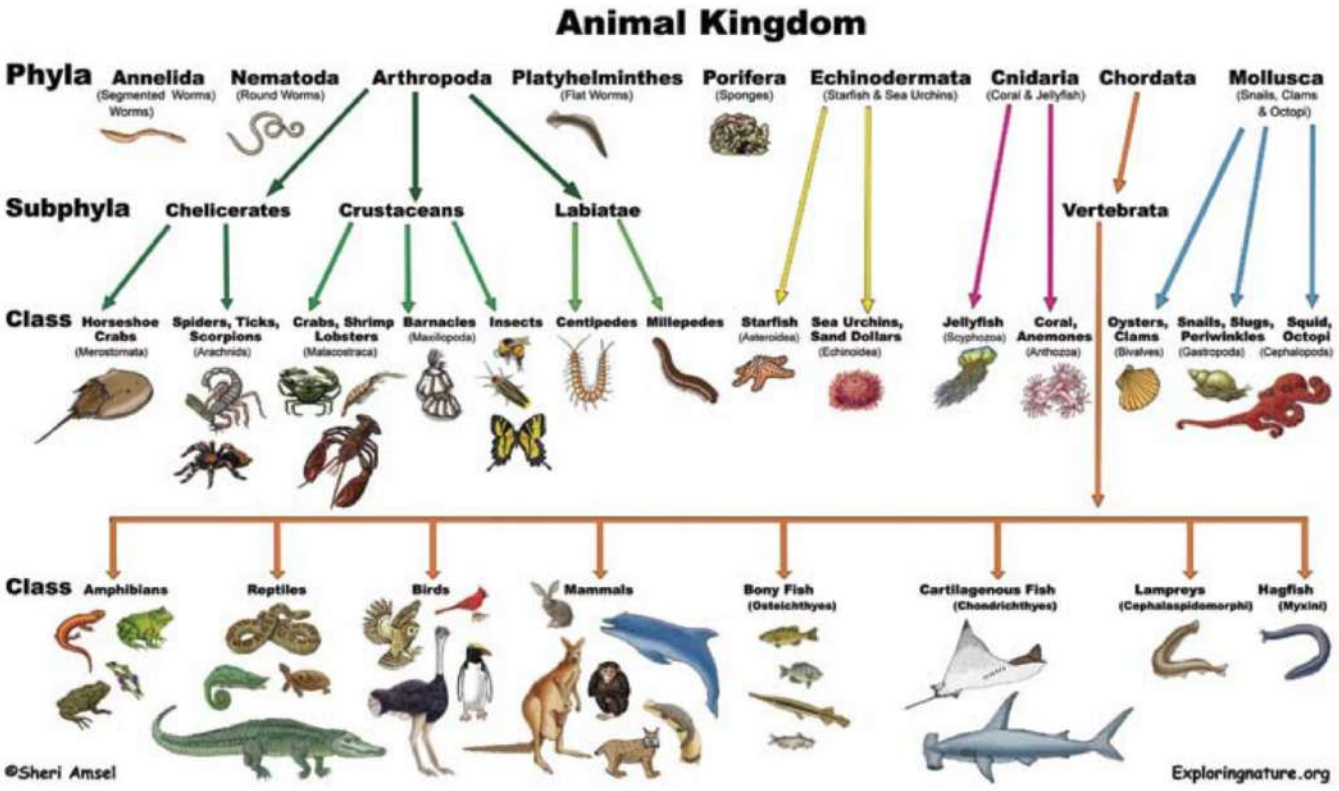
Chapter 19: Taxonomy, Systematics and Phylogeny



http://www.exploringnature.org/graphics/header_classification.jpg

19.1 Systematic Biology

- study of the history of biodiversity
- uses the characteristicsof living and fossil organisms to infer the relationships of organisms over time

Taxonomy

- branch of systematic biology that identifies, names and organizes biodiversity into related categories (taxa - pl; taxon - sing)
- in the past, used physical traits
- now, try to classify into natural groups with a shared evol hist
- use DNA sequences
- phylogeny - is contructed from natural groups to show evolutionary history of taxa (evol family tree)

Carolus Linnaeus

- classification hierarchy
- binomial nomenclature (specific epithet)
- eliminates confusion

