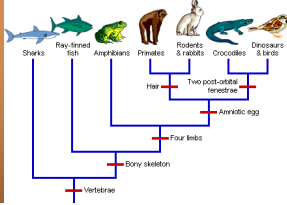
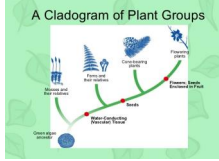




Evolution and Biodiversity

5.4- Cladistics



Essential idea:

- The ancestry of groups of species can be deduced by comparing their base or amino acid sequences.

Compare the sequences

```

1) AATCGCCGAAGCTTGGATTGGCAA
2) AATCGCGAAGCTTGGATTGCCAA
3) AATCGCGAAGCTTGGATTGGCAA
4) AATCGCGAAGCTTGGATTGGCAA
    
```

● = Differences when compared to species 1)

3) and 4) have only one base pair difference and so therefore are the closest relatives
 1) and 3) have the most differences (2bp) so are most distantly related

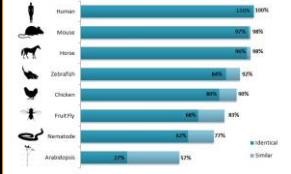
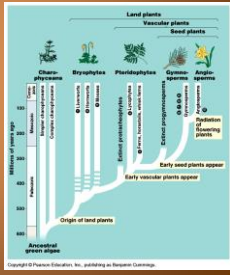
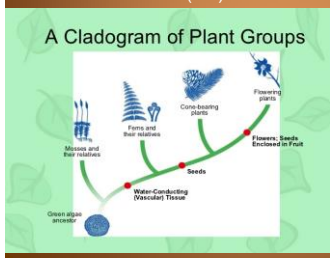


Figure 2. Comparison of percent similar (light blue) and percent identical (dark blue) between different species' proteins to the human ACTN3 protein. The homologs are arranged from most identical to least identical.

Ex: ACTN3 gene encodes the protein alpha-actinin-3, a component of the contractile apparatus in fast skeletal muscle fibers

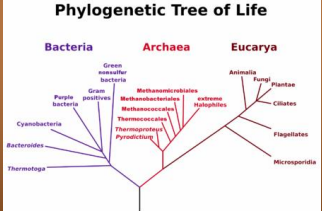
Nature of science:

- Falsification of theories with one theory being superseded by another
 - plant families have been reclassified as a result of evidence from cladistics. (1.9)



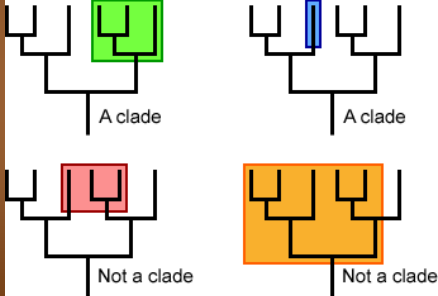
Theory of knowledge:

- A major step forward in the study of bacteria was the recognition in 1977 by **Carl Woese** that *Archaea* have a separate line of evolutionary descent from bacteria. Famous scientists, including Luria and Mayr, objected to his division of the prokaryotes.
- To what extent is conservatism in science desirable?
- Is it necessary to consider the social context when evaluating ethical aspects of knowledge claims?



Understandings

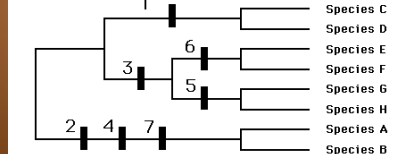
- A clade is a group of organisms that have evolved from a common ancestor. (branching point is a node)



Understandings

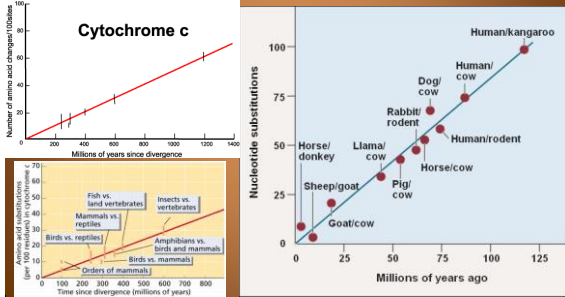
- Evidence for which species are part of a clade can be obtained from the base sequences of a gene or the corresponding amino acid sequence of a protein.

