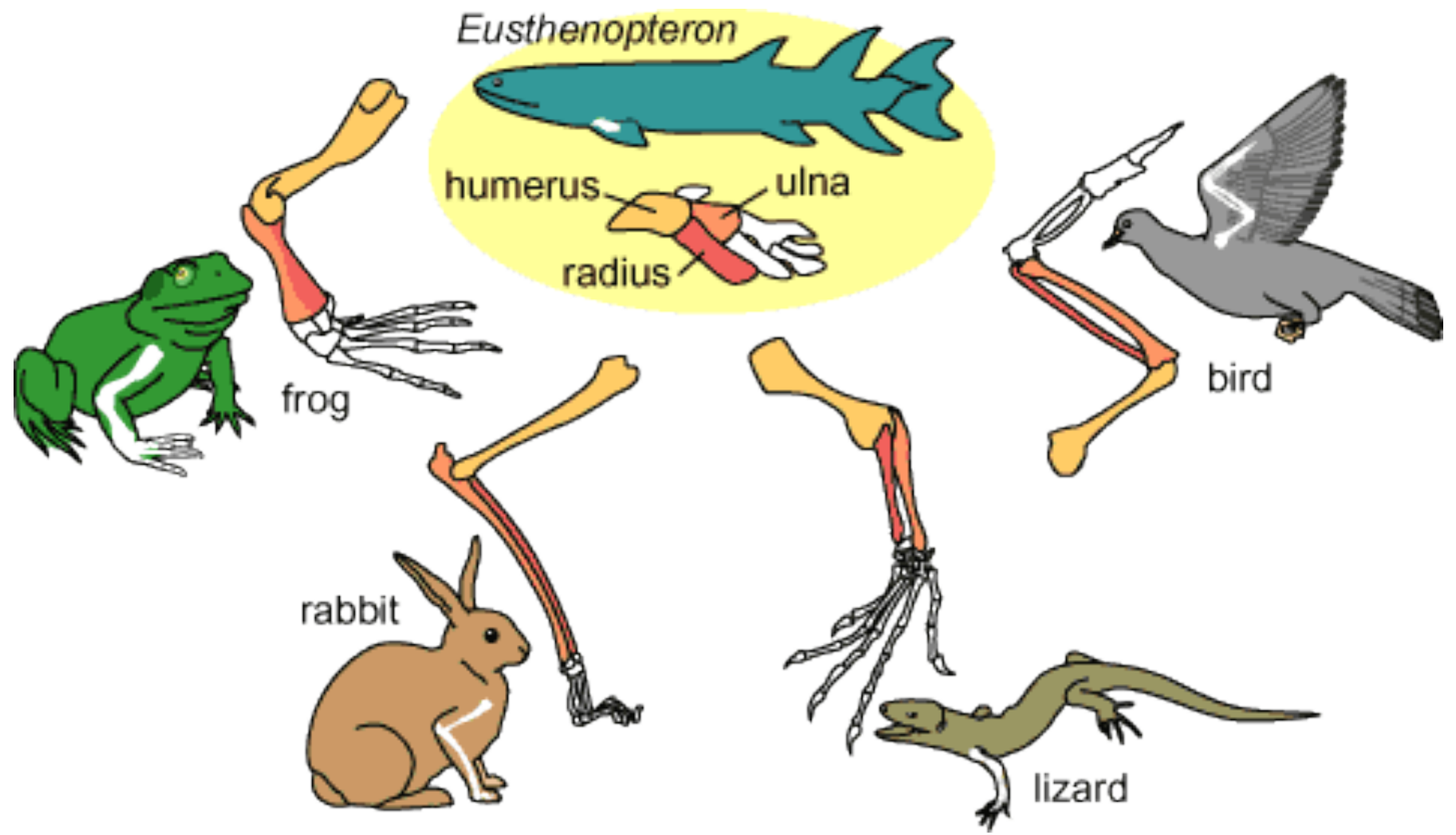
No “mixed” animals

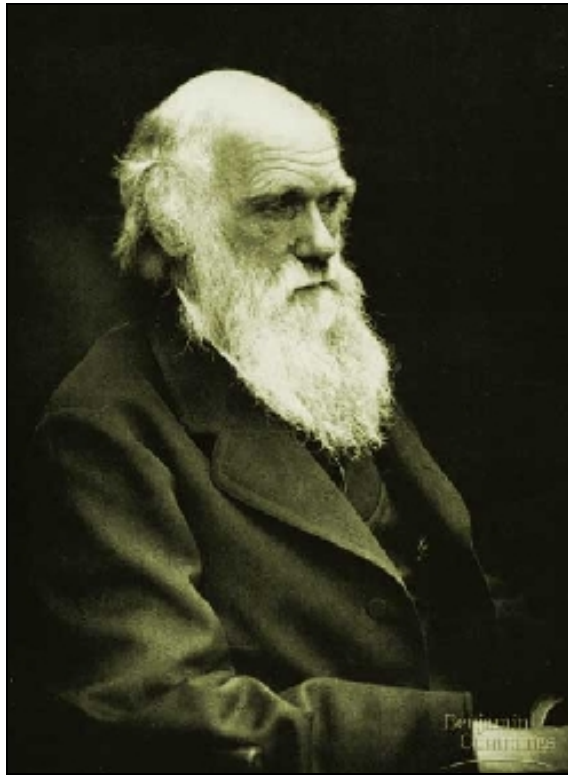


Classification depicted as a tree

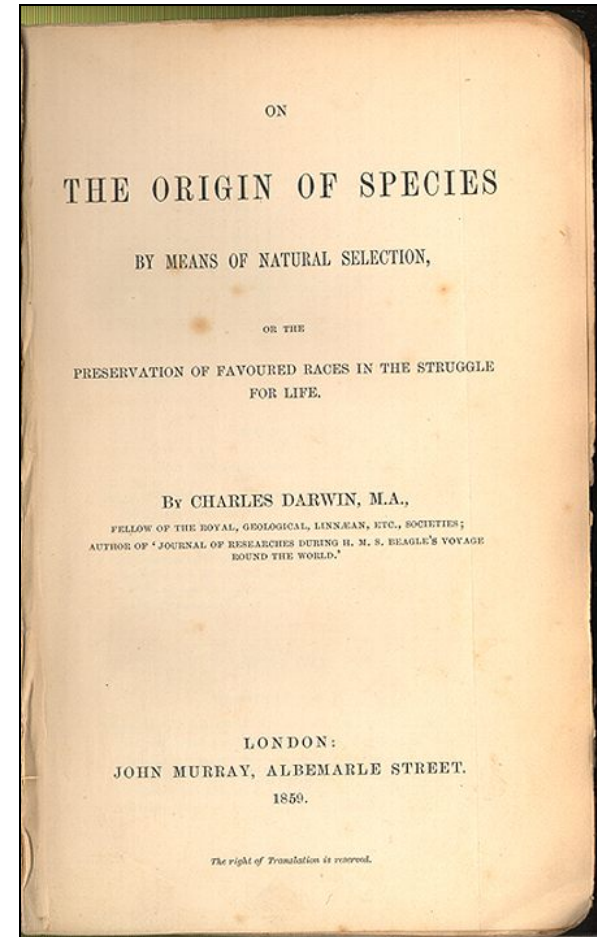


Comparison of limbs



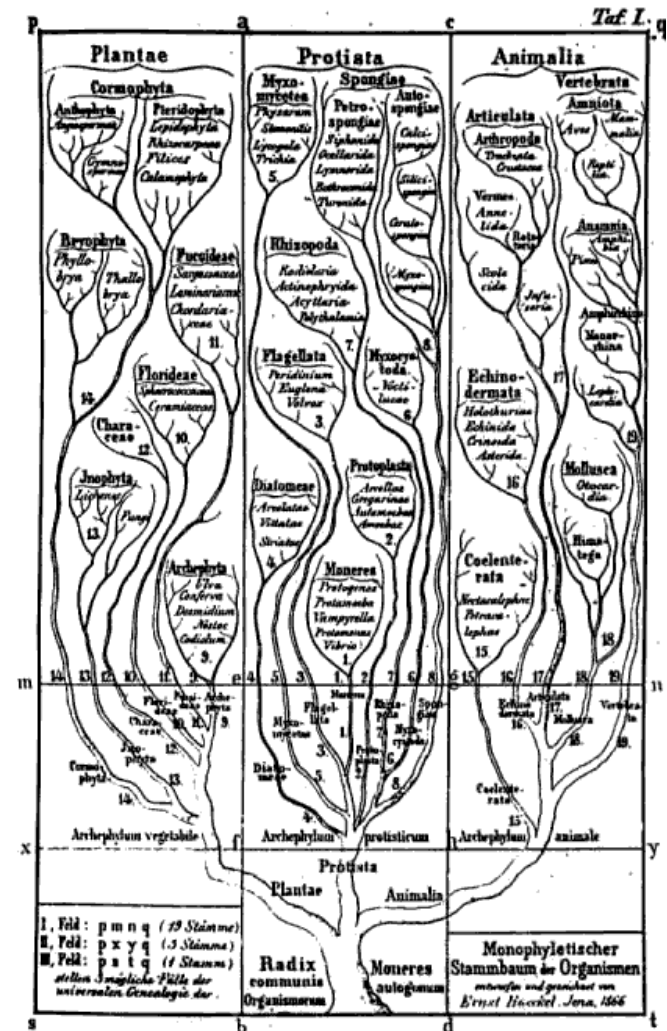


Charles Darwin
1809-1882



Phylogenetic basis of systematics

- **Linnaeus:**
Ordering principle is God.
- **Darwin:**
Ordering principle is shared descent from common ancestors.
- Today, systematics is explicitly based on phylogeny.

