Classification
Cladistics
&
The Three Domains of Life

Biology

Mrs. Flannery

Finding Order in Diversity

- Earth is over 4.5 billion years old.
- Life on Earth appeared approximately 3.5 billion years ago and has been changing due to natural selection as well as other processes and has led to an incredible amount of diveristy.
- 1.5 million species have been named so far!!!
- 2-100 million more species have yet to be discovered!!!!

Table 14.1 The Geologic Time Scale

Geologic Time	Period	Epoch	Age (millions of years ago)	Some Important Events in the History of Life
Cenozoic era	Quaternary	Recent	0.01	Historical time
		Pleistocene	1.8	Ice ages; humans appear
	Tertiary	Pliocene	5	Origin of genus *Homo*
		Miocene	23	Continued speciation of mammals and angiosperms
		Oligocene	34	Origins of many primate groups, including apes
		Eocene	56	Angiosperm dominance increases; origins of most living mammalian orders
		Paleocene	65	Major speciation of mammals, birds, and pollinating insects
Mesozoic era	Cretaceous		145	Flowering plants (angiosperms) appear; many groups of organisms, including most dinosaur lineages, become extinct at end of period (Cretaceous extinctions)
	Jurassic		200	Gymnosperms continue as dominant plants; dinosaurs become dominant
	Triassic		251	Cone-bearing plants (gymnosperms) dominate landscape; speciation of dinosaurs, early mammals, and birds
Paleozoic era	Permian		299	Extinction of many marine and terrestrial organisms (Permian extinctions); speciation of reptiles; origins of mammal-like reptiles and most living orders of insects
	Carboniferous		359	Extensive forests of vascular plants; first seed plants; origin of reptiles; amphibians become dominant
	Devonian		416	Diversification of bony fishes; first amphibians and insects
	Silurian		444	Early vascular plants dominate land
	Ordovician		488	Marine algae are abundant; colonization of land by diverse fungi, plants, and animals
	Cambrian		542	Origin of most living animal phyla (Cambrian explosion)
Precambrian			600	Diverse algae and soft-bodied invertebrate animals appear
			635	Oldest animal fossils
			2,100	Oldest eukaryotic fossils
			2,700	Oxygen begins accumulating in atmosphere
			3,500	Oldest fossils known (prokaryotes)
			4,600	Approximate time of origin of Earth

Relative Time Span

Cenozoic

Mesozoic

Paleozoic

Pre-cambrian

??????????????

What is the scientific name for the human species???

What do you think the common name is for *Felis catus?*

How about *Canis familiaris*?

In each case, what does the first of the two names refer to?

What do the two names together refer to?

Which group is more inclusive?

What is Classification?

- **Classification** is the arrangement of organisms into orderly groups based on their similar characteristics.
- The science of classification which involves identifying, classifying and naming is also known as **taxonomy**.
- taxis = **arrangement or order**
- nomy = **law**

Why Do We Need to Classify Organisms?

Coryphaena hippurus

Tursiops truncatus

Why Do We Need to Classify Organisms?

- Cougar
- Mountain lion
- Puma
- Panther

Puma concolor

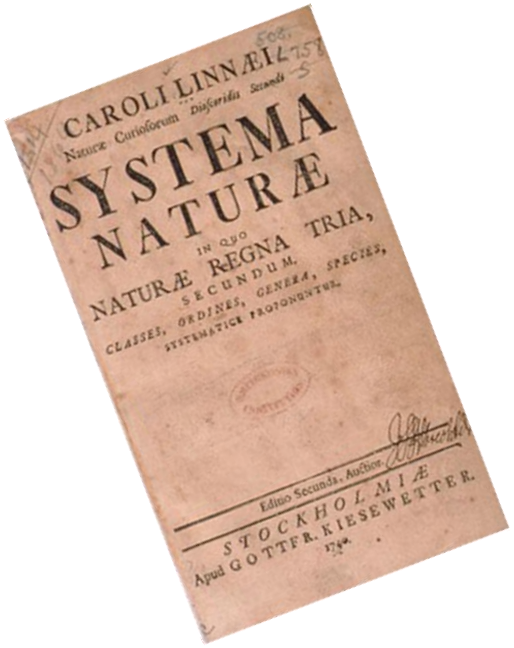
Panthera onca


UNE MOUFFETTE
EIN STINKTIER
SKUNK
UN ZORRILLO
CHECHE


Mephitis mephitis!
Mephitis
mephitis

Carolus Linnaeus

- 18th century Swedish botanist
- Known as the "Father of Taxonomy"
- Classified organisms by their structure, size, shape and color.
- Developed the binomial nomenclature system.
- Every organism gets a two-word name (Genus & species)


CAROLI LINNÆI
Naturæ Curiosorum Dissertatio Secunda
SYSTEMA NATURÆ
IN QUO NATURÆ REGNA TRIA,
SECUNDUM CLASSES, ORDINES, GENERA, SPECIES,
SYSTEMATICE PROPONUNTUR.
Editio Secunda, Auctior.
STOCKHOLMIÆ
Apud GOTTFR. KIESEWETTER.


Doct. LINNÆI
METHODUS plantarum SEXUALIS
in SYSTEMATE NATURÆ
descripta

Present System of Classification

- uses language of Latin
- system uses **binomial nomenclature (*bi* = two, *nomen* = name)**
- creatures are known by their genus and species name
- based on structure, DNA, evolutionary descent

• human	*Homo sapien*
• gorilla	*Gorilla gorilla*
• rainbow trout	*Oncorhynchus mykiss*

- genus name and species name italics if typed, underline if handwritten
- genus name capitalized, species name lower case