Names of Taxa

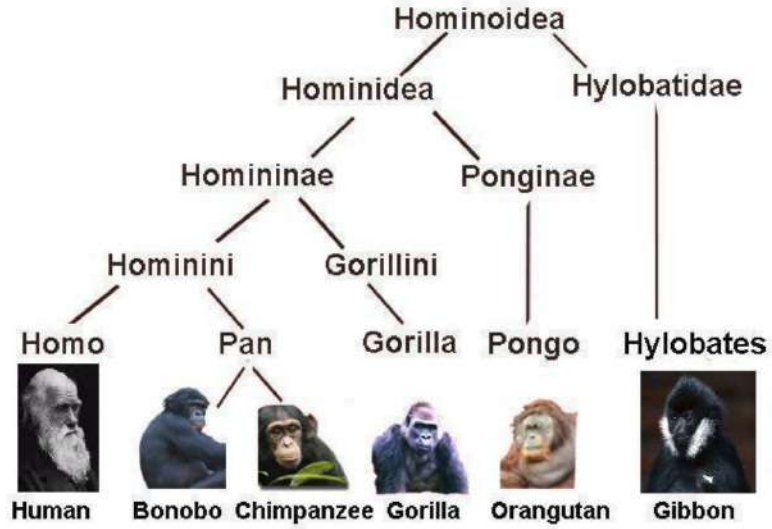
- domain
- kingdom
- phylum
- class
- order
- family
- genus
- species

Kingdom	*Animalia*	Different than a plant or fungus
Phylum	*Chordata*	Having a backbone
Class	*Mammalia*	Having hair, producing milk and giving birth to live young
Order	*Primates*	Having binocular vision, a generalized body plan and an increased reliance on vision
Family	*Hominidae*	Being a member of all of the family of higher apes (humans, chimpanzees, gorillas, orang-utans, gibbons and siamangs)
Sub-family	*Homininae*	A primate separate from the remainder of the family of apes
Genus	*Homo*	In the human line, distinct from other human precursors
Species	*sapiens*	Modern human

http://biologos.org/uploads/static-content/kidder_figure_5.jpg

Scientific Classification:

Domain:	Eukarya
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Primates
Family:	Hominidae
Genus:	Pongo
Species:	Pongo pygmaeus Pongo abelii



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http://www.conservenature.org/learn_about_wildlife/chimpanzees/taxonomy/great-apes1.jpg

19-2 The Three-Domain System

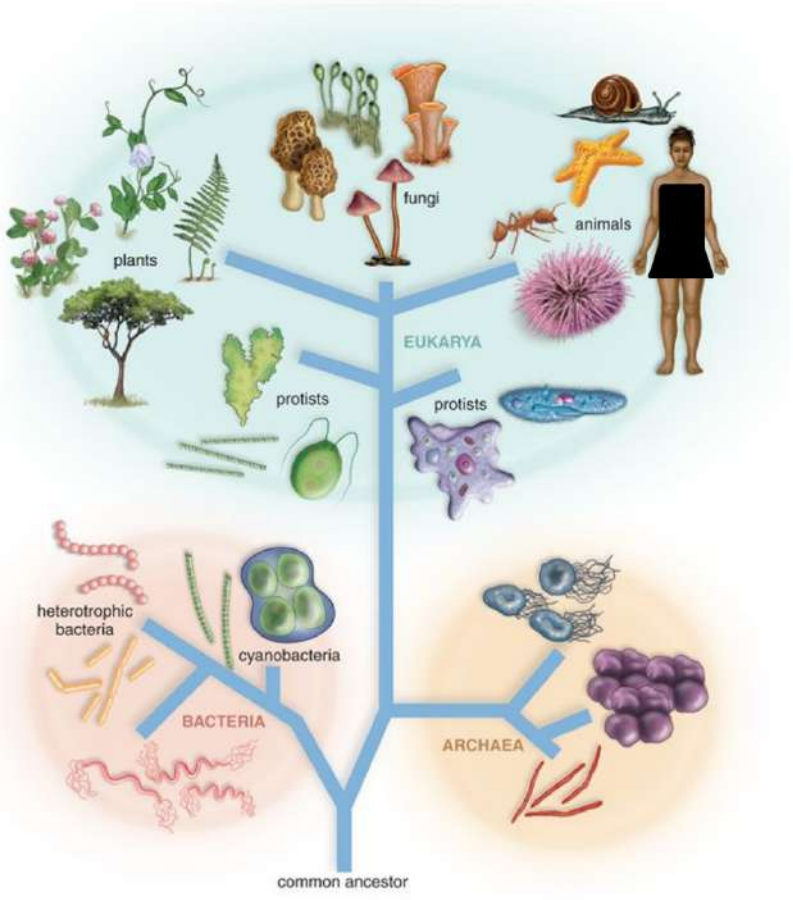

Table 19.1 Major Distinctions Among the Three Domains of Life

	Bacteria	*Archaea*	*Eukarya*
Unicellularity	Yes	Yes	Some, many multicellular
Membrane lipids	Phospholipids, unbranched	Varied branched lipids	Phospholipids, unbranched
Cell wall	Yes (contains peptidoglycan)	Yes (no peptidoglycan)	Some yes, some no
Nuclear envelope	No	No	Yes
Membrane-bounded organelles	No	No	Yes
Ribosomes	Yes	Yes	Yes
Introns	No	Some	Yes

