Sytematics

Chapter 23

Reconstructing and using phylogenies

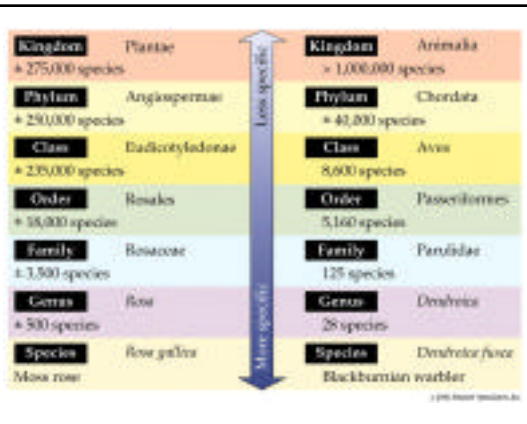
Binomial system

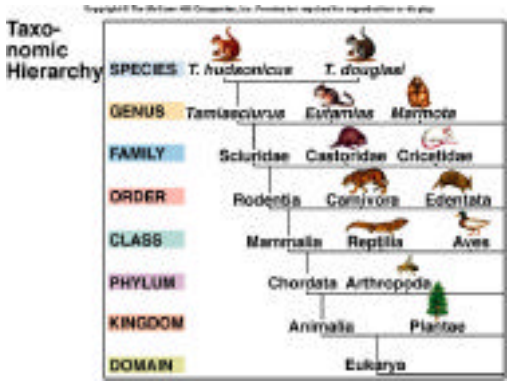
✓Two names (*Genus species*)
✓Require a type specimen
✓May be grouped into subspecies or varieties
✓Part of a broader taxonomic hierarchy

Unrelated robins

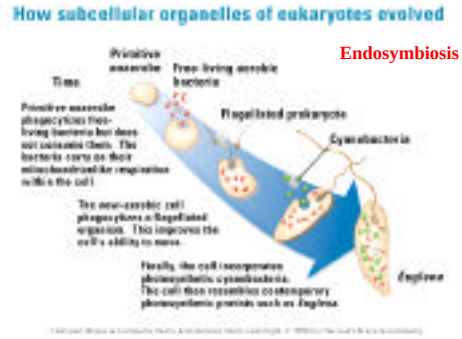
Heirarchical classification

Taxon	Human	Barn owl	Box turtle	Maize
Domain	Eukarya	Eukarya	Eukarya	Eukarya
Kingdom	Animalia	Animalia	Animalia	Plantae
Phylum	Chordata	Chordata	Chordata	Anthophyta
Class	Mammalia	Aves	Reptilia	Monocotyledones
Order	Primates	Strigiformes	Chelonia	Commelinales
Family	Hominidae	Tytonidae	Emydidae	Poaceae
Genus	*Homo*	*Tyto*	*Terrapene*	*Zea*
Species	*Homo sapiens*	*Tyto alba*	*Terrapene carolina*	*Zea mays*

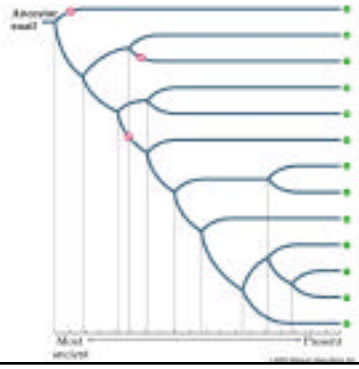




Evolution is descent with modification



Snail species that can transmit *Schistosoma*



Comparative Anatomy

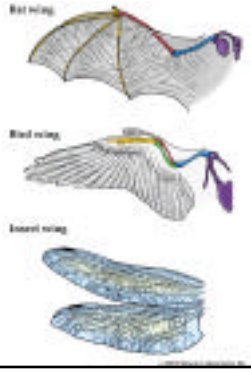
✓Homologous structures - Species descended from a common ancestor may evolve in different directions and yet retain some of the same characteristics.

- ✒Forelimbs - humans, horses, bats, moles and whales - same bones -

✓Analogous structures - Species descended from different ancestral species may evolve to possess structures that serve the same function.

- ✒Wings of bird and dragonfly

Homologous structures suggest a common ancestor



3 strategies in systematics

✓Orthodox or traditional
✓Phenetic (1960's - 70's)
✓Cladistics (current)

Orthodox or Traditional

✓Combines a number of traits
✓Does not look at one particular trait
✓Not all traits are given the same weight

- ✒Feathers may score higher
- ✒Birds are given their own group

Selected Characters Used in Analyzing the Phylogenetic Relationships of Four Plant Taxa

Taxon	Characters*			
	Xylem and Phloem	Wood	Seeds	Flowers
Mosses	–	–	–	–
Ferns	+	–	–	–
Pines	+	+	+	–
Oaks	+	+	+	+

*The character state "present" (+) is the derived condition; the character state "absent" (–) is the ancestral condition.