Linnaeus's System of Classification

- Hierarchical system (consists of levels)
- Each level is called a **taxon.**

Domain
Kingdom
Phylum
Class
Order
Family
Genus
Species

Kingdom – largest and most inclusive

Phylum – group of closely related classes

Class – group of similar orders

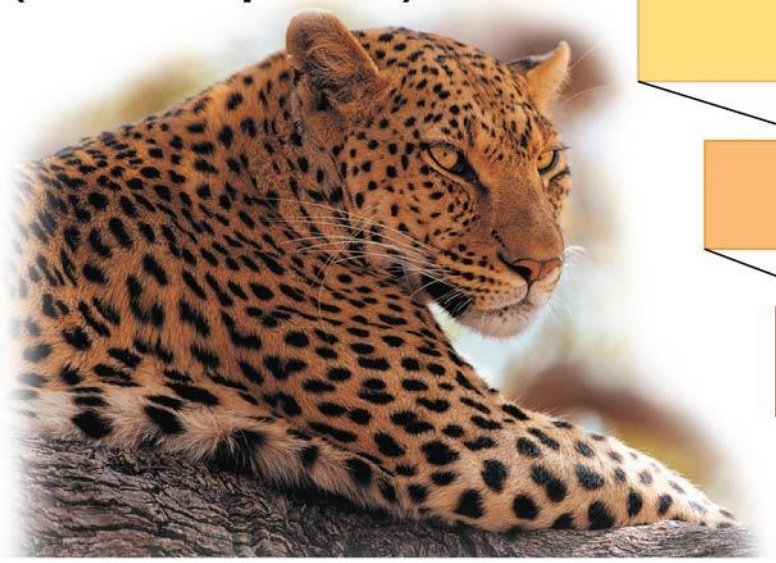
Order – group of similar families

Family – a group of genera that share many characteristics

Genus – a group of closely related species

Species – a group of similar organisms that can breed and produce fertile offspring.

Leopard
(*Panthera pardus*)



Species
Panthera pardus

Genus
Panthera

Family
Felidae

Order
Carnivora

Class
Mammalia

Phylum
Chordata

Kingdom
Animalia

Domain
Eukarya

Which two animals are more closely related?

Ursus arctos

Ursus maritimus

Ailuropoda melanoleuca

Kingdom:	Animalia	Animalia	Animalia
Phylum:	Chordata	Chordata	Chordata
Class:	Mammalia	Mammalia	Mammalia
Order:	Carnivora	Carnivora	Carnivora
Family:	Ursidae	Ursidae	Ursidae
Genus:	*Ursus*	*Ursus*	*Ailuropoda*
Species:	*U. maritimus*	*U. arctos*	*A. melanoleuca*

Kingdom:	Animalia	Animalia	Animalia
Phylum:	Chordata	Chordata	Chordata
Class:	Mammalia	Mammalia	Mammalia
Order:	Carnivora	Carnivora	Carnivora
Family:	Felidae	Felidae	Felidae
Genus:	*Panthera*	*Felis*	*Felis*
Species:	*P. leo*	*F. silvestris*	*F. catus*

Modern Evolutionary Classification

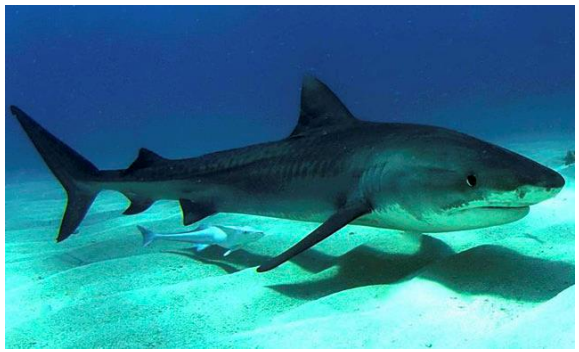
- In Linnaeus's time organisms where classified based solely on their observable adult traits.
- This posed many problems because animals that looked similar were classified together even though they were not closely related.

Family: Ailuridae

Family: Ursidae

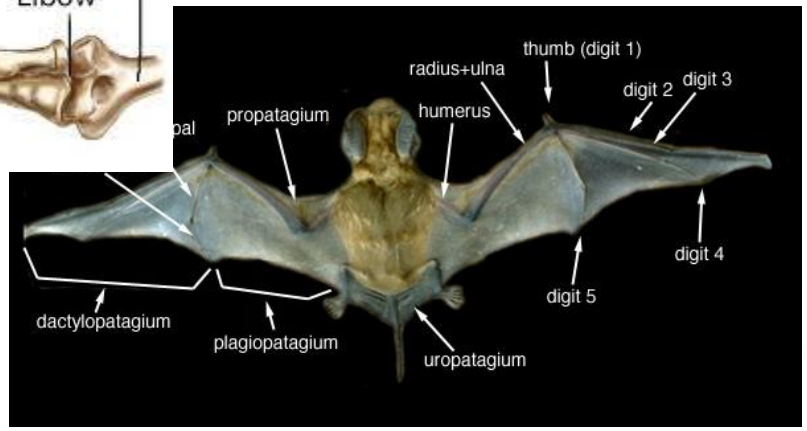
Evolutionary Classification- Systematics

- Darwin's ideas about descent with modification gave rise to the study of phylogeny.
- **Phylogeny** is the study of evolutionary relationships among organisms.
- **Evolutionary classification** is the strategy of grouping organisms together based on their evolutionary history.



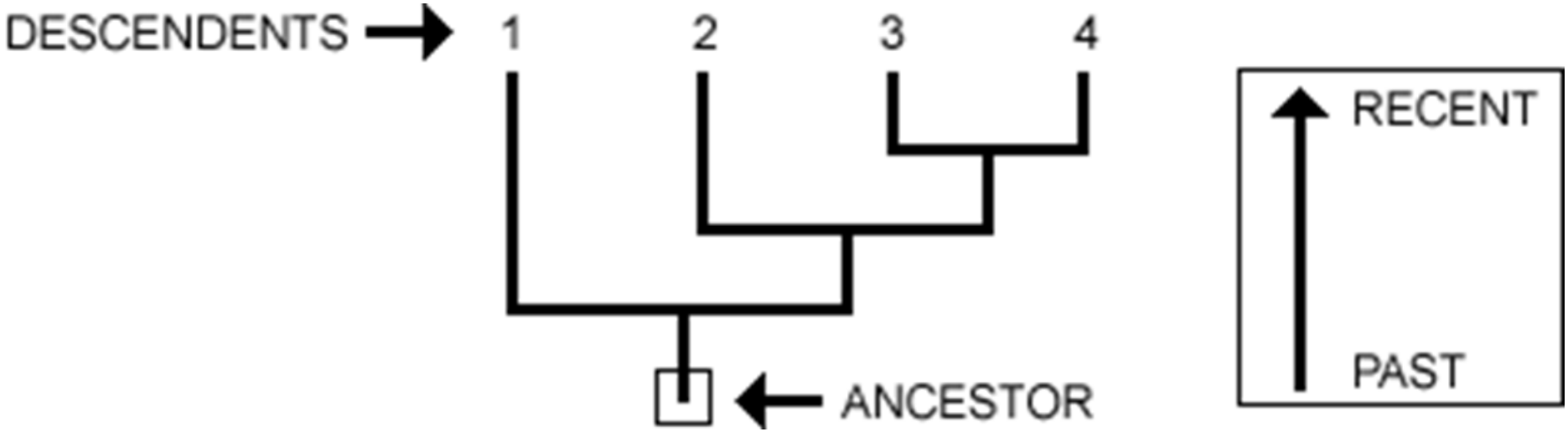
Evolutionary Classification- Systematics

