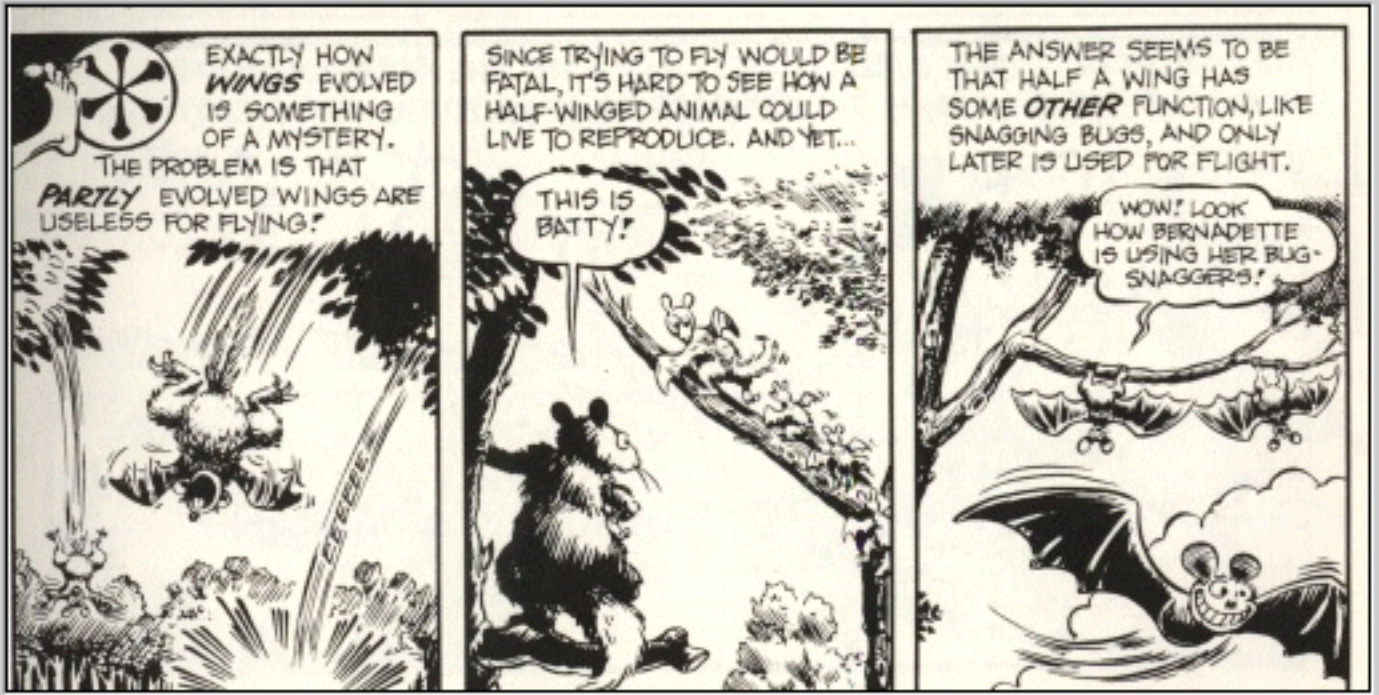
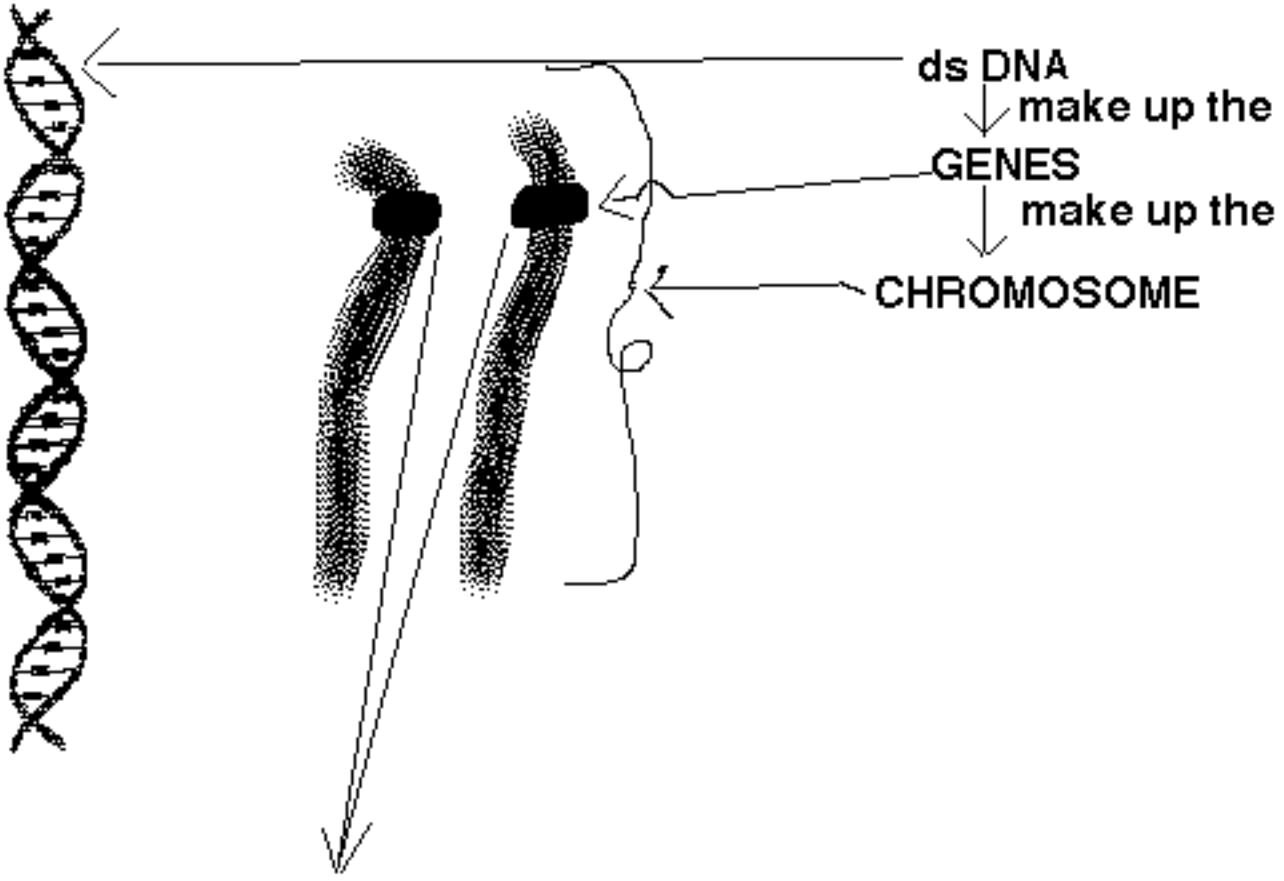
species = groups of actually or potentially interbreeding natural populations