	1	2	3	4	5	6	7
Species A	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species B	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species C	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species D	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species E	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species F	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species G	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT
Species H	ACCAGC	TGTG	ATCG	ATGAC	TGACT	AACT	AAAGACT



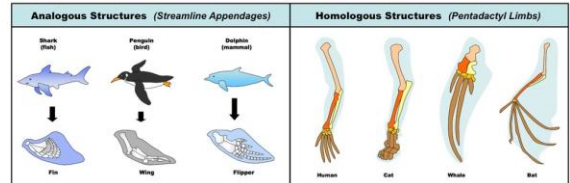
Understandings

- Sequence differences accumulate gradually so there is a positive correlation between the number of differences between two species and the time since they diverged from a common ancestor.



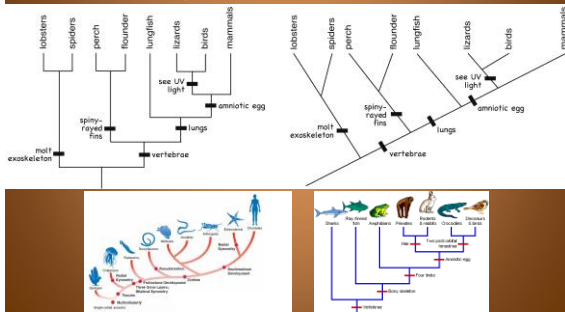
Understandings

- Traits can be analogous or homologous.
 - Analogy implies convergence and no close relation
 - Homology implies divergence and close relation



Understandings

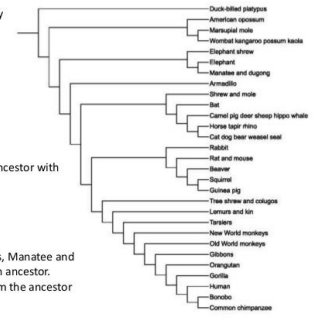
- Cladograms are tree diagrams that show the most probable sequence of divergence in clades.



Skills

- Skill: Analysis of cladograms to deduce evolutionary relationships.

- What animal is most closely related to a squirrel?
- What animals are more closely related to humans than old world monkeys?
- Tarsiers share a common ancestor with which animals?
- Elephant shrews, Elephants, Manatee and dugong all share a common ancestor. Which animal diverged from the ancestor first?

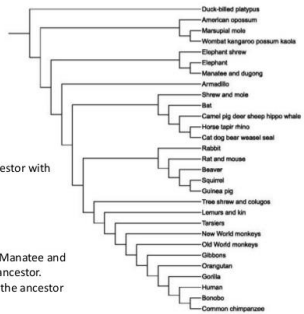


http://commons.wikimedia.org/wiki/File:The_Ancessor_Tele_Mammals cladogram.png

Skills

- Skill: Analysis of cladograms to deduce evolutionary relationships.

- What animal is most closely related to a squirrel?
Guinea pig
- What animals are more closely related to humans than old world monkeys?
- Tarsiers share a common ancestor with which animals?
- Elephant shrews, Elephants, Manatee and dugong all share a common ancestor. Which animal diverged from the ancestor first?

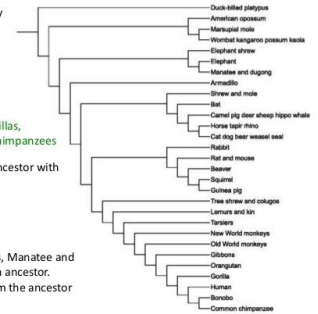


http://commons.wikimedia.org/wiki/File:The_Ancessor_Tele_Mammals cladogram.png

Skills

- Skill: Analysis of cladograms to deduce evolutionary relationships.

- What animal is most closely related to a squirrel?
Guinea pig
- What animals are more closely related to humans than old world monkeys?
Gibbons, Orangutans, Gorillas, Bonobos, and Common Chimpanzees
- Tarsiers share a common ancestor with which animals?
- Elephant shrews, Elephants, Manatee and dugong all share a common ancestor. Which animal diverged from the ancestor first?