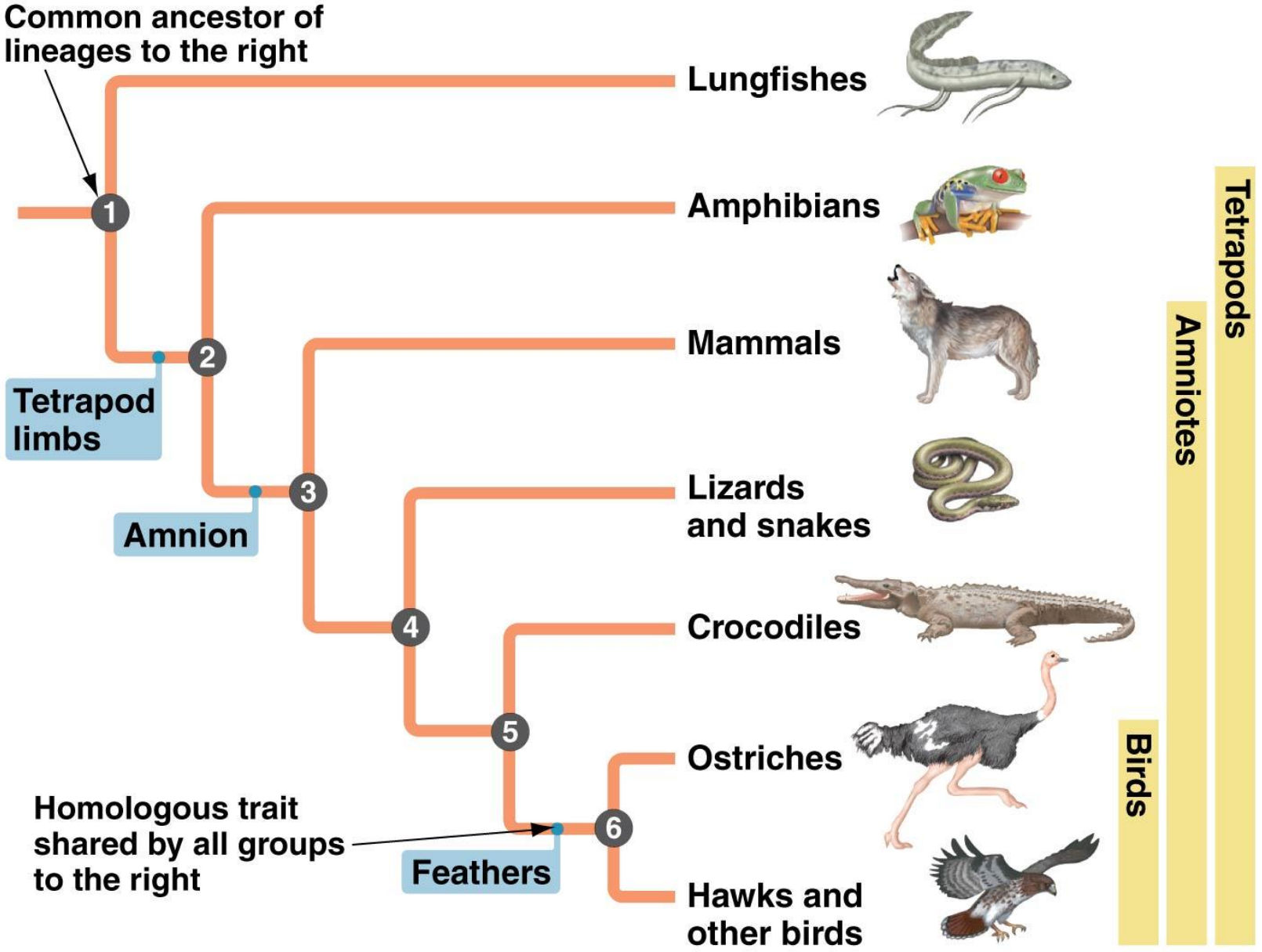
- Homologous structures are one of the best sources of information for phylogenetic relationships.
- The greater the number of homologous structures between two species, the more closely related the two species are.
- DNA comparisons



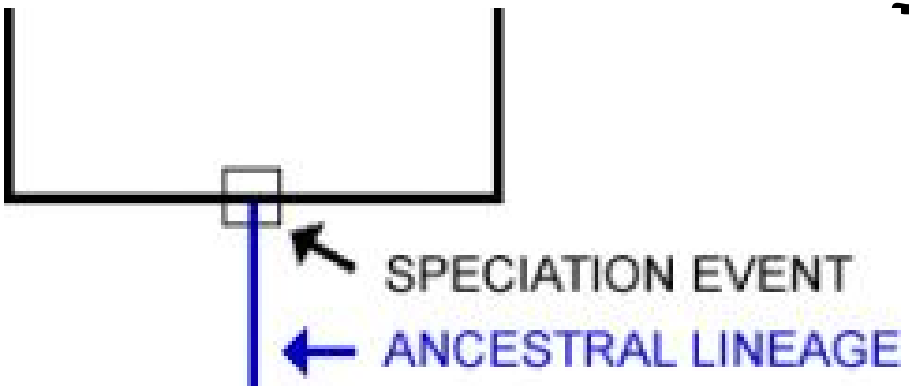
Classification Using Cladograms

Derived characters are characteristics that appear in recent parts of a lineage or "family tree" but not in its older members. These characteristics are used to derive **cladograms**, which are diagrams that show the evolutionary relationship amoung a group of organisms.