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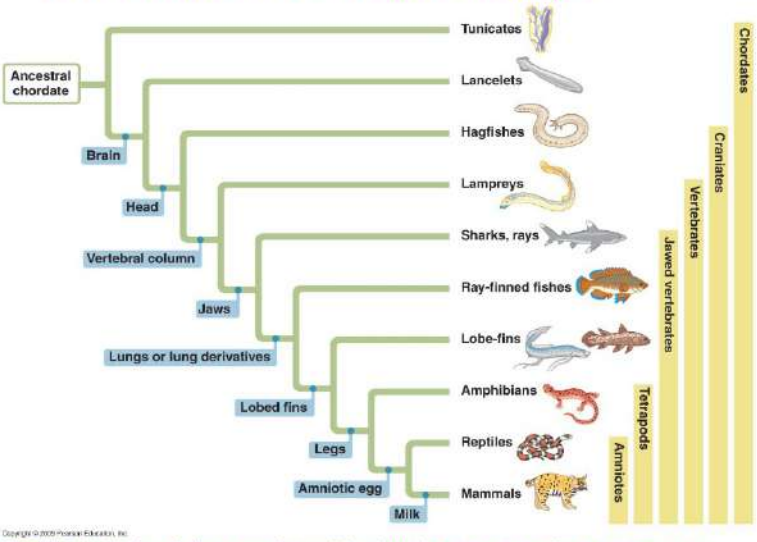
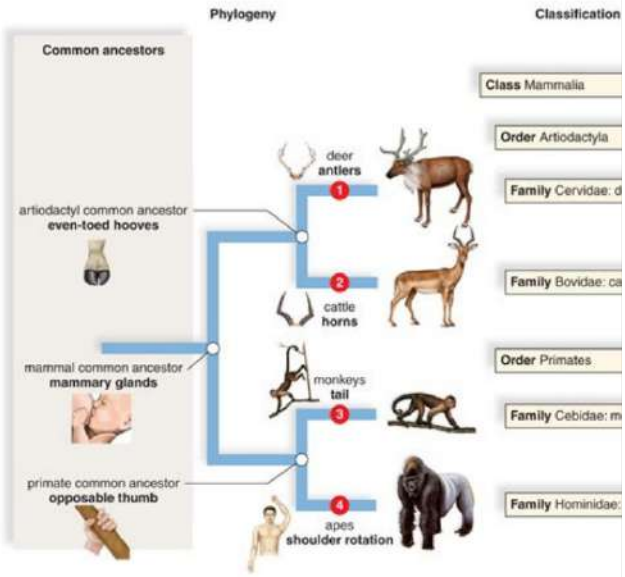
19.3 Phylogeny

- visual representation of history of biodiversity
- developed using:
  - fossil record
  - comparative anatomy and development
  - sequence, structure and function of DNA and RNA

Interpreting a Phylogeny

- constructed from traits that are shared by and unique to a taxon and their common ancestor
- when a new trait arises, a new path diverges from the old and a new branch is formed
- ancestral traits - are traits found in the lineage from common ancestor
- derived traits - are not found in common ancestor and help determine evol relationships

