Unit 8: Evolution & Classification
Topic 3: Classification

Topic 3 learning targets

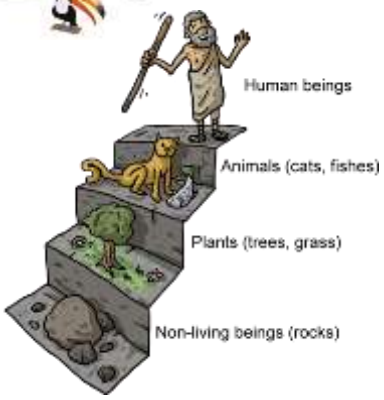
- Explain the development of the six kingdoms and three domain systems of classification of organisms.
- Contrast the characteristics of organisms found in each of the six kingdoms and three domains.
- Use a dichotomous key to identify an organism's classification and interpret a cladogram.

Guiding question: Why do scientists classify organisms?

What does classification mean?
Grouping organisms based on their similarities

Aristotle (2000 years ago)

- Aristotle developed the first known classification system – making him the first taxonomist
- Taxonomy is the science of classifying organisms
- He classified organism by:
  - Levels of complexity
  - Plant (stem characteristics) vs. animal (habitats characteristics: land, sea, or air)

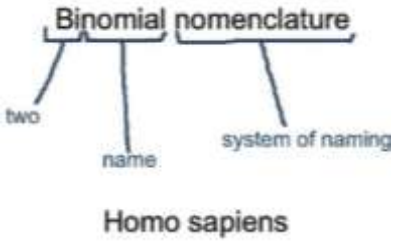


Carolus Linnaeus (1707-1778)
The first scientist to use a more modern system of taxonomy (Father of Modern Taxonomy)

- In 1735, he published *Systema Naturae*, his classification of living things that organized species into taxa (groups) that formed a hierarchy or set of ordered ranks
- Linnaeus developed a two-word naming system called binomial nomenclature. In binomial nomenclature, each species is assigned a two-part scientific name.

Binomial nomenclature
When writing the scientific name of an organism, both words must be underlined or *italicized*.

- The genus is always capitalized
- The species always begins with a lower-case letter.



Examples

- *Homo sapiens* = human beings
- *Ursus arctos* = grizzly bear
- Felis domesticus = domestic cat
- Ursus americanus = black bear
- Binomial nomenclature

Scientific names are always written in Latin or ancient Greek so that they have the same name everywhere!
Genus is a group of similar species and can be abbreviated with one letter.
Examples

- *H. sapiens* = human beings
- *U. arctos* = grizzly bear
- F. domesticus = domestic cat
- U. americanus = black bear

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How did we define a species in our evolution notes?

- Scientific names may describe the organism (Ex: *Chaos chaos)*
- They may also honor a person or suggest the habitat of the organism (*(Linnaea borealis*)
- Accurately and uniformly name organisms while preventing misnomers such as starfish and jellyfish that aren't really fish

The Linnaean classification system

His original system had <u>four levels</u> (kingdom, order, genus, species)

- Grouping species according to anatomical (structural) similarities and differences
- Similar to Aristotle's classification system, he had two kingdoms: Animalia and Plantae

Over time, Linnaeus's original classification system expanded to include <u>seven hierarchical taxa</u>: kingdom, phylum, class, order, family, genus, species

Modern classification system

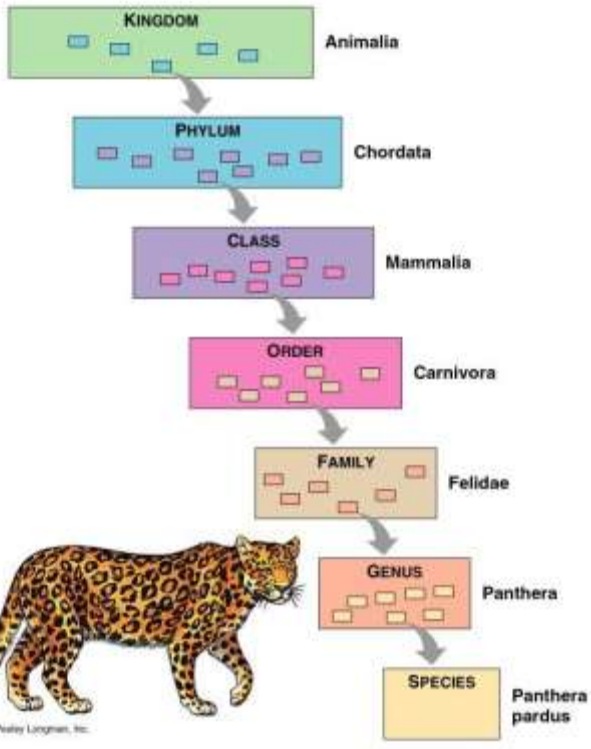
Today, scientists continue to use the Linnaean system of binomial nomenclature