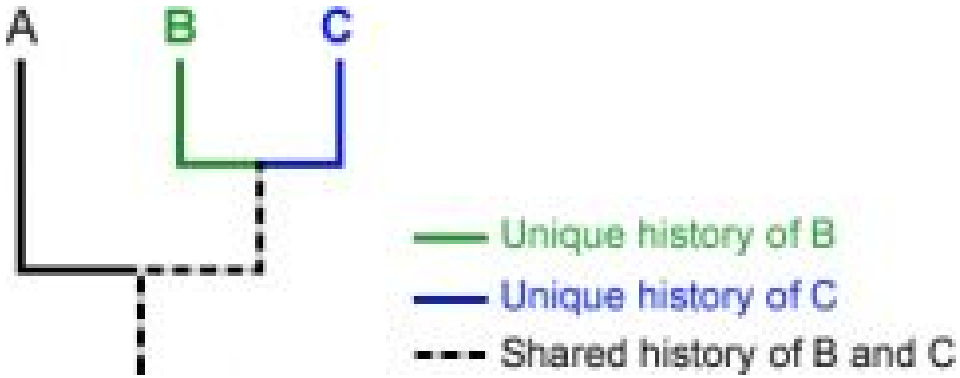


Understanding Phylogenies

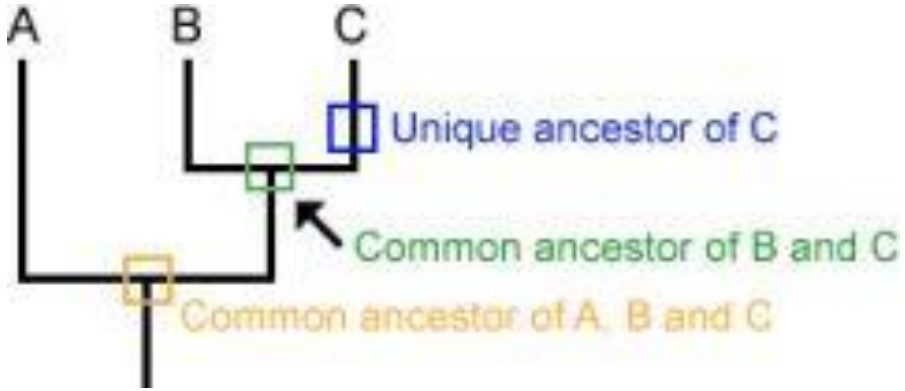


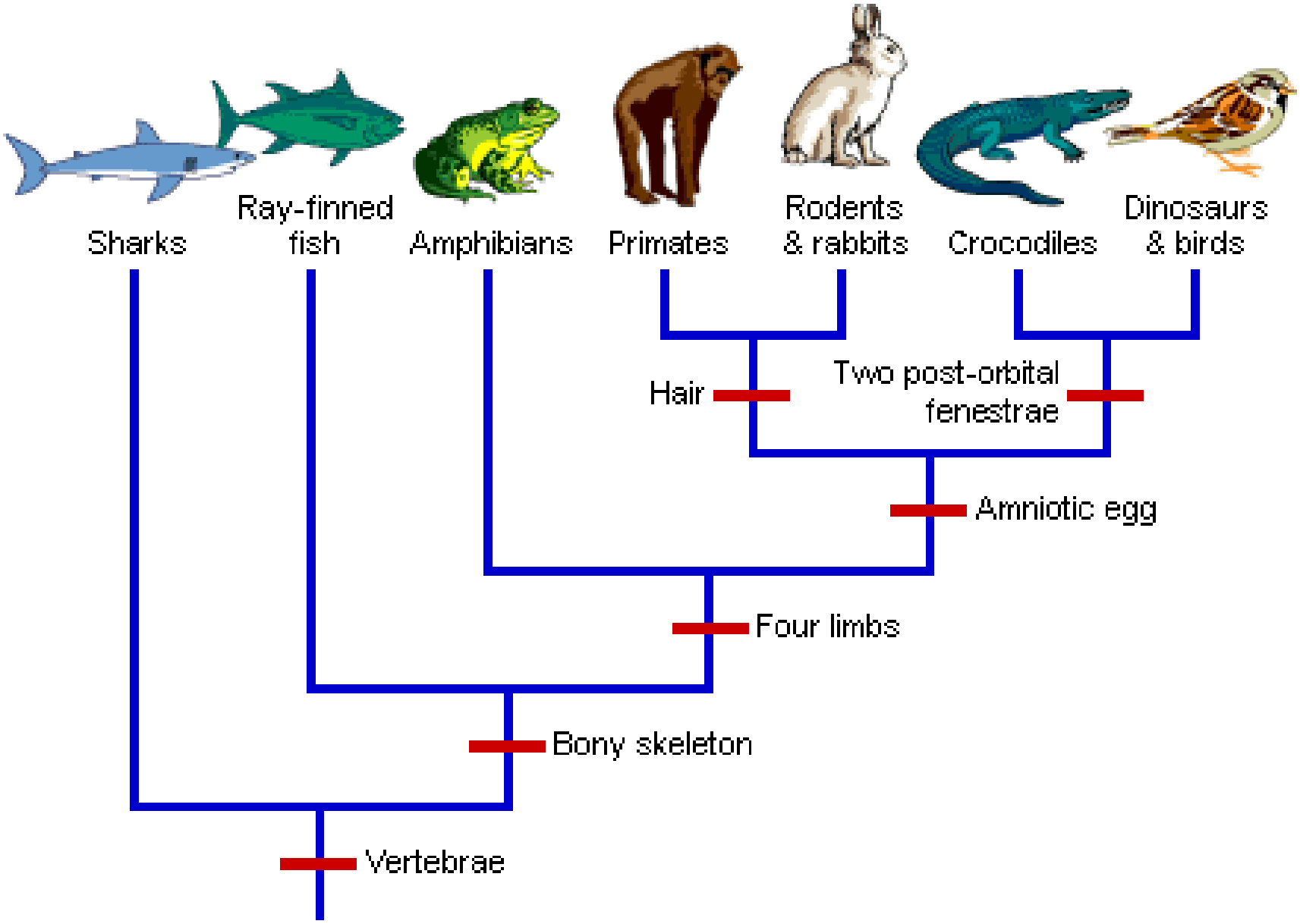
When a lineage splits (speciation), it is represented as branching on a phylogeny. When a speciation event occurs, a single ancestral lineage gives rise to two or more daughter lineages.

Phylogenies trace patterns of shared ancestry between lineages. Each lineage has a part of its history that is unique to it alone and parts that are shared with other lineages.