population = individuals of the same species living in some defined area.

Evolution = (in a biological context) a change in the genetic content of a population with time. If the time period for the change is short, the genetic change is small and a new species does not result (microevolution). However, if the time period for the change is long, the genetic change is large and a new species will result (macroevolution).


EXACTLY HOW WINGS EVOLVED IS SOMETHING OF A MYSTERY.
THE PROBLEM IS THAT PARTLY EVOLVED WINGS ARE USELESS FOR FLYING!
EEEEEE!
SINCE TRYING TO FLY WOULD BE FATAL, IT'S HARD TO SEE HOW A HALF-WINGED ANIMAL COULD LIVE TO REPRODUCE. AND YET...
THIS IS BATTY!
THE ANSWER SEEMS TO BE THAT HALF A WING HAS SOME OTHER FUNCTION, LIKE SNAGGING BUGS, AND ONLY LATER IS USED FOR FLIGHT.
WOW! LOOK HOW BERNADETTE IS USING HER BUG-SNAGGERS!



ALLELES: Two different forms of the gene

For many hereditary traits, genes exist in two or more different forms called alleles. On each pair of chromosomes, there is one allele for a particular gene on each. Ex. A, B, O blood groups. In humans there are 3 alleles: A, B, and O.

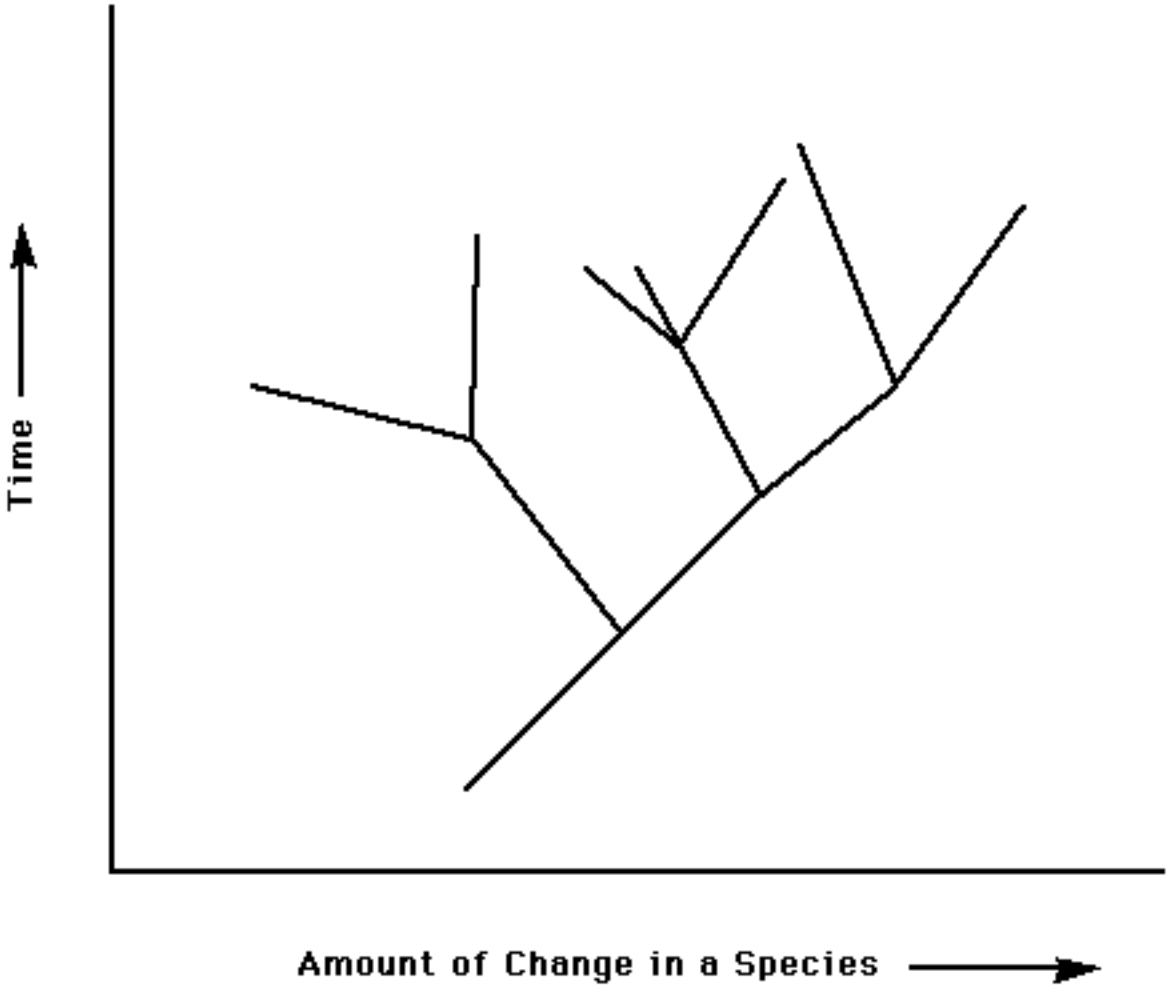
1. Factors that produce new alleles

Mutation

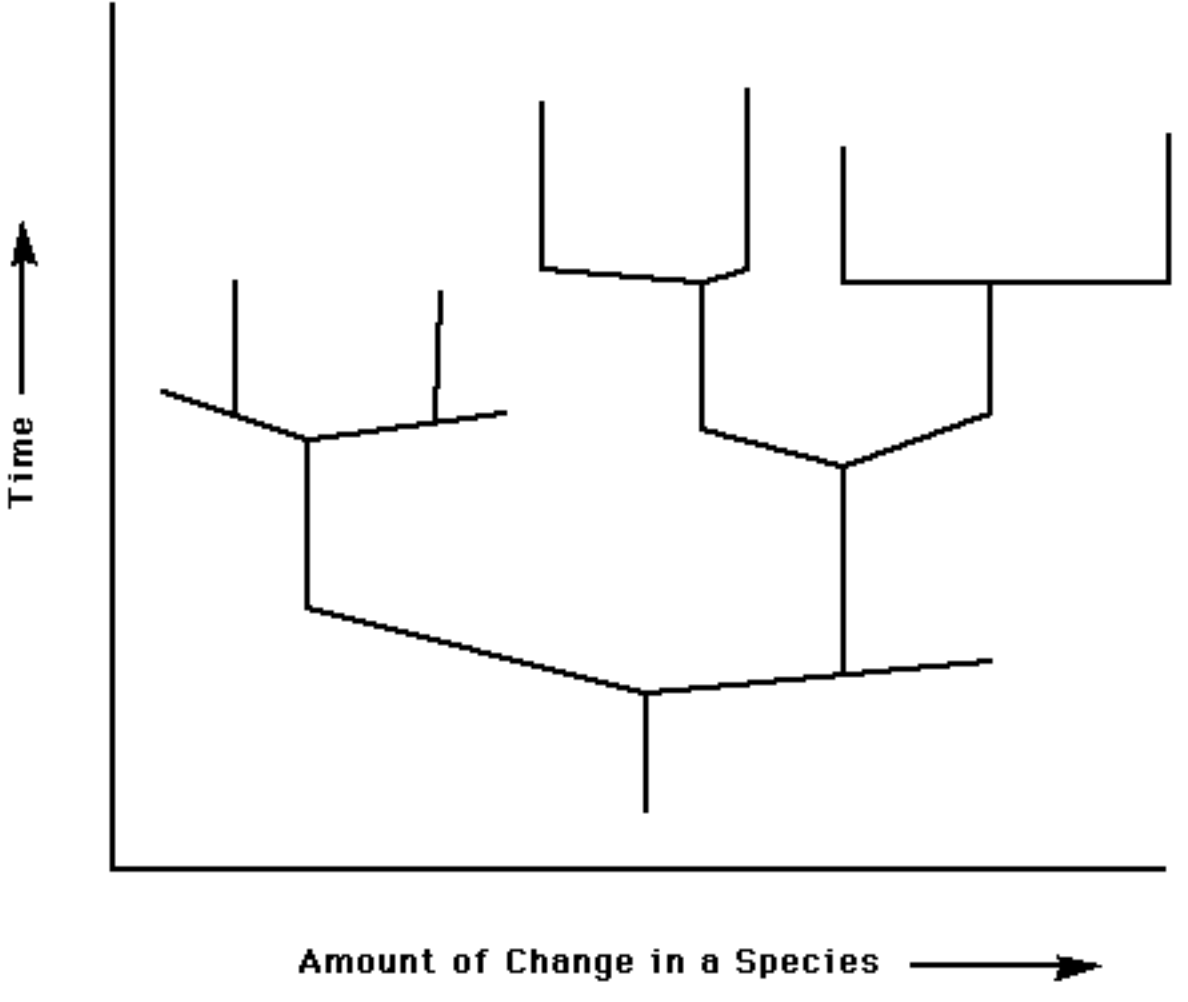
2. Factors which just reshuffle already existing alleles

a) recombination – alleles from each parent
b) genetic drift – Separation of small populations
c) migrations – into or out of a population
d) selection pressures
    1. Natural selection
    2. Artificial selection

Gradualism



Punctuated Equilibria



There are two approaches to tracing the family tree of any organism:

1. Examine the fossil record – Paleontology

Archaeopteryx Fossil

Archaeopteryx Picture

2. Examine the genes of living organisms – Molecular genetics

Archaeopteryx

Camel Evolution

ARCHAEOPTERYX

150 MILLION OLD FOSSIL

Molecular Genetics

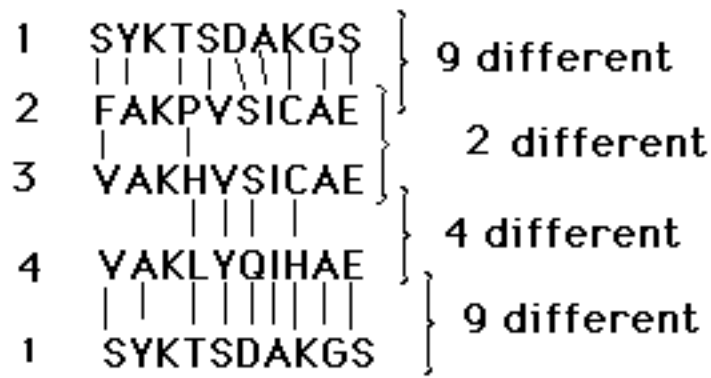
The sequence of monomers in DNA, RNA or a protein can be used to estimate the degree of "relatedness" between organisms. As an example, consider the partial proteins below in which each letter represents an amino acid.

Which pair is the most closely related ?