- Each <u>kingdom</u> (plant and animal) was divided into a phylum* (division for plants)
- Each <u>phylum</u> into smaller groups called class.
- Each <u>class</u> was divided into an order.
- Each <u>order</u> was divided into family (families).
- Each <u>family</u> was divided into a genus (plural-genera)
- Each <u>genus</u> was divided into a <u>species</u>. (scientific name)

*Note: Phyla and family were not in Linnaeus's classification system but were added by modern scientists.



	Bobcat	Lion	Human
Kingdom	Animalia	Animalia	Animalia
Phylum	Chordata	Chordata	Chordata
Class	Mammalia	Mammalia	Mammalia
Order	Carnivora	Carnivora	Primata
Family	Felidae	Felidae	Hominidae
Genus	*Lynx*	*Panthera*	*Homo*
Species	*Lynx rufus*	*Panthera leo*	*Homo sapien*



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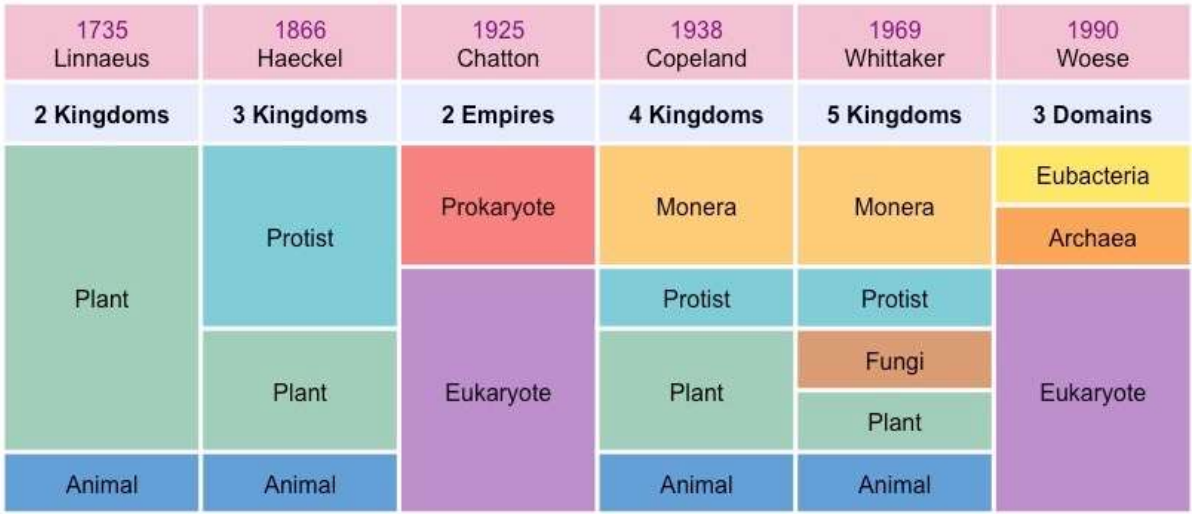
Taxonomic mnemonics
Kingdom → Phylum → Class → Order → Family → Genus → Species

- King Philip Can Order Five Good Soups
- Katy Perry Came Over For Grape Soda
- Dirty Krabby Patties Crawl On Frightened Grandpa Squidward

The groups within each taxa are constantly changing as we discover new relationships between organisms



The three domains

- Broadest, most inclusive taxon
- Three domains
    1. Archaea: unicellular prokaryotes (no nucleus or membrane-bound organelles)
    2. Bacteria: unicellular prokaryotes (no nucleus or membrane-bound organelles)
    3. Eukarya (Eukaryota): More complex with nucleus and membrane-bound organelles

Characteristic	Archaea	Bacteria	Eukarya
Membrane lipids with branched hydrocarbons	✔		
Chromosomes are circular	✔	✔	
Lacks nuclear envelopes	✔	✔	
Lacks membrane bound organelles	✔	✔	
Methionine is the initiator amino acid for protein synthesis	✔		✔
Lack peptidoglycan in the cell wall	✔		✔
Growth not inhibited by streptomycin and chloramphenicol	✔		✔
Histones are associated with DNA	✔		✔
Contains several types of RNA polymerase	✔		✔