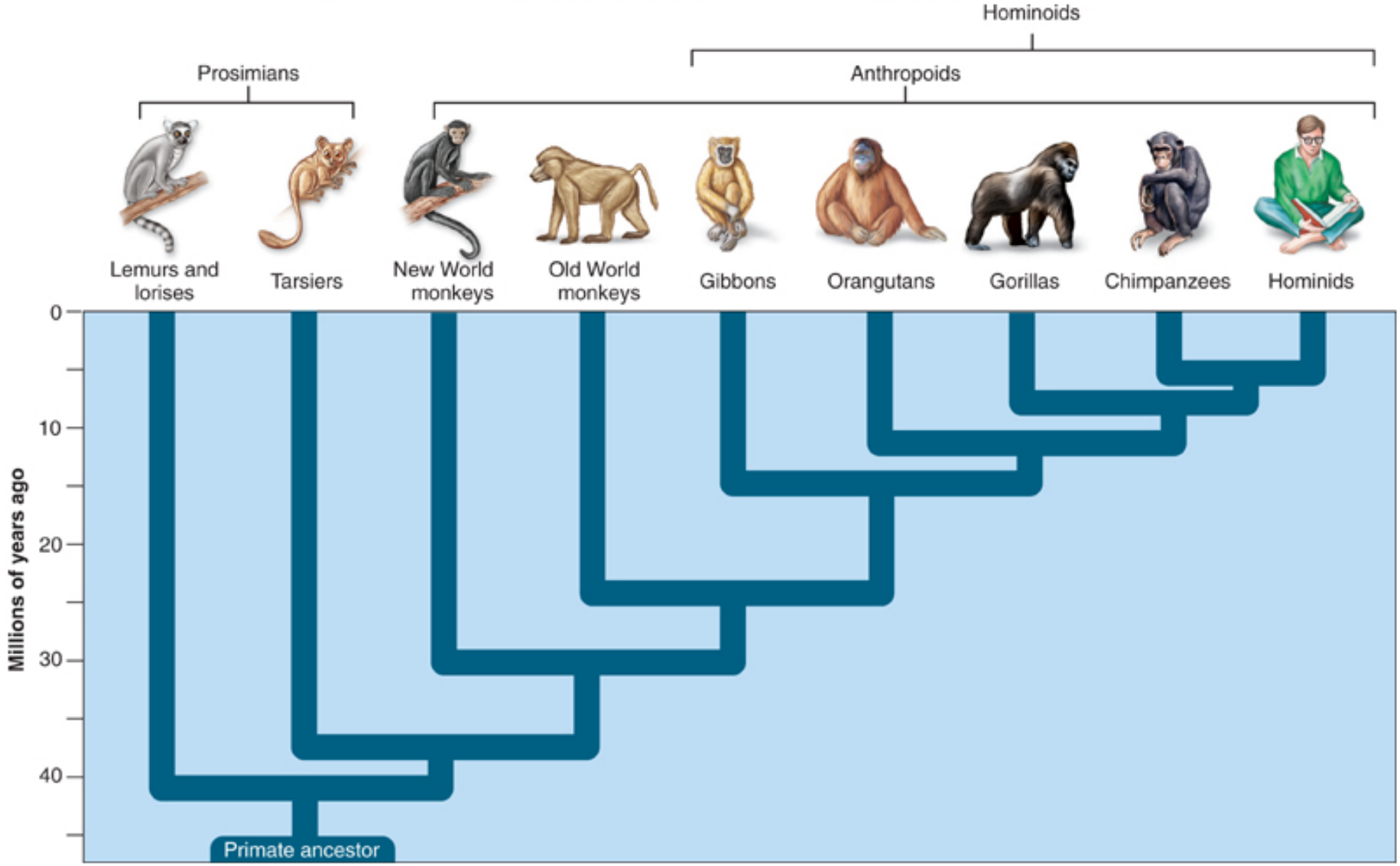
Similarly, each lineage has ancestors that are unique to that lineage and ancestors that are shared with other lineages — common ancestors.

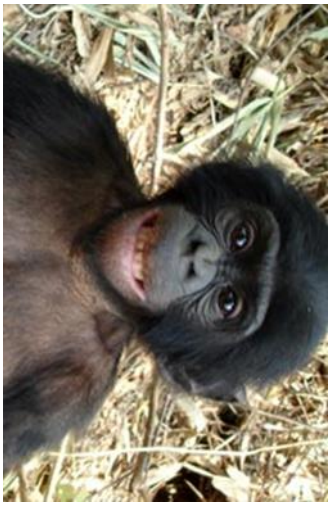


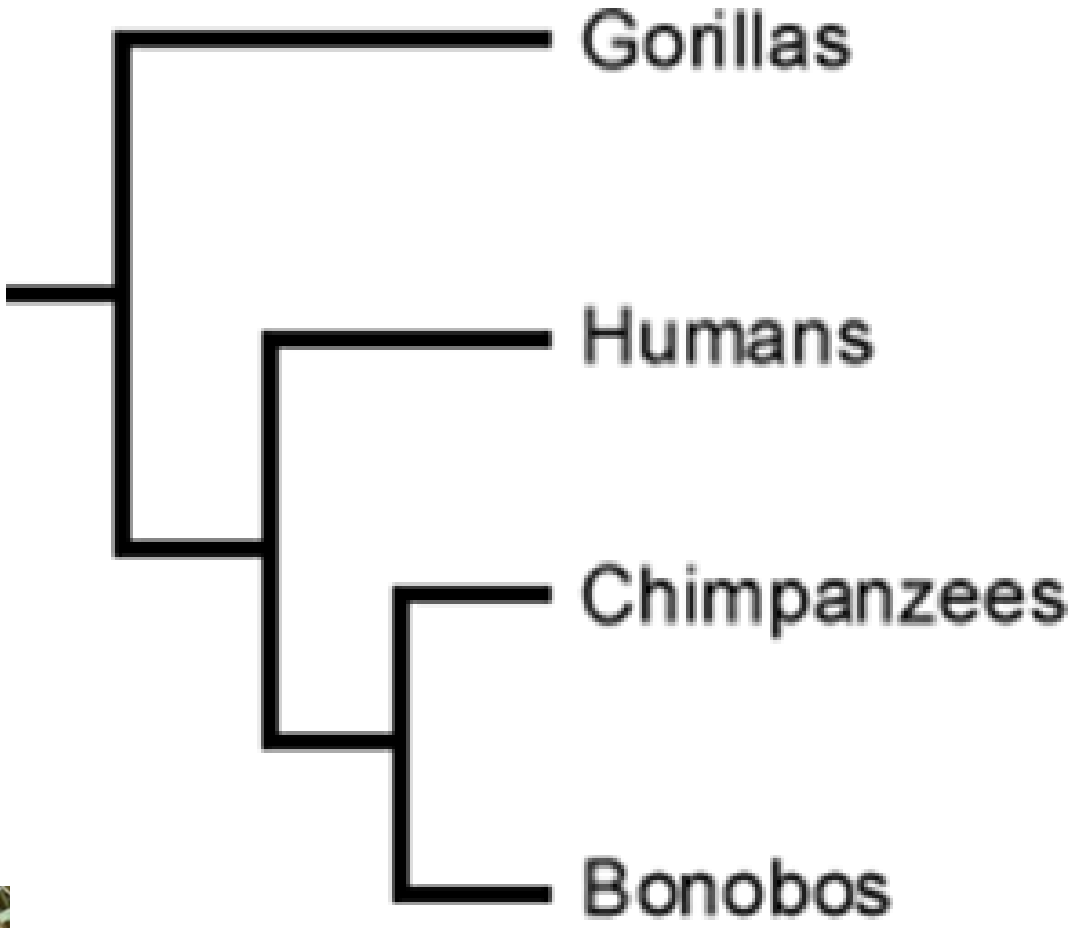

Sharks
Ray-finned fish
Amphibians
Primates
Rodents & rabbits
Crocodiles
Dinosaurs & birds
Hair
Two post-orbital fenestrae
Amniotic egg
Four limbs
Bony skeleton
Vertebrae