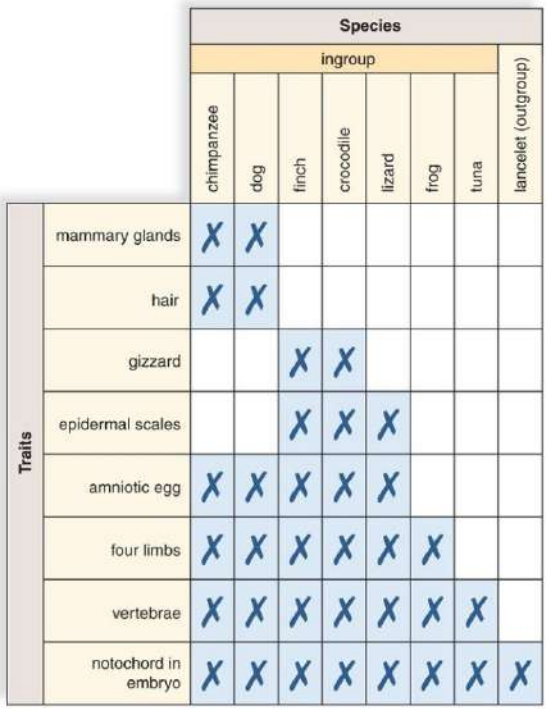




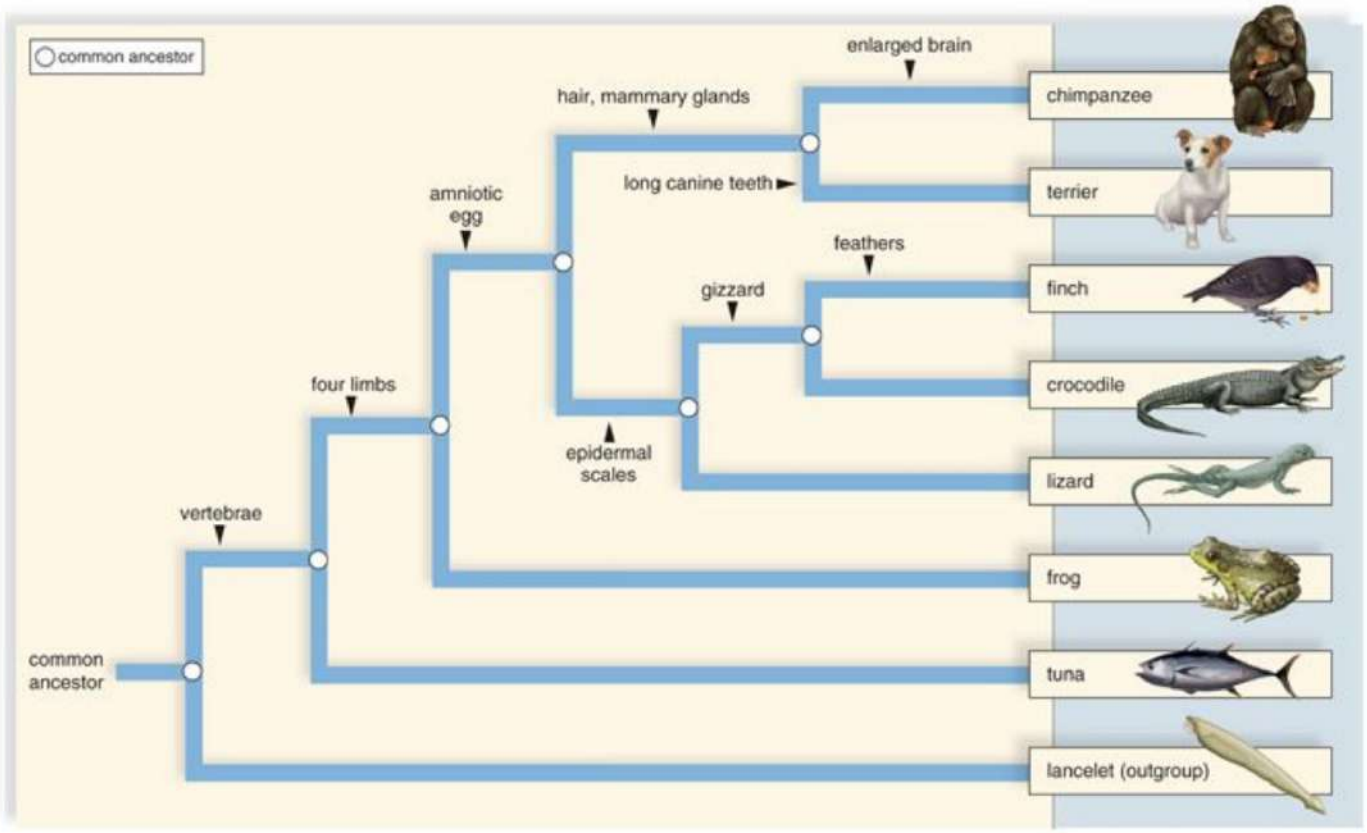
http://www.anselm.edu/homepage/jpitocch/genbi101/19_01KeyDerivedTraits-L%20copy.jpg