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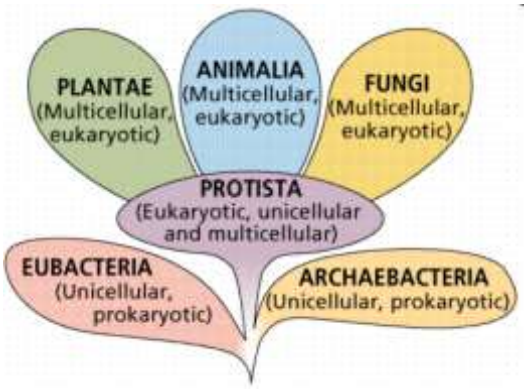

Archaea and Bacteria

- Combined have the greatest number of organisms on Earth
- All of the prokaryotes are in these two kingdoms
- Both reproduce by binary fission, but they do have some ways to recombine genes, allowing evolution to occur

Archaea

Kingdom: Archaebacteria

- Most likely to be first cells to evolve
- Often called "extremophiles" because they live in harsh environments
- Three major types:
    1. Methanogens: Methane producers; areas with low concentrations of oxygen (Sewage treatment plants, bogs, intestinal tract of ruminants)
    2. Thermophiles: Areas with high exposure to heat (Volcanic vents, geysers, hot springs)
    3. Halophiles: Areas with high concentrations of salt (Dead Sea, Great Salt Lakes)

Bacteria

Kingdom: Eubacteria

- Pathogenic (disease-causing) or probiotic
- Found in all habitats because they can be either auto- and heterotrophic
- Important decomposers for the environment
- Commercially important in making cottage cheese, yogurt, buttermilk, etc.

Eukarya

Four Kingdoms

1. Protista (protozoans, algae…)
2. Fungi (mushrooms, yeasts…)
3. Plantae (multicellular plants)
4. Animalia (multicellular animals)

Protista

- Most are unicellular or some are multicellular
- Autotrophic or heterotrophic

In what environment might these organisms be found?

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Fungi

- Multicellular, except yeast
- Absorptive heterotrophs (digest food outside their body and then absorb it)
    1. Obtain their nutrients by releasing digestive enzymes into a food source
    2. Absorb their food after it has been digested by the enzyme
- Cell walls made of chitin

Plantae

- Multicellular, autotrophic
- Use photosynthesis to make glucose
- Cell walls made of cellulose
- Two major groups

1. Nonvascular plants: Mosses
2. Vascular plants: ferns, gymnosperms (cone-bearing plants), and angiosperms (flowering plants)

	Structures	Vascularisation	Reproduction	Other Features	Examples
Bryophyta	No 'true' leaves, roots or stems	None	Spores	Anchored by rhizoids	Mosses
Filicinophyta	Have leaves, roots and stems	Present	Spores	Leaves are pinnate	Ferns
Coniferophyta	Have leaves, roots and stems	Present	Seeds (in cones)	Woody stems	Conifers
Angiospermophyta	Have leaves, roots and stems	Present	Seeds (in fruits)	Have flowers & fruits	Flowers

Animalia

- Multicellular, ingestive heterotrophs (consume food and digest it inside their bodies)
- Feed on plants or animals
- Most members of the Animal Kingdom can move from place to place.
- Some are permanently attached to surfaces such as sponges and barnacles.
- Major groups
    - Invertebrates: Sponges, jellyfish, worms, sea stars, and insects.
    - Vertebrates: Fish, Birds, Reptiles, Amphibians, and mammals-including humans

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	Symmetry	Body Cavity	Segmentation	Other Features	Examples
Porifera	Asymmetrical	None (have pores)	None	Spicules for support	Sea sponge
Cnidaria	Radial	Mouth but no anus	None	Stinging cells (cnidocytes)	Jellyfish, coral, sea anemone
Platyhelmintha	Bilateral	Mouth but no anus	None	Flattened body (↑ SA:Vol ratio)	Tapeworm, planaria
Annelida	Bilateral	Mouth and anus	Segmented	Move via peristalsis	Earthworm, leech
Mollusca	Bilateral	Mouth and anus	Non-visible (mantle & foot)	May have a shell (made by mantle)	Snail, octopus, squid, bivalves
Arthropoda	Bilateral	Mouth and anus	Segmented	Exoskeleton (chitin)	Insects, spiders, crustaceans