Similarities in DNA and RNA

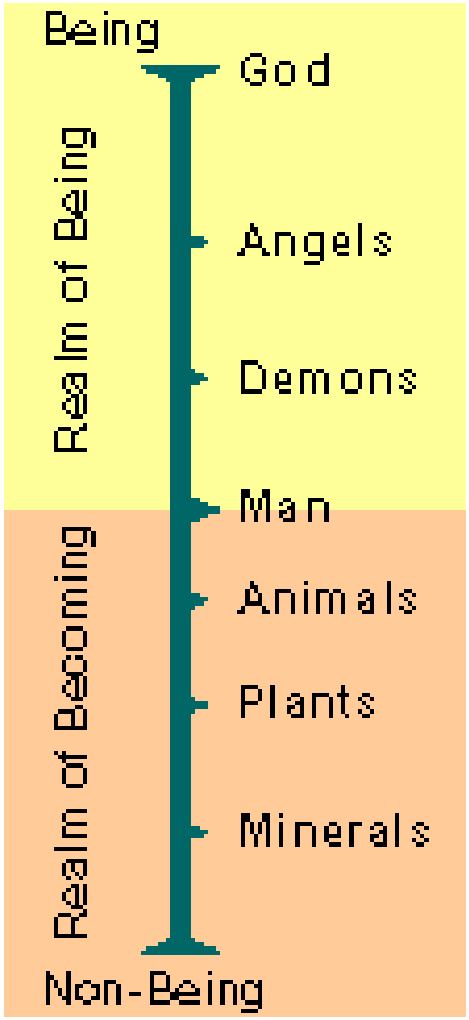
- All organisms use DNA and RNA to pass on information to their offspring and to control growth and development
- Genes (DNA) of many organisms show important similarities at the molecular level. These similarities can be used to help determine classification and evolutionary relationships.
- For example…..myosin is a protein found in our muscles. We have a gene that codes for myosin, but so does yeast!!! Which means that we must share a common ancestor!!






Gorillas
Humans
Chimpanzees
Bonobos

Kingdoms and Domains



Aristotle's Classification

In Linnaeus's time the only known differences among living things were the fundamental traits that separated animals from plants.

Animals were mobile and ate food for energy

Plants were green, used photosynthesis to convert the sun's rays into energy.

Tree of Life Evolves

As more information about the natural world became known biologists realized they needed more than just two kingdoms to classify all of the organisms.

Changing Number of Kingdoms						
First Introduced	Name of Kingdoms					
1700s	Plantae					Animalia
Late 1800s	Protista			Plantae		Animalia
1950s	Monera		Protista	Fungi	Plantae	Animalia
1990s	Eubacteria	Archaebacteria	Protista	Fungi	Plantae	Animalia

We use the six kingdom system of classification today!!!

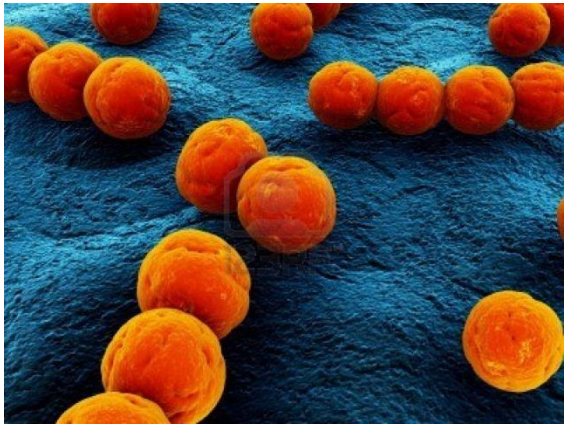
Three Domain System

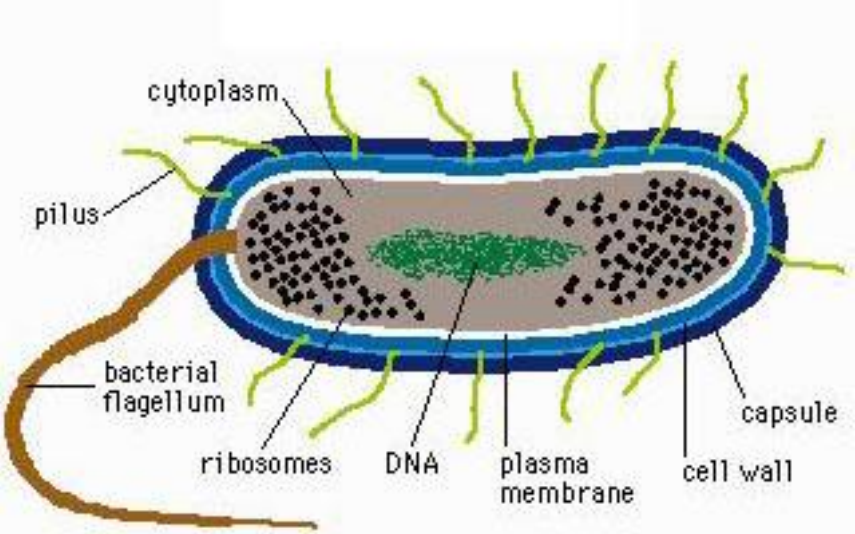
- Scientist now group modern organisms according to how long they nave been evolving independently.
- Domain is a more inclusive category larger than a kingdom.
- There are 3 Domains
  - **Bacteria: Eubacteria**
  - **Archaea: Archaebacteria**
  - **Eukarya: Protista, Fungi, Plantae, Animalia**