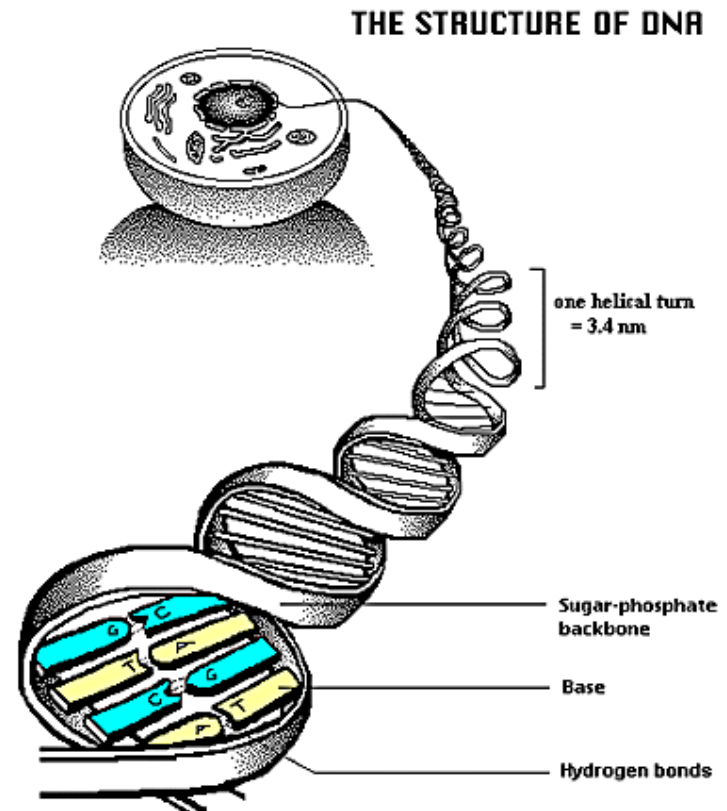


Natural Selection: Darwin's four postulates

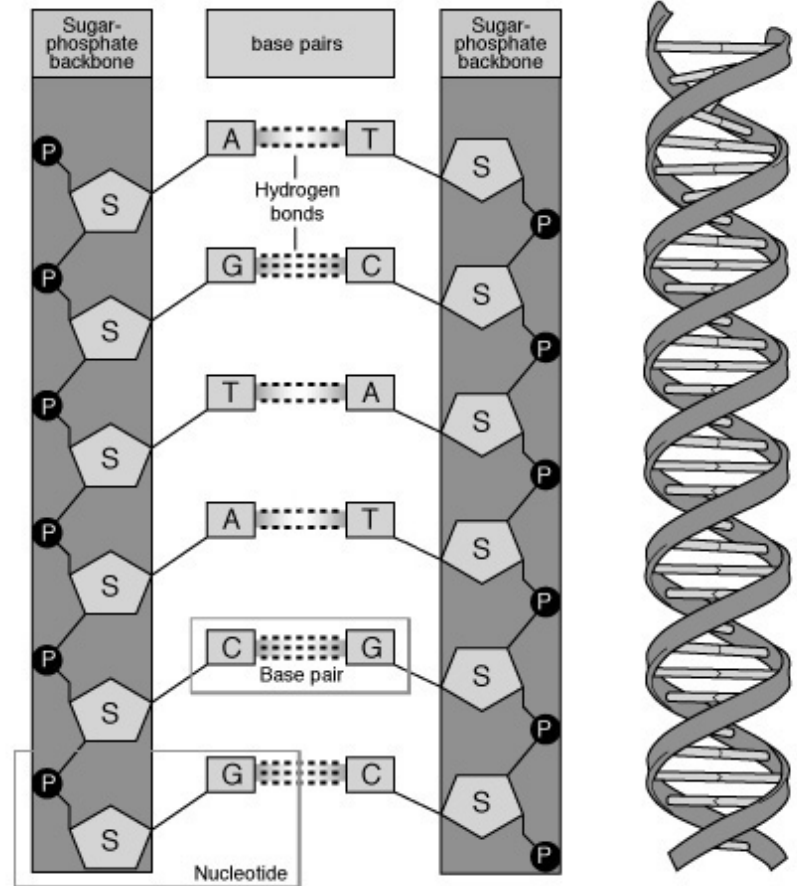
- More young are produced each generation than can survive to reproduce.
 - Individuals in a population vary in their characteristics.
 - Some differences among individuals are based on genetic differences.
 - Individuals with favorable characteristics have higher rates of survival and reproduction.
-
- Evolution by means of natural selection
 - Presence of "design-like" features in organisms:
 - Quite often features are there "for a reason"