	Body covering	Reproduction	Breathing	Temperature	Other Features
Fish	Scales made out of bony plates	External	Gills	Ectothermic	Have a swim bladder
Amphibian	Moist skin	External	Simple lungs (and via skin)	Ectothermic	Larval state in water, adult state on land
Reptile	Scales made out of keratin	Internal (lays soft eggs)	Lungs with extensive folding	Ectothermic	Simple teeth with no living tissue
Bird	Feathers	Internal (lays hard eggs)	Lungs with bronchial tubes	Endothermic	Have wings and beaks with no teeth
Mammal	Hair	Internal – live births (except monotremes)	Lungs with alveoli	Endothermic	Feed young with milk from mammary gland

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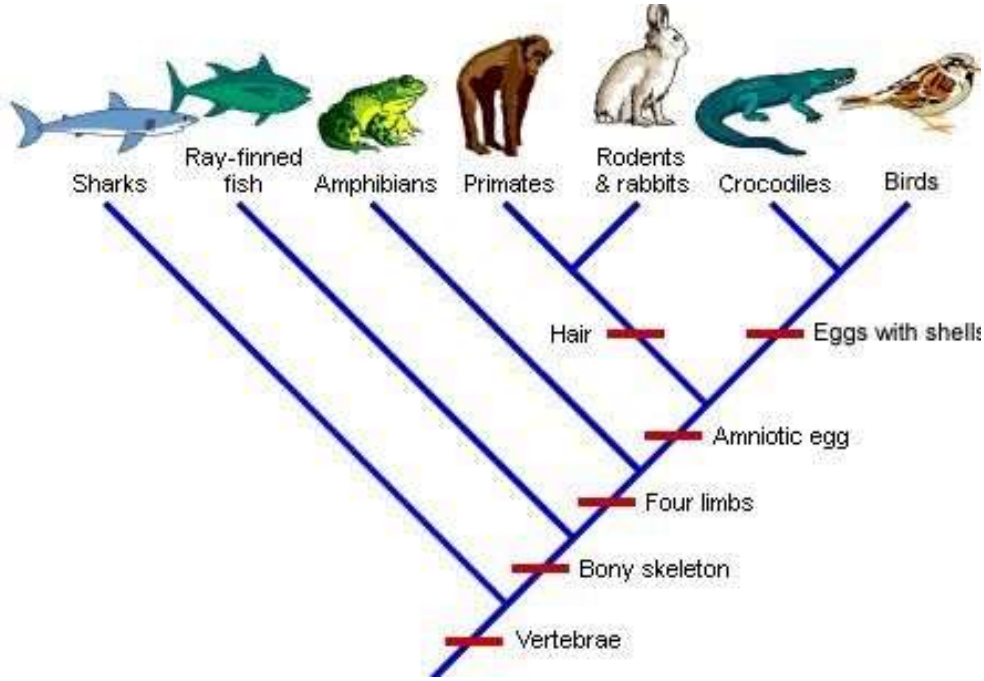
What is a cladogram?
A diagram showing how organisms are related based on shared, derived characteristics such as feathers, hair, or scales



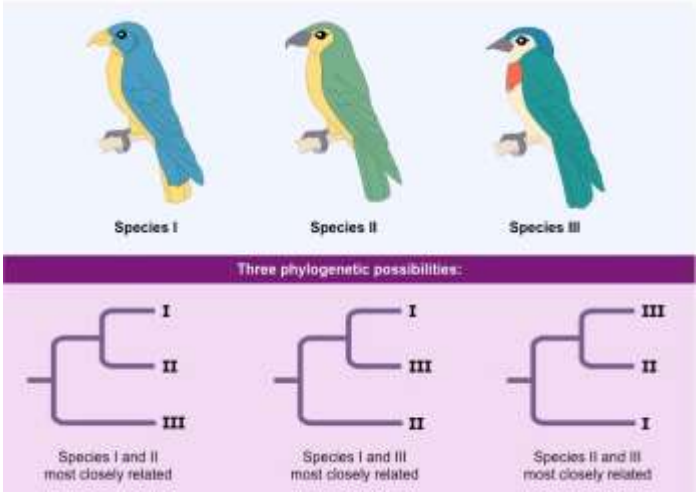
1. Does a cladogram show divergent or convergent evolution?

