Fig. 26-1  Phylogeny & Systematics
Tree of Life – phylogenetic relationship for 3 clades

(http://evolution.berkeley.edu)
Phylogenetic tree
Figure 26.3

**Taxonomy**

**Taxon**

Carolus Linnaeus

---

**Species:** *Panthera pardus*

**Genus:** *Panthera*

**Family:** *Felidae*

**Order:** *Carnivora*

**Class:** *Mammalia*

**Phylum:** *Chordata*

---

**Domain:** *Bacteria*

**Domain:** *Animalia*

**Domain:** *Eukarya*

---

**Domain:** *Archaea*
Branch point: where lineages diverge

This branch point represents the common ancestor of taxa A–G.

This branch point forms a polytomy: an unresolved pattern of divergence.

PhyloCode - grps that include ancestors & all descendents

Figure 26.5
Which taxon on the tree below is most closely related to taxon C?

- a. A
- b. B
- c. D
- d. B and D are equally closely related to C
- e. All of the above are equally closely related to C

Speciation event
Which taxon on the tree below is most closely related to taxon C?
Clades

(http://evolution.berkeley.edu)
- Classification
- Phylogeny

Fig. 26-4

Order
  
  Carnivora

Family Genus
  
  Felidae
  Panthera
  Taxidea
  Mustelidae
  Lutra
  Canidae
  Canis

Species
  Panthera pardus
  Taxidea taxus
  Lutra lutra
  Canis latrans
  Canis lupus

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Figure 22.8

Hyracoidea (Hyraxes)
Sirenia (Manatees and relatives)

†Deinotherium
†Mammut
†Platybelodon
†Stegodon
†Mammuthus

Elephas maximus (Asia)
Loxodonta africana (Africa)
Loxodonta cyclotis (Africa)

60 34 24 5.5 210^4 0
Millions of years ago  Years ago

PRESENT

EXTINCT
Draw this phylogenetic tree on your paper
Which taxon on the tree below is most closely related to taxon A?

- a. B
- b. C
- c. D
- d. All of the above are equally closely related to A
RESULTS

- Minke (Antarctica)
- Minke (Australia)
- Unknown #1a, 2, 3, 4, 5, 6, 7, 8
- Minke (North Atlantic)
- Unknown #9
- Humpback (North Atlantic)
- Humpback (North Pacific)
- Unknown #1b
- Gray
- Blue (North Atlantic)
- Blue (North Pacific)
- Unknown #10, 11, 12
- Unknown #13
- Fin (Mediterranean)
- Fin (Iceland)

Phylogenetic uses
- Whale meat market
- From 6 years ago
RESULTS

Phylogenetic uses
- Whale meat market

Figure 26.6
(a) Monophyletic group (clade)  
(b) Paraphyletic group  
(c) Polyphyletic group
(a) Monophyletic group (clade)
Monophyletic
Group II

(b) Paraphyletic group
Paraphyletic
(c) Polyphyletic group
RESULTS

Figure 26.6

Minke (Southern Hemisphere)
Unknowns #1a, 2, 3, 4, 5, 6, 7, 8

Minke (North Atlantic)
Unknown #9

Humpback (North Atlantic)
Humpback (North Pacific)
Unknown #1b

Gray
Blue

Unknowns #10, 11, 12
Unknown #13

Fin (Mediterranean)
Fin (Iceland)
Nested clades

(http://evolution.berkeley.edu)
- Classification
- Phylogeny

Blue circles = clades
Red circle = larger clade
Mustelids & Canids are nested
Cladistic Analysis

• Cladistics
  ➢ Most closely related
  ➢ Derived & shared characteristics
  ➢ Apomorphies
  ➢ Plesiomorphies
  ➢ Synapomorphies
  ➢ Symplesiomorphies
Constructing Cladograms

• Choose the taxa that are clades
• Determine characteristics
• Determine polarity of characteristics
  • Use outgroup comparison
• Group taxa by synapomorphies
• Rule of parsimony

C  B  A
Outgroup comparison

Must have a list of synapomorphies common to all taxa above the node
Resolving the Node

All taxa goes on endpoints

Amphibian  Horse  Lizard  Human

am

node

synapomorphy
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<thead>
<tr>
<th>CHARACTERS</th>
<th>TAXA</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lancelet</td>
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<tr>
<td></td>
<td>Lamprey</td>
</tr>
<tr>
<td></td>
<td>Tuna</td>
</tr>
<tr>
<td></td>
<td>Salamander</td>
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<td></td>
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</tr>
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<td>0</td>
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<tr>
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<tr>
<td>Four walking legs</td>
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</tr>
<tr>
<td>Jaws</td>
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</tr>
<tr>
<td>Vertebral column (backbone)</td>
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</table>

(a) Character table
**Phylogenetic Tree**

(a) Character table

<table>
<thead>
<tr>
<th>CHARACTERS</th>
<th>Lancelet (outgroup)</th>
<th>Lamprey</th>
<th>Tuna</th>
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<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

(b) Phylogenetic tree

- Lancelet (outgroup)
- Lamprey
- Tuna
- Salamander
- Turtle
- Leopard
### Character Table

**TAXA**

<table>
<thead>
<tr>
<th>CHARACTERS</th>
<th>Lancelet (outgroup)</th>
<th>Lamprey</th>
<th>Tuna</th>
<th>Salamander</th>
<th>Turtle</th>
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</thead>
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</table>

(a) Character table
(b) Phylogenetic tree
Rule of Parsimony
“Occam’s Razor”

TECHNIQUE

Three phylogenetic hypotheses:

Species I

Species II

Species III

1

Species I

Species II

Species III

Ancestral sequence

RESULTS

6 events

7 events

7 events
The phylogenies below show two hypotheses regarding the relationships among vertebrates. The phylogeny on the right groups sharks and ray-finned fish together as a clade, and the phylogeny on the left does not.

Which hypothesis do you think is more likely to be accurate and why?
Phylogenetic Trees with Proportional Branch Lengths

- Number of genetic changes in a particular DNA sequence
<table>
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<tr>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

*Although adult dolphins have only two obvious limbs (their flippers), as embryos they have two hind-limb buds, for a total of four limbs.*
Why do we need to understand cladistics?

• Creating systems of classification
• Predicts the properties of organisms
  • Describes and predicts what’s observed
  • Predicting how genes might function in other organisms
  • How biological compounds in plants function?
    » Pharmaceutical companies
    » Improving crop yield
    » Disease resistance
• Elucidate mechanisms of evolution
  • How characteristics change in groups