Evolution at the sequence level

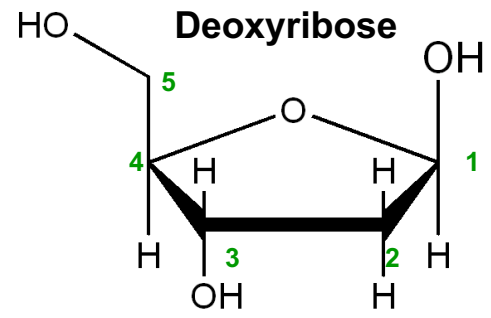
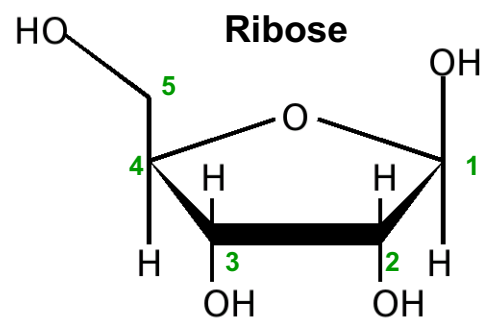
- DNA contains the recipes of how to make protein / enzymes.
- Every time a cell divides its DNA is duplicated, and each daughter cell gets a copy.



- The information in the DNA is written in a four-letter code: **A**, **T**, **G**, **C**.
- The DNA can be "sequenced" and the result stored in a computer file.
- ATGGCCCTGTGGAT

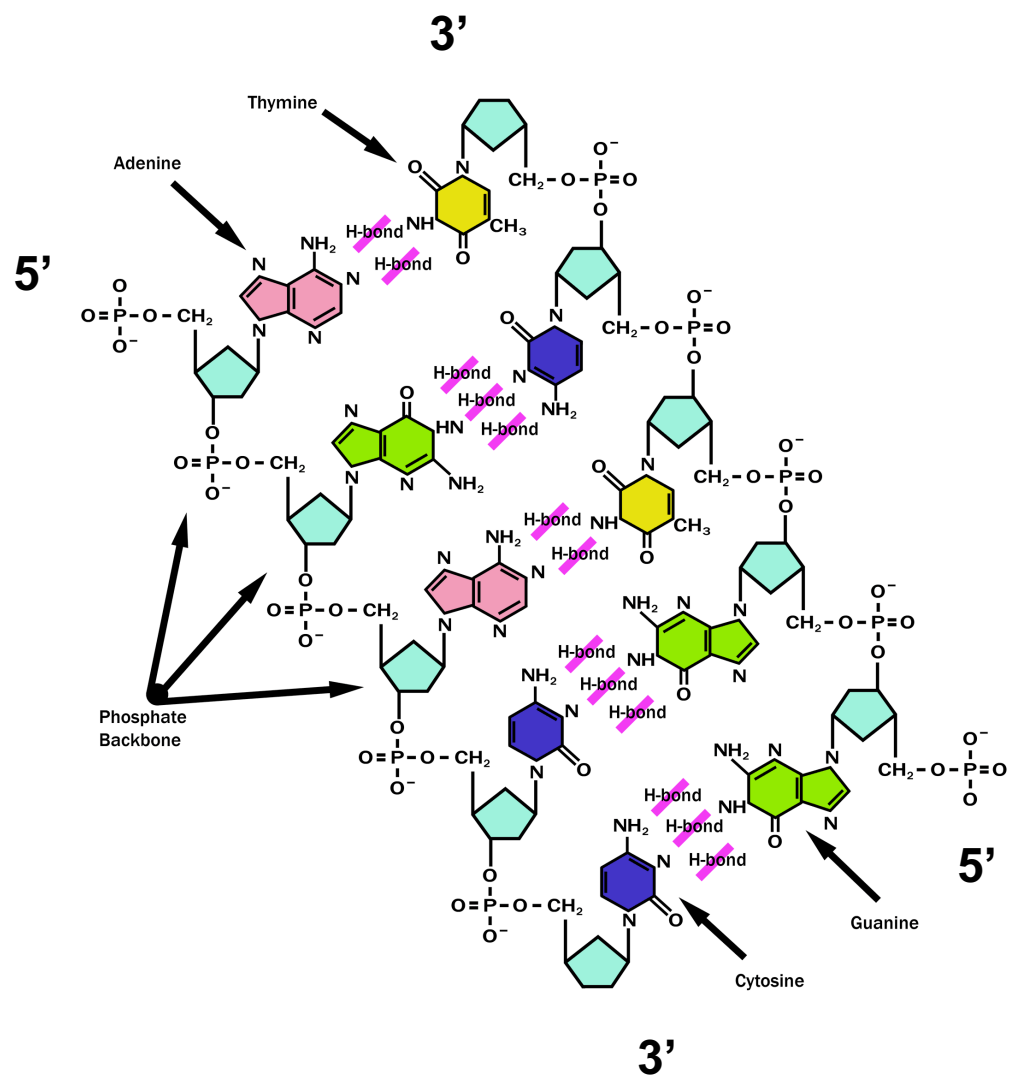


DNA is always written 5' → 3'



5' AGCC 3'
3' TCGG 5'

5' ATGGCCAGGTAA 3'



Can DNA be changed?