Some Major Distinguishing Features of the Three Domains of Life*

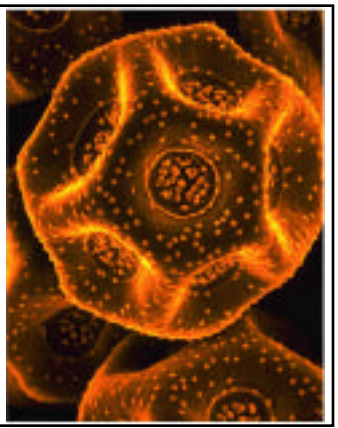
Characteristic	Bacteria	Archaea	Eukarya
Cell type	Prokaryotic	Prokaryotic	Eukaryotic
Nuclear envelope	Absent	Absent	Present
Number of chromosomes	1	1	More than 1
Chromosome configuration	Circular	Circular	Linear
Organelles (mitochondria and plastids)	Absent	Absent	Present (in all but a few)
Cytoskeleton	Absent	Absent	Present
Chlorophyll-based photosynthesis	Yes	No	Yes

*Note that some features listed apply to only certain representatives of a certain domain.

Radula of a snail

Bristles on a marine worm

Pollen grains of plants - fossils and sediments



Cladistics

✓Determine the evolutionary relationships

- ✒Single derived ancestor - monophyletic groups
  - ☞Groups terminating in adjacent nodes share a common ancestor
- ✒Shared derived characteristics
- ✒Equal weight to all traits

- ✒Birds are grouped with reptiles

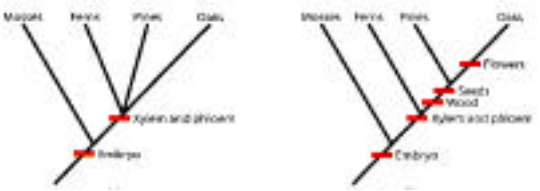
23.1 Eight Vertebrates Ordered According to Unique Shared Derived Traits

TAXON	DERIVED TRAIT* JAWS	LUNGS	CLAWS OR NAILS	FEATHERS	FUR	MAMMARY GLANDS	FOUR-CHAMBERED HEART
Hagfish	–	–	–	–	–	–	–
Perch	+	–	–	–	–	–	–
Salamander	+	+	–	–	–	–	–
Lizard	+	+	+	–	–	–	–
Crocodile	+	+	+	–	–	–	+
Pigeon	+	+	+	+	–	–	+
Mouse	+	+	+	–	+	+	+
Chimpanzee	+	+	+	–	+	+	+

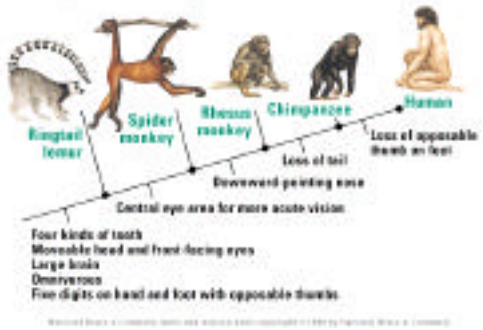
*A plus sign indicates the trait is present, a minus sign that it is absent.

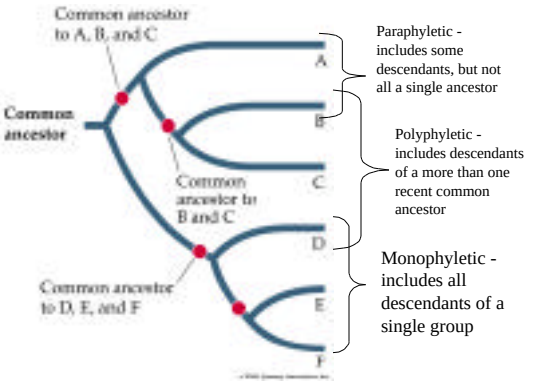
Shared derived traits

Shared derived traits



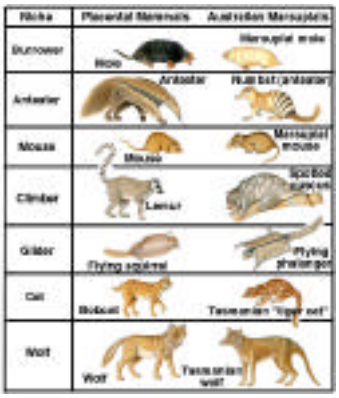
Cladogram for five primates





Parallel evolution

Similar developmental traits may arise independent of each other in distantly related organisms