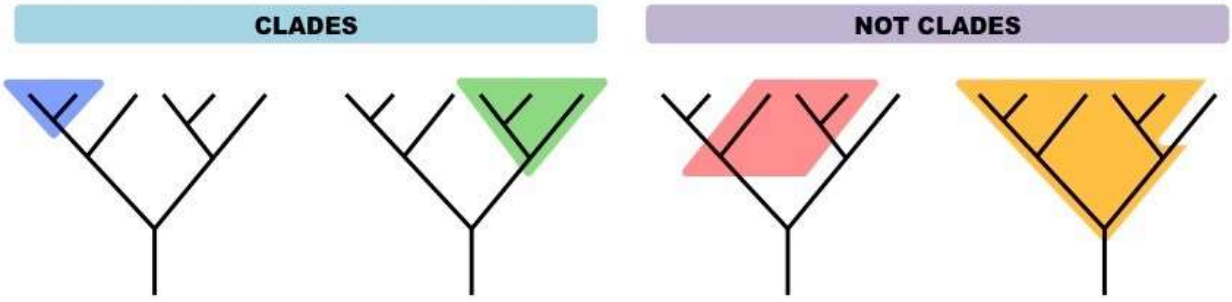
2. Where is the common ancestor between amphibians are birds?

3. Where is the common ancestor between primates and rodents?

4. Where is the common ancestor between crocodiles and sharks?

What is a clade?
A group of organisms believed to have evolved from a common ancestor, according to the principles of cladistics





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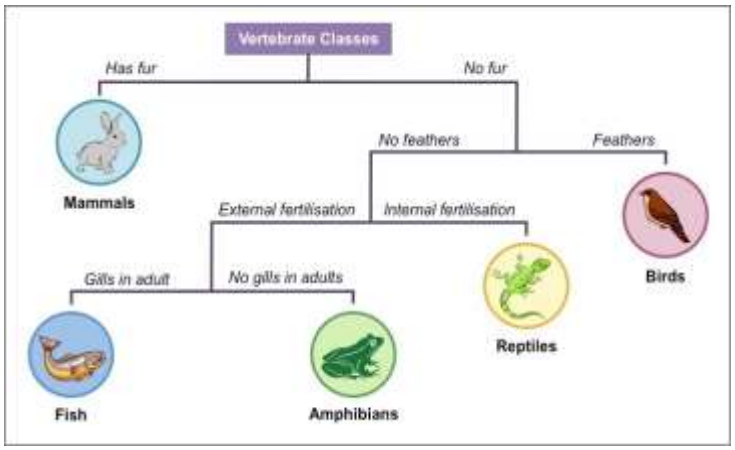
What is a dichotomous key?
A method of identification whereby groups of organisms are divided into two categories repeatedly

- With each sequential division, more information is revealed about the specific features of a particular organism
- When the organism no longer shares 100% of selected characteristics with any organisms, it has been identified



Step	Description of Leaves	Go to Step
1. a	Leaves are evergreen, thin, needle-like	2
b	Leaves are broad, deciduous	6
2. a	Needles are over 1 inch long, in clusters	3
b	Needles are $\frac{1}{2}$ inch long or less	4
3. a	Needles are in clusters of 3	Pitch pine
b	Needles are in clusters of 5	Eastern white pine
4. a	Needles are scale-like, sharp, cover twigs	Eastern red cedar
b	Needles protrude from twigs	5
5. a	Needles are flat, rounded tips, in 2 rows along twig	Eastern hemlock
b	Needles are in whorl around the stem	White spruce

How to use a dichotomous key:

1. Read both statements laid out in a numbered sequence (descriptive representation)
2. Choose statement that better matches the organism
3. Go to next series of paired statements <u>or</u> identify the organism

Dichotomous Key For Leaves

1.	a. Needle leaves	go to 2
	b. Non-needle leaves	go to 3
2.	a. Needles are clustered	Pine
	b. Needles are in singlets	Spruce
3.	a. Simple leaves (single leaf)	go to 4
	b. Compound leaves (made of "leaflets")	go to 7
4.	a. Smooth edged	go to 5
	b. Jagged edge	go to 6
5.	a. Leaf edge is smooth	Magnolia
	b. Leaf edge is lobed	White Oak
6.	a. Leaf edge is small and tooth-like	Elm
	b. Leaf edge is large and thorny	Holly
7.	a. Leaflets attached at one single point	Chestnut
	b. Leaflets attached at multiple points	Walnut