- ATGGCCCTGTGGATGCG

Can DNA be changed?

- ATGGCCCTGTGGATGCG
- ↓
- ATGGCCCT**A**TGGATGCG

A history of mutations

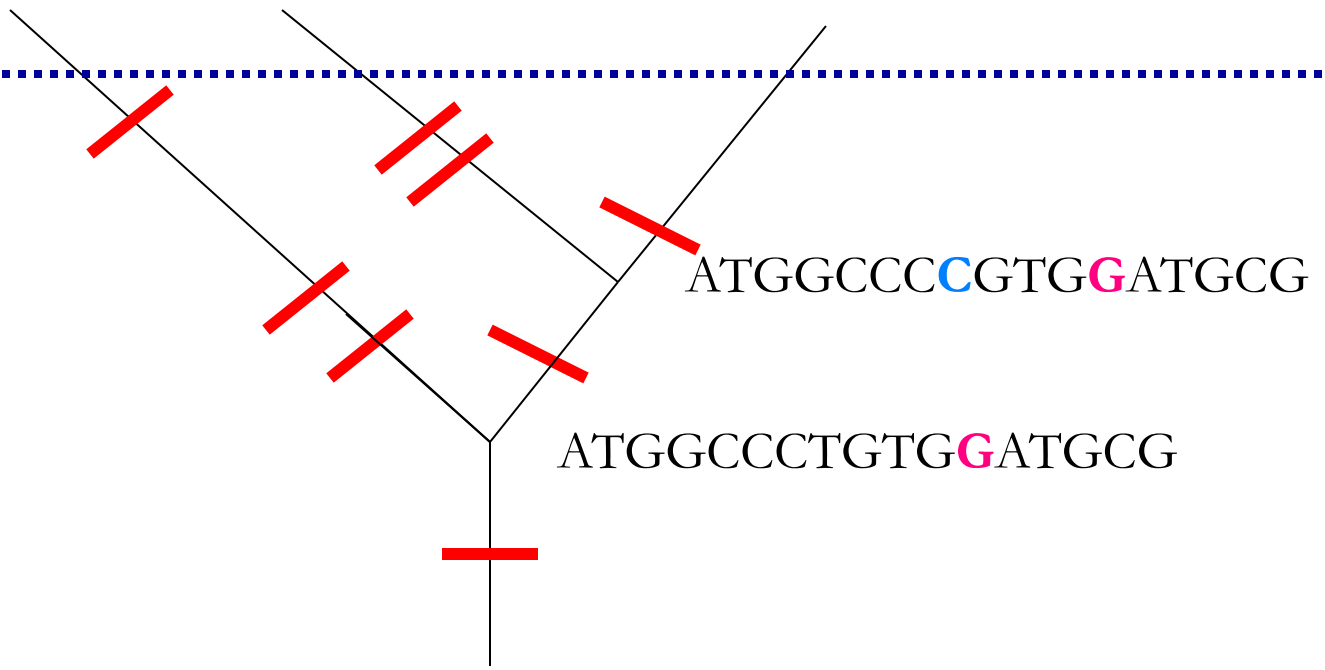
ATGGCAATGTG**G**ATGCA

ATGGCCCC**C**GTG**G**AACCG

ATGTCCCC**C**GTG**G**ATGCG



Time

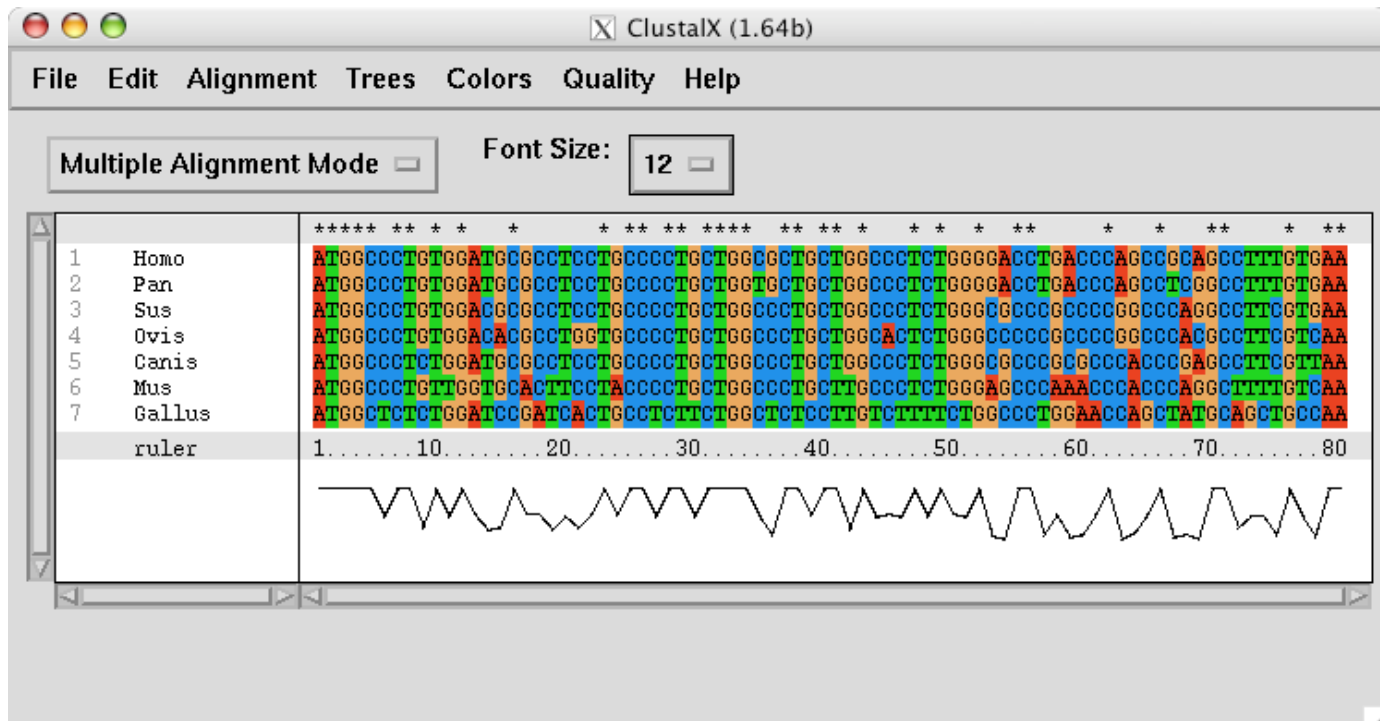


ATGGCCCTGTG**G**ATGCG