Cladistics

- uses shared, derived traits to develop a hypothesis of evol hist
- used to build cladogram - type of phylogeny
- clade - common ancestor and its decendants
- parsimony - using simplest solution (smallest number of evol changes)
- often change with new info
- outgroup v. ingroup
- each clade contains a uniquely derived trait

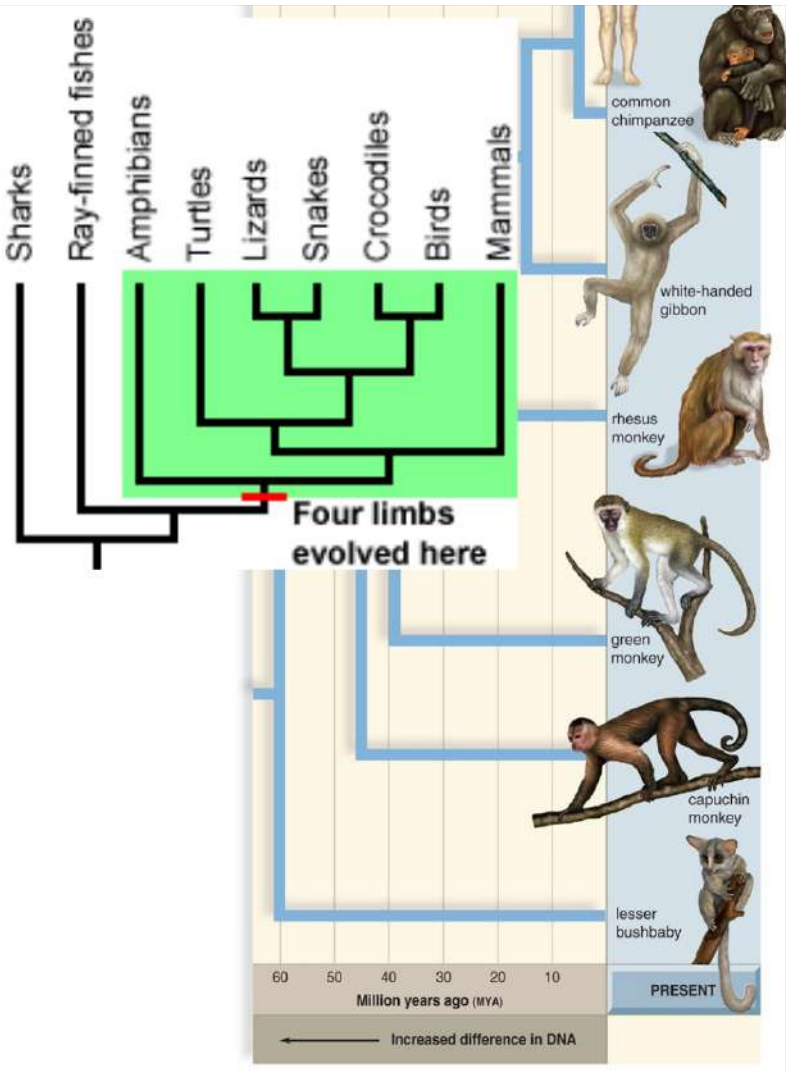


Traits	Species: ingroup: chimpanzee	dog	finch	crocodile	lizard	frog	tuna	Species: lancelet (outgroup)
mammary glands	✗	✗						
hair	✗	✗						
gizzard			✗	✗				
epidermal scales			✗	✗	✗			
amniotic egg	✗	✗	✗	✗	✗			
four limbs	✗	✗	✗	✗	✗	✗		
vertebrae	✗	✗	✗	✗	✗	✗	✗	
notochord in embryo	✗	✗	✗	✗	✗	✗	✗	✗


common ancestor
enlarged brain
hair, mammary glands
long canine teeth
amniotic egg
feathers
gizzard
four limbs
epidermal scales
vertebrae
common ancestor
chimpanzee
terrier
finch
crocodile
lizard
frog
tuna
lancelet (outgroup)

Tracing Phylogeny

- morphology is misleading
- fossil record helpful, but incomplete
- morphology - homologous/analagous traits
- behavioral traits - can be used to separate species (mating calls)
- molecular traits - mutations in DNA accumulate over time
  - more diff means more separation
  - more closely related also means fewer amino acid diff in proteins



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- mtDNA mutates faster and can be used to differentiate closely related species
- molecular data also useful for agriculture, medicine and forensics

Molecular Clock

- neutral mutations can be used to provide a timeline of evol hist
- accumulate but do not affect fitness