Classification of Living Things						
DOMAIN	**Bacteria**	**Archaea**	**Eukarya**			
KINGDOM	**Eubacteria**	**Archaebacteria**	**Protista**	**Fungi**	**Plantae**	**Animalia**
CELL TYPE	Prokaryote	Prokaryote	Eukaryote	Eukaryote	Eukaryote	Eukaryote
CELL STRUCTURES	Cell walls with peptidoglycan	Cell walls without peptidoglycan	Cell walls of cellulose in some; some have chloroplasts	Cell walls of chitin	Cell walls of cellulose; chloroplasts	No cell walls or chloroplasts
NUMBER OF CELLS	Unicellular	Unicellular	Most unicellular; some colonial; some multicellular	Most multicellular; some unicellular	Multicellular	Multicellular
MODE OF NUTRITION	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
EXAMPLES	*Streptococcus, Escherichia coli*	Methanogens, halophiles	*Amoeba, Paramecium,* slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants	Sponges, worms, insects, fishes, mammals

Domain: Bacteria
Kingdom: Eubacteria

- Prokaryotic
- Unicellular
- Thick rigid cell walls surrounded by a cell membrane
- Peptidoglycan in cell wall
- Autotroph or heterotroph

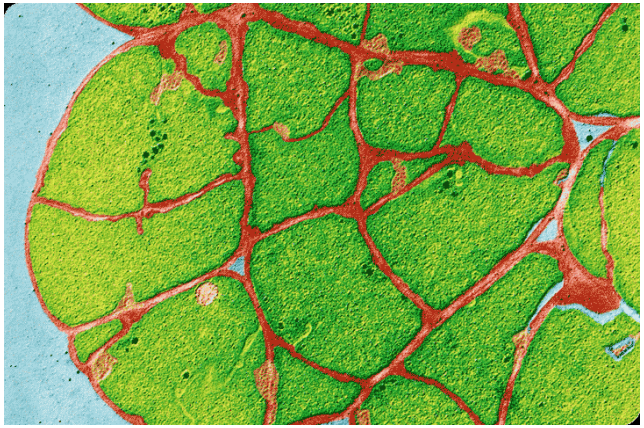




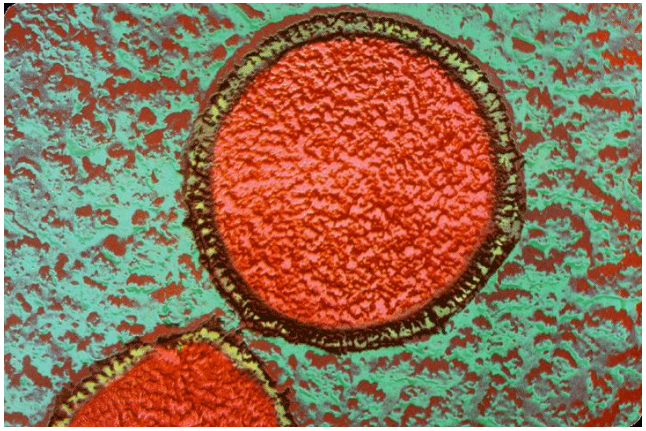
Domain: Archaea
Kingdom: Archaebacteria

- Prokaryotic (some research suggests they are closer to eukaryotes based on gene comparison)
- Cell wall without peptidoglycan
- Autotroph or heterotroph
- Can survive without oxygen
- Extremophiles: halophiles and thermophiles.
- Methanogens – produce methane gas (CH_4)

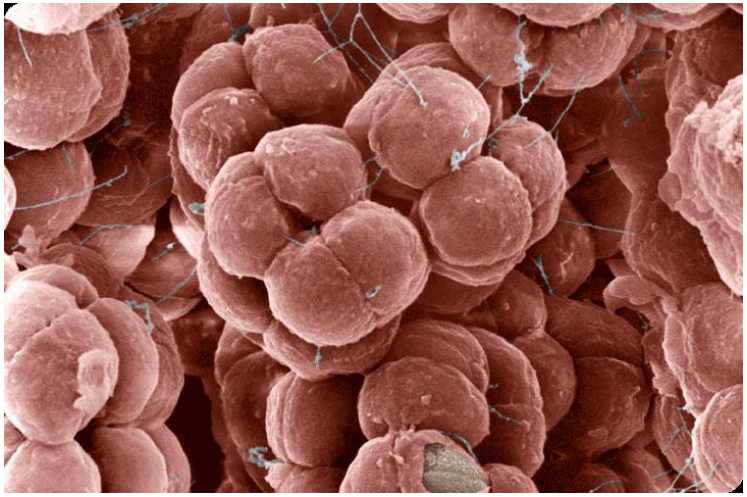
Sulfolobus is an extremophile that is found in hot springs and thrives in acidic and sulphur-rich environments.



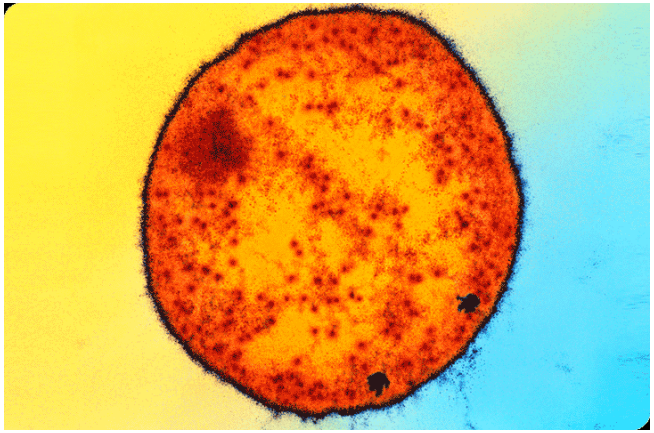
Methanosarcina rumen is anaerobic, and is found in places with little or no oxygen. It is a methane- producing organism that digests decaying organic matter. It is found in the rumen of a group of animals called ruminants such as cattle and sheep.



Staphylothermus marinus is an extremophile found in deep ocean hydrothermal vents, thriving on volcanic sulphur and surviving in water temperatures of up to 98°C.



Halococcus salifodinae is found in water with high concentrations of salt. These high salt concentrations would be deadly to most other forms of life, and so *H. salifodinae* is also known as an extremophile.