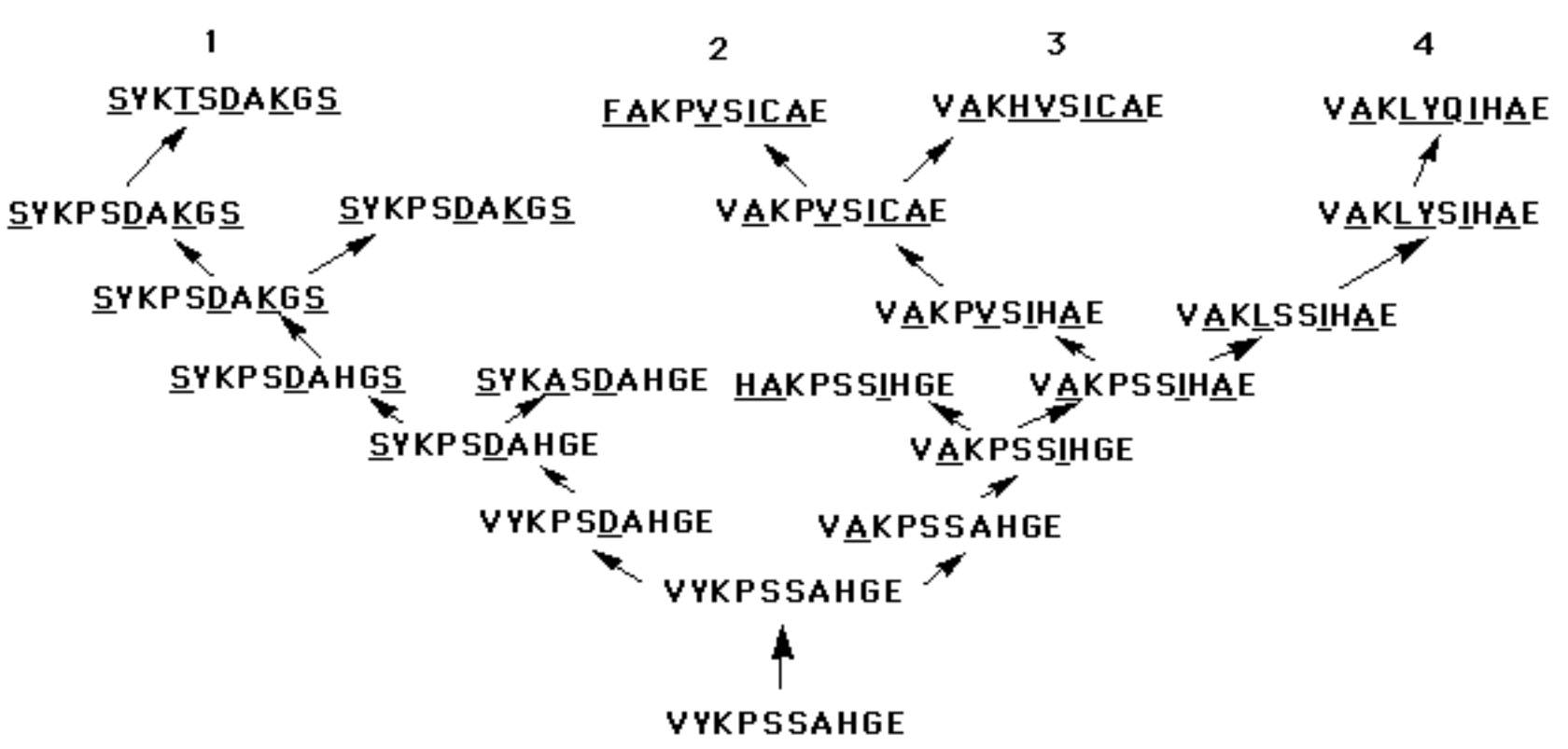
SYKTSDAKGS	FAKPVSICAE	VAKHVSICAE	VAKLYQIHAE
1	2	3	4

SYKTSDAKGS	FAKPVSICAE	VAKHVSICAE	VAKLYQIHAE
1	2	3	4

Compare their sequences:



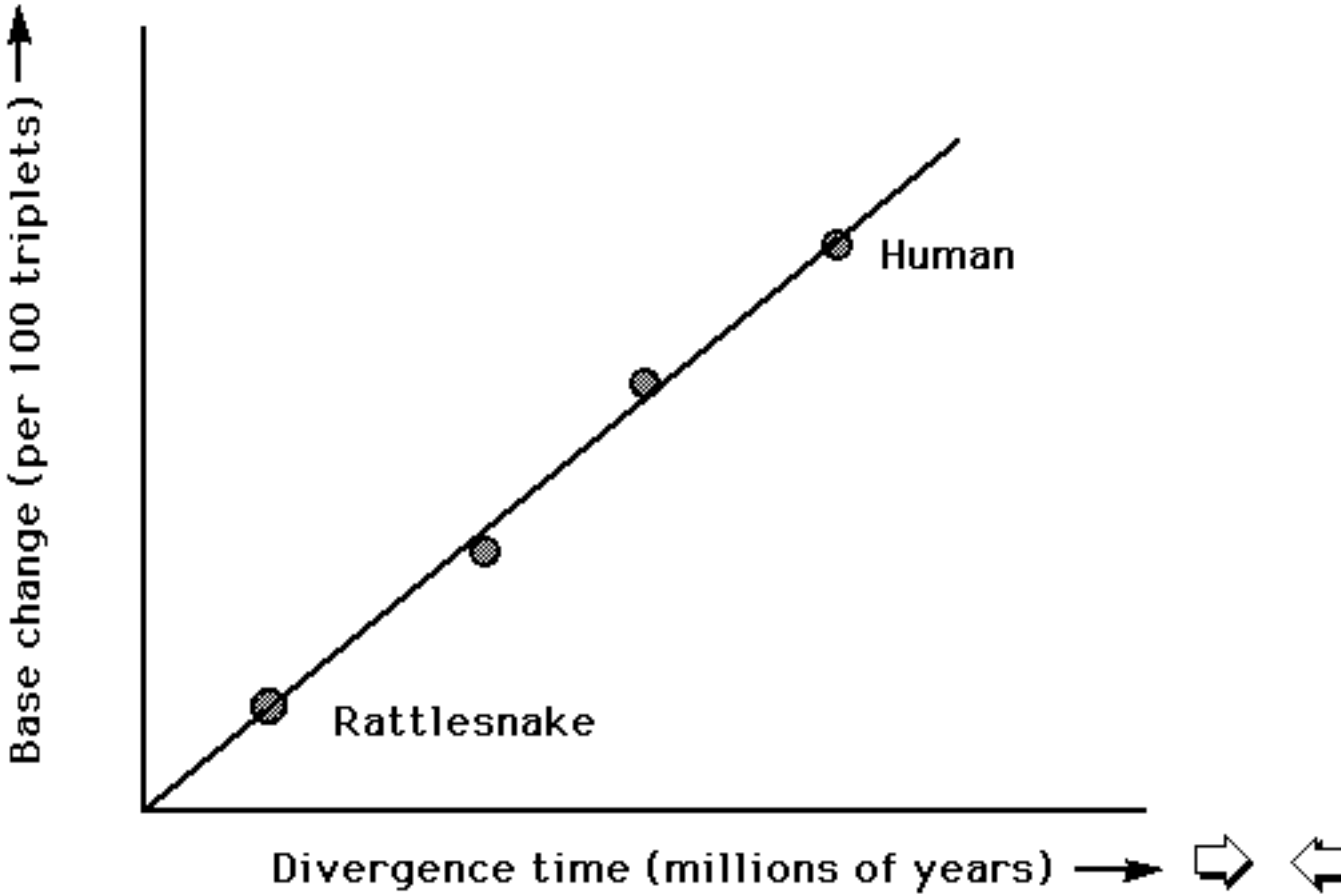
You would obviously conclude that 2 and 3 were the closest relatives and that 4 was closer to 2 and 3 than 1.


1
2
3
4
SYKTSDAKGS
FAKPVSICAE
VAKHVSICAE
VAKLYQIHAE
SYKPSDAKGS
SYKPSDAKGS
VAKPVSICAE
VAKLYSIHAE
SYKPSDAKGS
VAKPVSIHAE
VAKLSSIHAE
SYKPSDAHGS
SYKASDAHGE
HAKPSSIHGE
VAKPSSIHAE
SYKPSDAHGE
VAKPSSIHGE
VYKPSDAHGE
VAKPSSAHGE
VYKPSSAHGE
VYKPSSAHGE

Number of amino acid differences for cytochrome c of a few representative species. These proteins all consist of at least 104 amino acid residues, so each pair have at least half their residues identical.