Convergent evolution

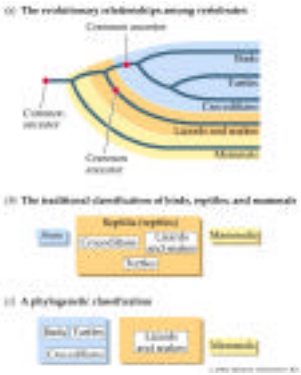
Similar structures developed because of similar selective pressures

Phenetics

✓Numerical taxonomy

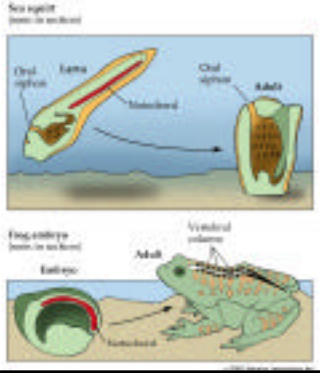
➪i.e. tassel, rows of kernels, weights, flowers, days to maturity, etc.

✒Susceptible to convergent (or parallel) evolution

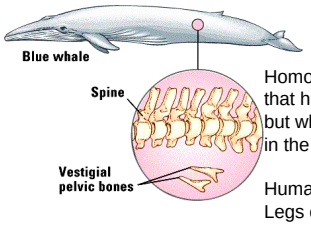


Morphology and development

Notochord



Morphology and development - Vestigial structures



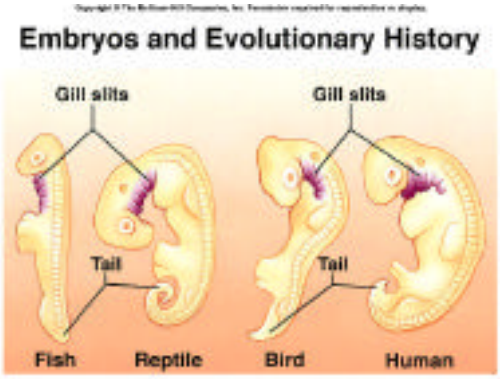
Homologous structures that have no apparent use, but which may have had use in the ancestral species.

Human tailbones
Legs on a snake

Morphology and development - Comparative Embryology

✓The early embryos of mammals resemble the embryos of birds, reptiles, amphibians and fishes.

✓All vertebrate embryos have tails and gill slits.

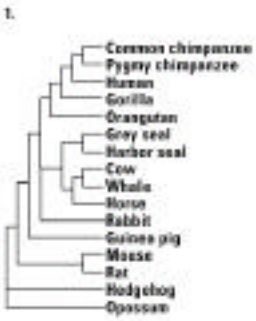


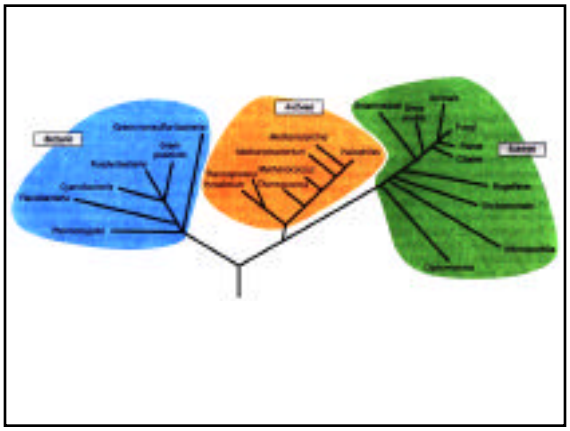
Molecular systematics

✓Sequence of amino acids in proteins, nucleotides in nucleic acids.