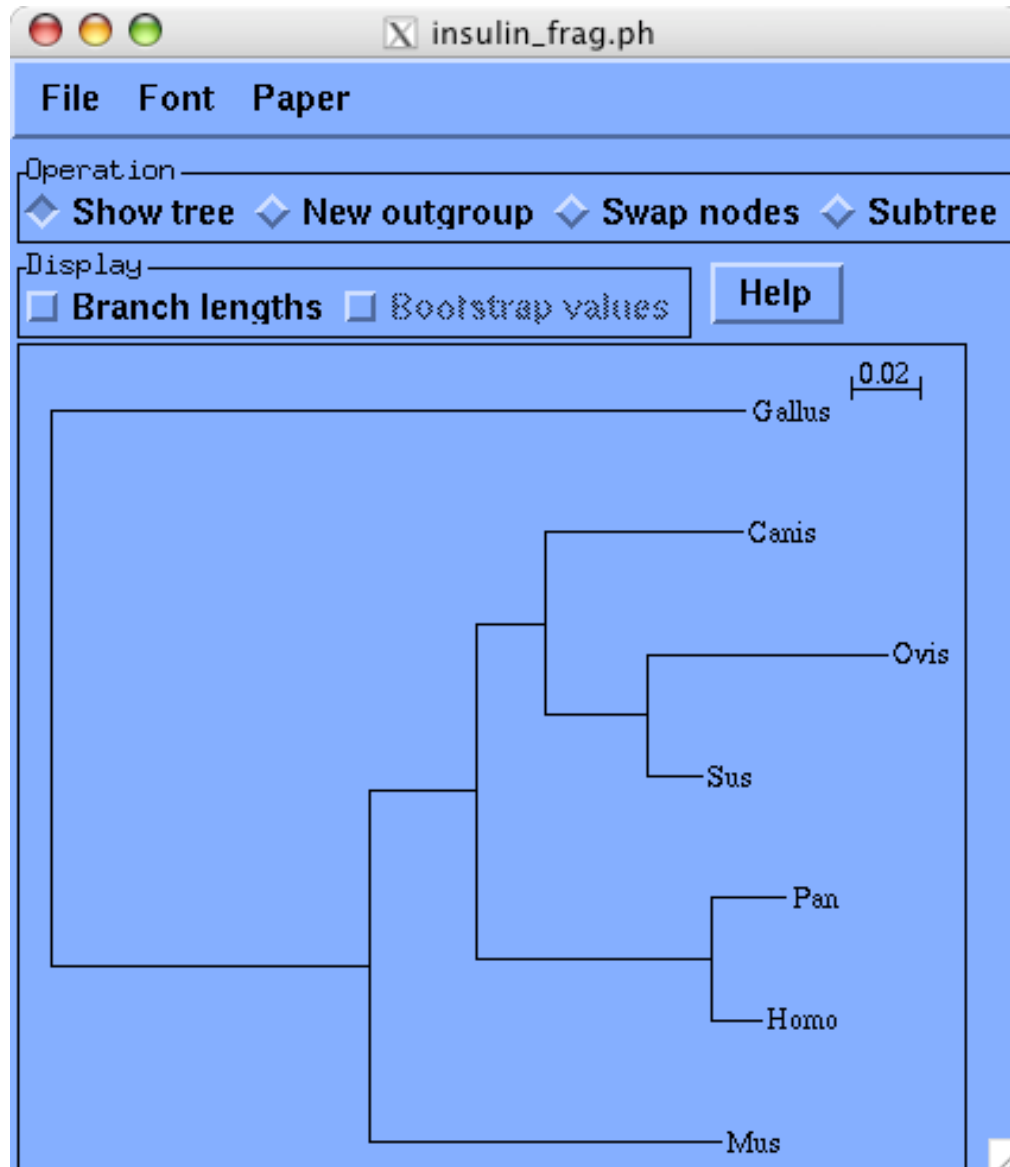
- Species1: ATGGC**AA**TGTG**G**ATGCA
 - Species2: ATGGCCC**C**GTG**G**A**AC**CG
 - Species3: ATG**T**CCC**C**GTG**G**ATGCG
-
- The diagram shows three DNA sequences aligned. Brackets on the right indicate alignment counts: 6 for the first two species, 3 for the last two, and 5 for all three.