http://commons.wikimedia.org/wiki/File:The_Ancessor_Tele_Mammals cladogram.png

Skills

- Skill: Analysis of cladograms to deduce evolutionary relationships.
 1. What animal is most closely related to a squirrel?
 - Guinea pig
 1. What animals are more closely related to humans than old world monkeys?
 - Gibbons, Orangutans, Gorillas, Bonobos, and Common Chimpanzees
 3. Tarsiers share a common ancestor with which animals?
 - New world monkeys, Old world monkeys, Gibbons, Orangutans, Gorilla, Humans, bonobos, common chimpanzees
 3. Elephant shrews, Elephants, Manatee and dugong all share a common ancestor. Which animal diverged from the ancestor first?
 - Elephant shrew

http://commons.wikimedia.org/wiki/File:The_Australian_Tele_Mamma%26Cladogram.png

Skills

- Skill: Analysis of cladograms to deduce evolutionary relationships.
 1. What animal is most closely related to a squirrel?
 - Guinea pig
 1. What animals are more closely related to humans than old world monkeys?
 - Gibbons, Orangutans, Gorillas, Bonobos, and Common Chimpanzees
 3. Tarsiers share a common ancestor with which animals?
 - New world monkeys, Old world monkeys, Gibbons, Orangutans, Gorilla, Humans, bonobos, common chimpanzees
 3. Elephant shrews, Elephants, Manatee and dugong all share a common ancestor. Which animal diverged from the ancestor first?
 - Elephant shrew

http://commons.wikimedia.org/wiki/File:The_Australian_Tele_Mamma%26Cladogram.png

Understandings

- Evidence from cladistics has shown that classifications of some groups based on structure did not correspond with the evolutionary origins of a group or species.
 - Lungs and epiglottis put lungfish closer relative to mammals
 - Humans closest to chimpanzees

Applications

- Application: Reclassification of the figwort family using evidence from cladistics.

5.4.108 Evidence from cladistics has shown that classifications of some groups based on structure did not correspond with the evolutionary origins of a group or species.

DNA evidence identified the different common ancestors

The similarities among the members of the old Scrophulariaceae family were superficial.

The general flower shape and form of the seed capsule evolved many times from different ancestors (**convergent evolution**). Different plant species adapted to similar pollinators and adopted similar seed dispersal strategies.

DNA evidence has cast doubt on some traditionally classified groups, but equally it has given support to others.

Though DNA evidence is very important, it must be remembered that is not the only evidence used to decide evolutionary relationships.

<http://www.bogapress.com/Books/Maps/Scrophulariaceae.jpg>

Applications

- Application: Reclassification of the figwort family using evidence from cladistics.
 - "Sadly the snapdragon family has suffered a nasty divorce, and what we now call the Scrophulariaceae (Figwort Family) no longer contains the snapdragons." (2012) <http://holerprofessor.blogspot.com/2012/04/whatever-became-of-snapdragon-family.html>

Now a plantain

Applications

- Application: Reclassification of the figwort family using evidence from cladistics.
 - The general flower shape and form of the seed capsule evolved many times from different ancestors (**convergent evolution**) because they were adapting to similar pollinators and seed dispersal strategies.
 - DNA evidence has been used to show more common ancestry.

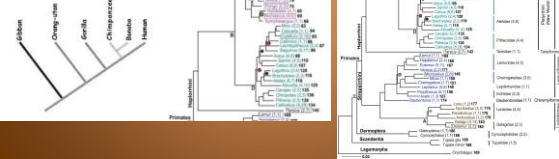
Applications

- Application: Cladograms including humans and other primates.

5.7 Analysis: Cladograms including humans and other primates.

This is part of a molecular phylogeny of all of the living primates. It clearly shows chimpanzees (*Pan*) as more closely related to humans than to gorillas.

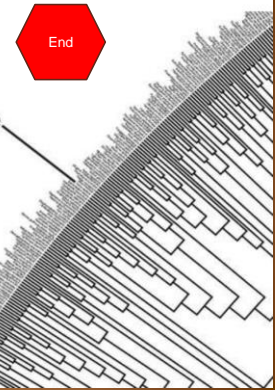
It was made by comparing 34,927 base pairs sequenced from 54 genes taken from each of a single species in each genus.



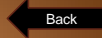
It's all connected...

Tree of Life

You are here



Carl Woese



- 1977
- Used ribosomal RNA to Demonstrate that it was possible to identify and classify microbes by intrinsic characteristics of their biological sequences.
- This resulted in the discovery of a third domain of life – the Archaea.
- Most biologists, unaccustomed to this new type of data, protected their dogmatic ideas by attacking Woese with harsh criticism and personal slander ("crazy crackpot" was one of the more civilized terms used).
- Marked the birth of molecular phylogeny.