Phylogenetic relationship

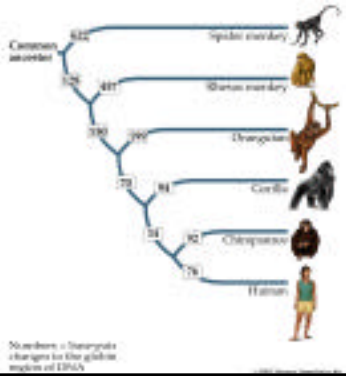
rRNA sequences

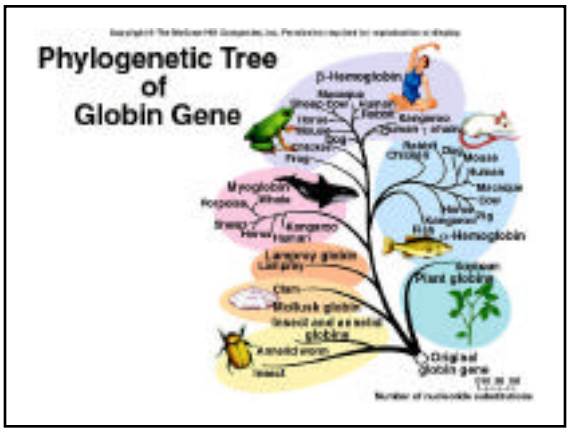




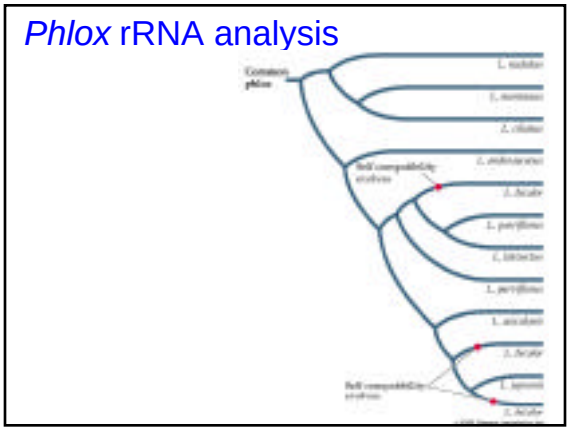
Globin DNA sequence

cpDNA
mtDNA

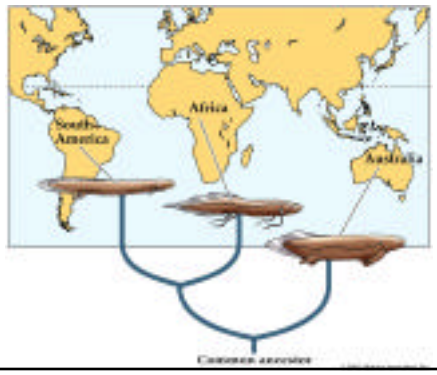


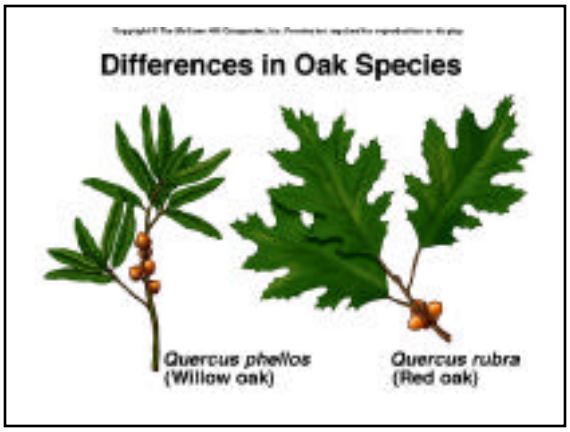


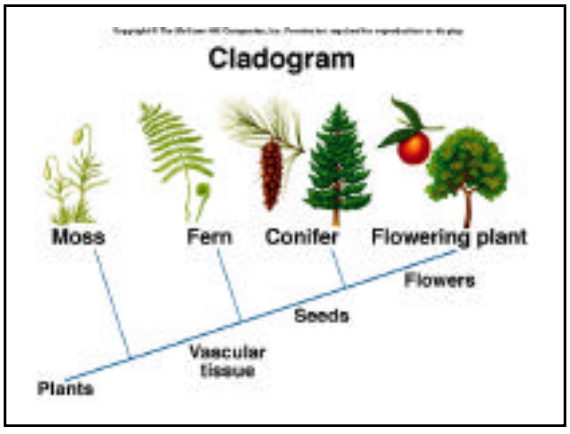
Phlox rRNA analysis

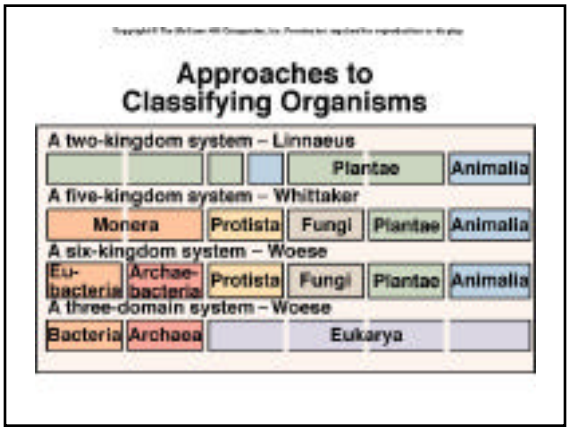


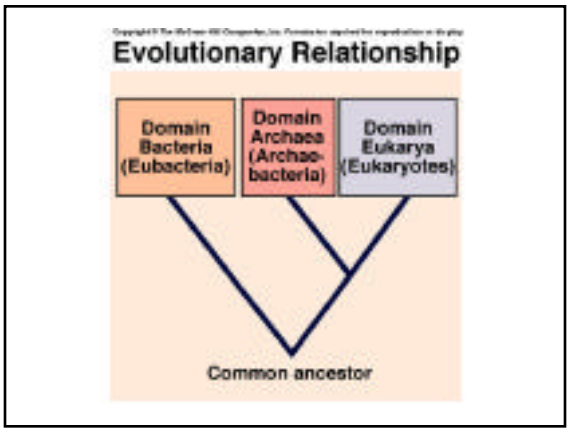
Fossil records

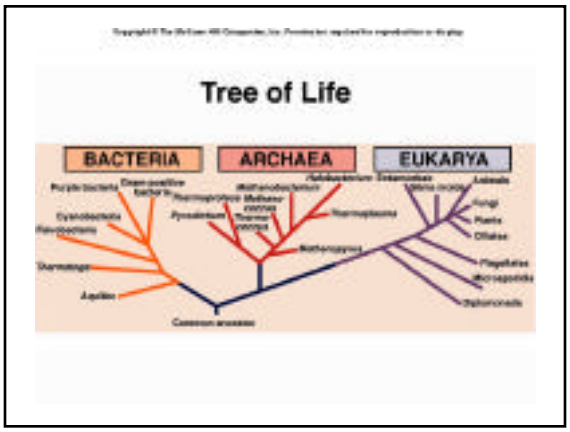


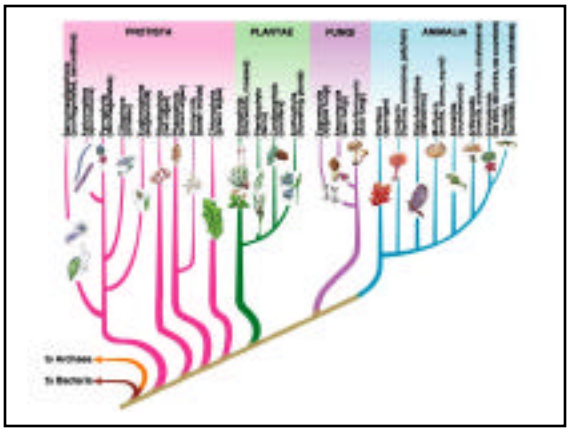


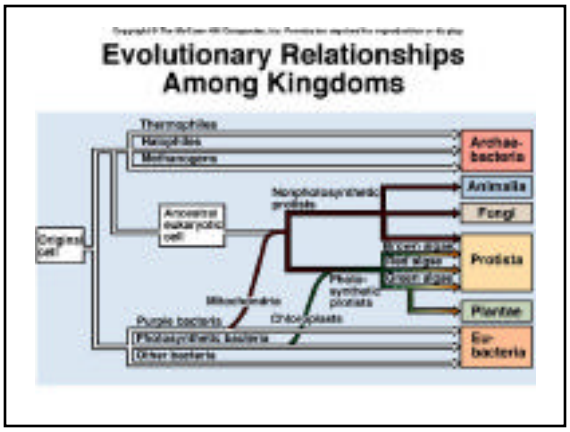












Two domains of prokaryotic organisms

T. Cavalier-Smith 8 Kingdom

	Cell type	Mt	Cp	Cell wall	Cell div.	Genetic recomb	nutrition	multi	nervous syst
Archaebacteria	Prok	No		not peptido-glycan	Bin. fission	transformation transduction conjugation	Chemolithotrophs heterotrophs	uni	-
Eubacteria	Prok	No		peptido-glycan	Bin. fission	transformation transduction conjugation	chemoutotrophs photosynthesis heterotrophs	uni	-
Archezoa	Euk	No		-	mitosisi	meiosis/ fert	heterotrophs	uni	-
Protozoa	Euk	yes	Yes /no	yes/no	mitosisi	meiosis/ fert	photosynthsis and/or heterotrophs		prim
Chromista	Euk	yes	yes	cellulose	mitosisi	sporic	photosynthsis and/or heterotrophs	mult	
Plantae	Euk	yes	yes	cellulose	mitosisi	sporic	Photosynthesis	mult	
Fungi	Euk	yes	yes	chitin	mitosisi	zygospor e	hetero - extracellular digestion/absorpti on hetro - injestion of food and digest	mult	
Animalia	Euk	yes	yes	-	mitosisi	gametic		mult	yes