- Insulin from 7 different species

- Homo: ATGGCCCTGTGGATGCGCCTCCTGCCCTGCTGGCGCTGCTGGCCCTCTGGGGACCTGACCCAGCCGAGCCTTTGTGAA
- Pan: ATGGCCCTGTGGATGCGCCTCCTGCCCTGCTGGTGTCTGCTGGCCCTCTGGGGACCTGACCCAGCCTCGGCCTTTGTGAA
- Sus: ATGGCCCTGTGGACGCGCCTCCTGCCCTGCTGGCCCTGCTGGCCCTCTGGGGACCCGCCCCGCCCCAGGCCTTCGTGAA
- Ovis: ATGGCCCTGTGGACACGCCTGGTGCCCTGCTGGCCCTGCTGGCACTCTGGGCCCCGCCCCGCCCCAGCCTTCGTCAA
- Canis: ATGGCCCTCTGGATGCGCCTCCTGCCCTGCTGGCCCTGCTGGCCCTCTGGGGACCCGCCCCACCCAGCCTTCGTAA
- Mus: ATGGCCCTGTTGGTGCACCTTCCTACCCCTGCTGGCCCTGCTGGCCCTCTGGGAGCCCAAACCCACCCAGGCTTTGTCAA
- Gallus: ATGGCTCTCTGGATCCGATCACTGCCTCTTCTGGCTCTCCTTGTCTTTTCTGGCCCTGGAACCAGCTATGCAGCTGCCAA