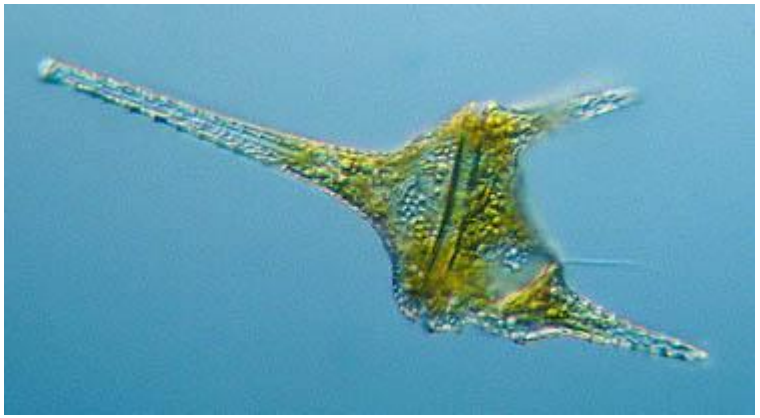


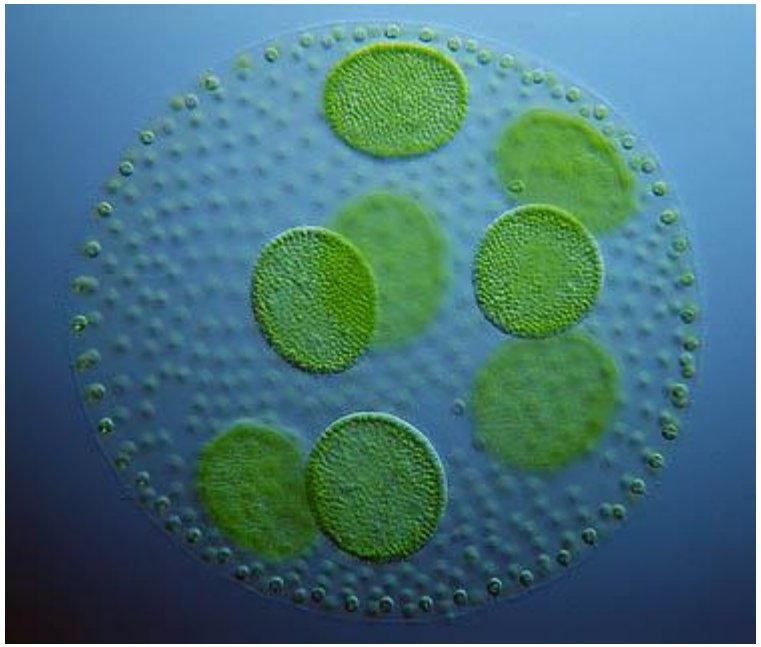
Methanococcoides burtonii is an extremophile and was discovered in 1992 in Ace Lake, Antarctica, and can survive in temperatures as low as -2.5 °C.

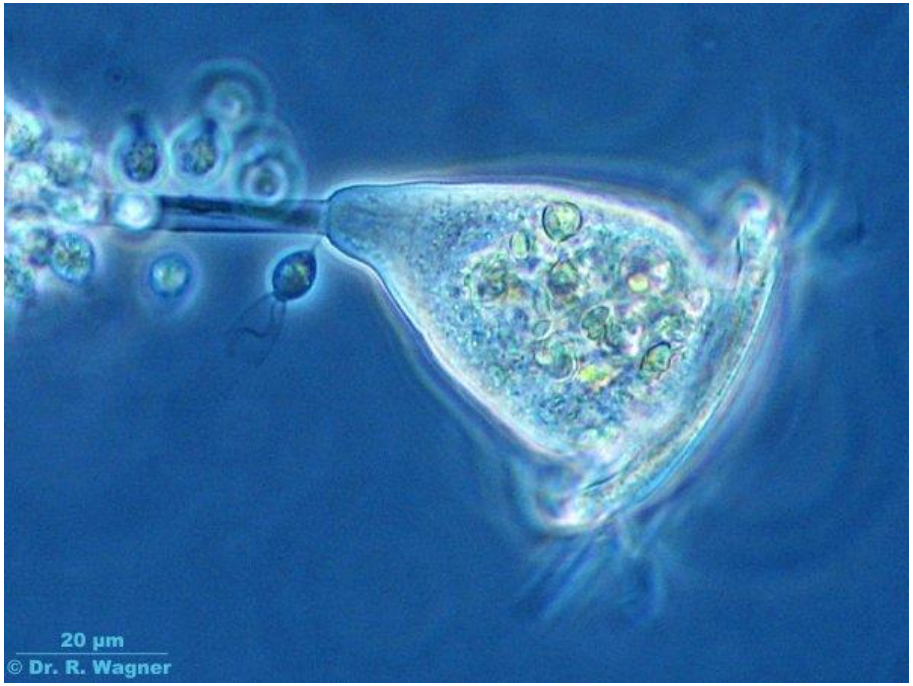
Domain: Eukarya
Kingdom: Protista

- Eukaryotic organisms that cannot be classified as animals, plants or fungi
- Greatest variety of all kingdoms!
- Unicellular for the most part, some are multicellular
- Some are photosynthetic and some heterotrophic


Power & Syred



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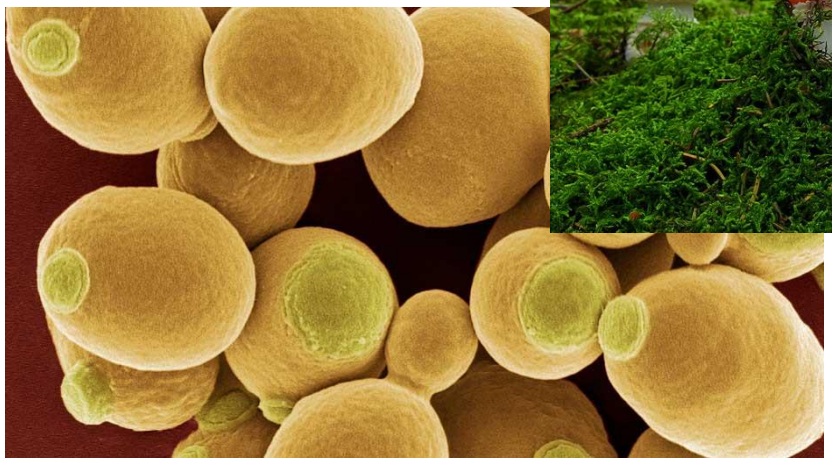
Domain: Eukarya
Kingdom: Fungi

- Heterotrophs
- Most multicellular, yeasts are unicellular



Domain: Eukarya
Kingdom: Plantae

- Multicelluar
- Photosynthetic autotrophs
- Non-motile
- Cell wall contains cellulose

Domain: Eukarya
Kingdom: Animalia

- Multicellular
- Heterotrophic
- No cell walls