	Chimpanzee	Sheep	Rattlesnake	Carp	Snail	Moth	Yeast	Cauliflower	Parsnip
Human	0	10	14	18	29	31	44	44	43
Chimpanzee		10	14	18	29	31	44	44	43
Sheep			20	11	24	27	44	46	46
Rattlesnake				26	28	33	47	45	43
Carp					26	26	44	47	46
Garden snail						28	48	51	50
Tobacco hornworm moth							44	44	41
Baker's yeast (iso-1)								47	47
Cauliflower									13

If a constant rate of mutation is assumed, the Divergence time may be calculated



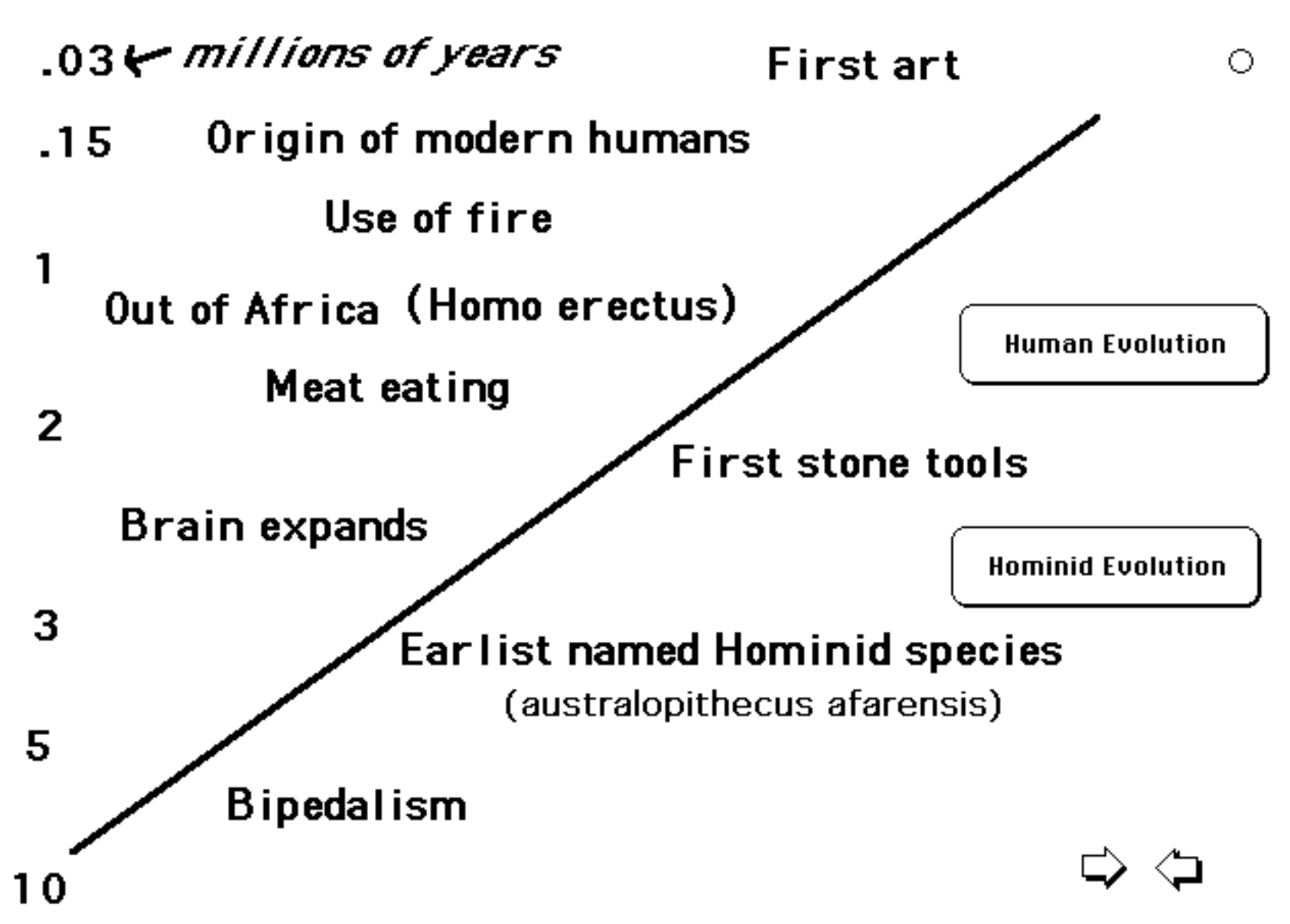
There are two approaches to tracing the family tree of humans:

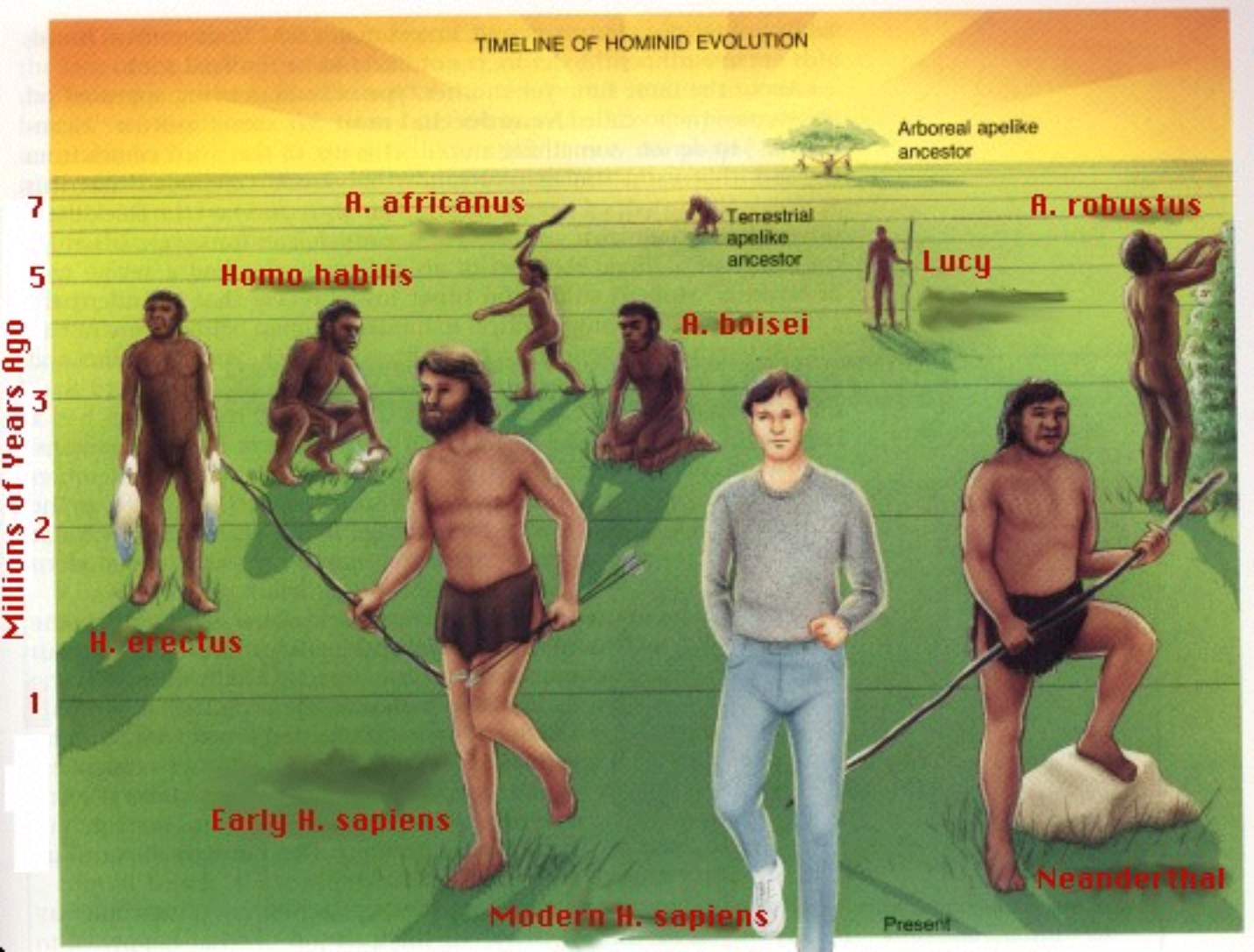
1. Examine the fossil record – Paleontology

2. Examine the genes of living organisms – Molecular genetics

Genetic studies have been taken to indicate that modern man (Homo Sapiens) arose in Africa 200,000 years ago

Fossil evidence argues that various human groups arose where they are found today.


.03 ← millions of years
First art
.15
Origin of modern humans
Use of fire
1
Out of Africa (Homo erectus)
Human Evolution
Meat eating
2
First stone tools
Brain expands
Hominid Evolution
3
Earlist named Hominid species
(australopithecus afarensis)
5
Bipedalism
10


TIMELINE OF HOMINID EVOLUTION
Arboreal apelike ancestor
A. africanus
Terrestrial apelike ancestor
A. robustus
Homo habilis
Lucy
A. boisei
Millions of Years Ago
7
5
3
2
1
H. erectus
Early H. sapiens
Modern H. sapiens
Neanderthal
Present

Mass Extinctions

The geological record show a number of instances in which the number of different species dropped dramatically These are mass extinctions brought about by some change in the environment:

Global climate change
- Glaciation (Ice ages)
- Continental Drift
- Global warming (rise in sea levels)

Extraterrestrial impacts

Where is evolution going now?

Should we try to control the gene pool?

Cloning — Making a genetic copy of an organism