Real life example: Tree

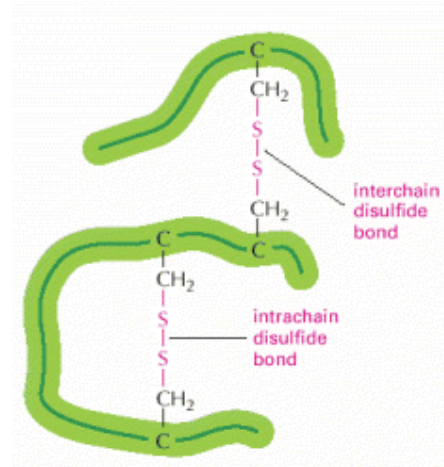


Interpretation of Multiple Alignments

Conserved features assumed to be important for functionality

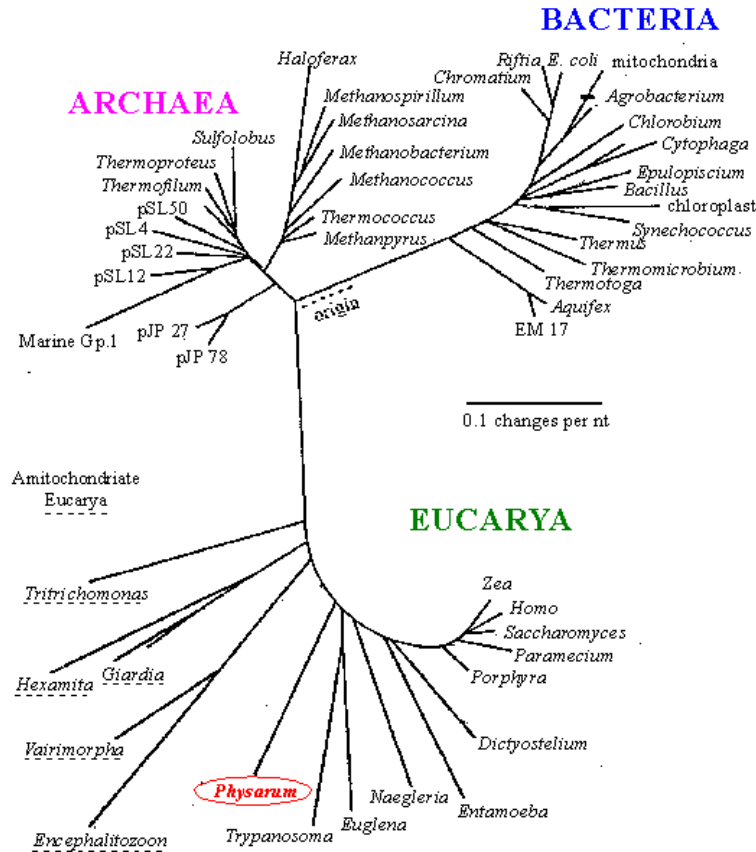
For instance: conserved pairs of cysteines indicate possible disulphide bridge

	100					105	
L	C	L	N	R	A	C	S
M	C	S	N	Q	G	C	A
A	C	G	S	S	A	C	N
F	C	A	S	E	N	C	A
T	C	D	S	N	G	C	Q
M	C	R	L	R	D	C	S



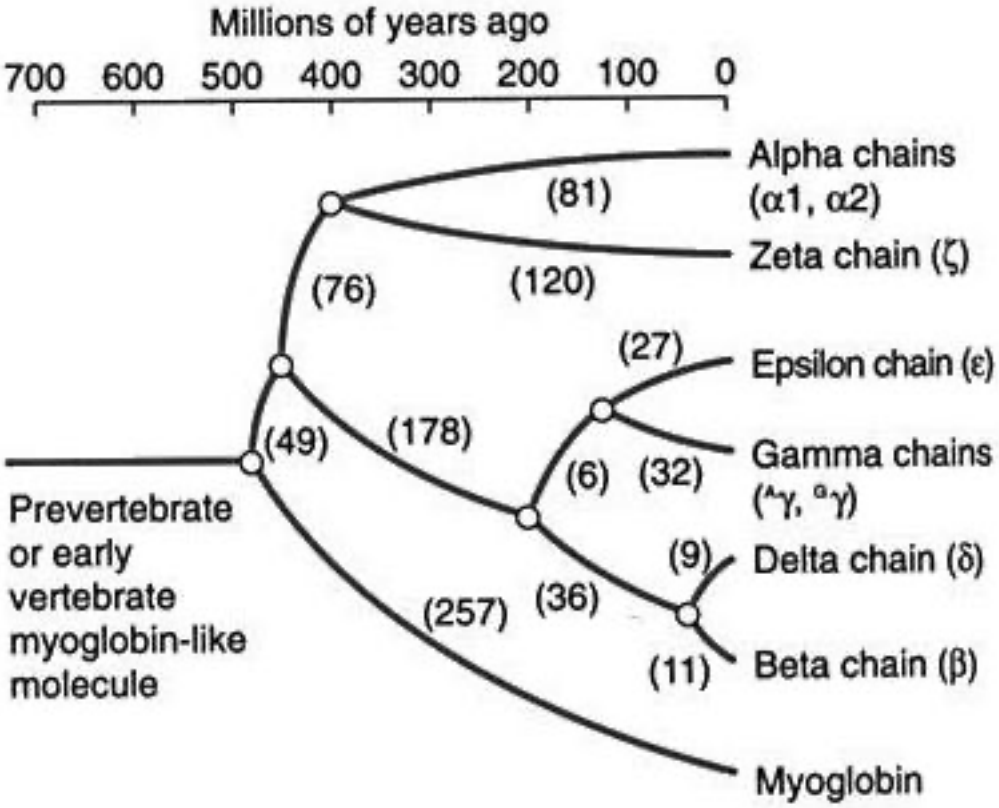
Sequences are related

- Darwin: all organisms are related through descent with modification
- Prediction: similar molecules have similar functions in different organisms



Protein synthesis carried out by very similar RNA-containing molecular complexes (ribosomes) that are present in all known organisms

Sequences are related, II



Related oxygen-binding proteins in humans