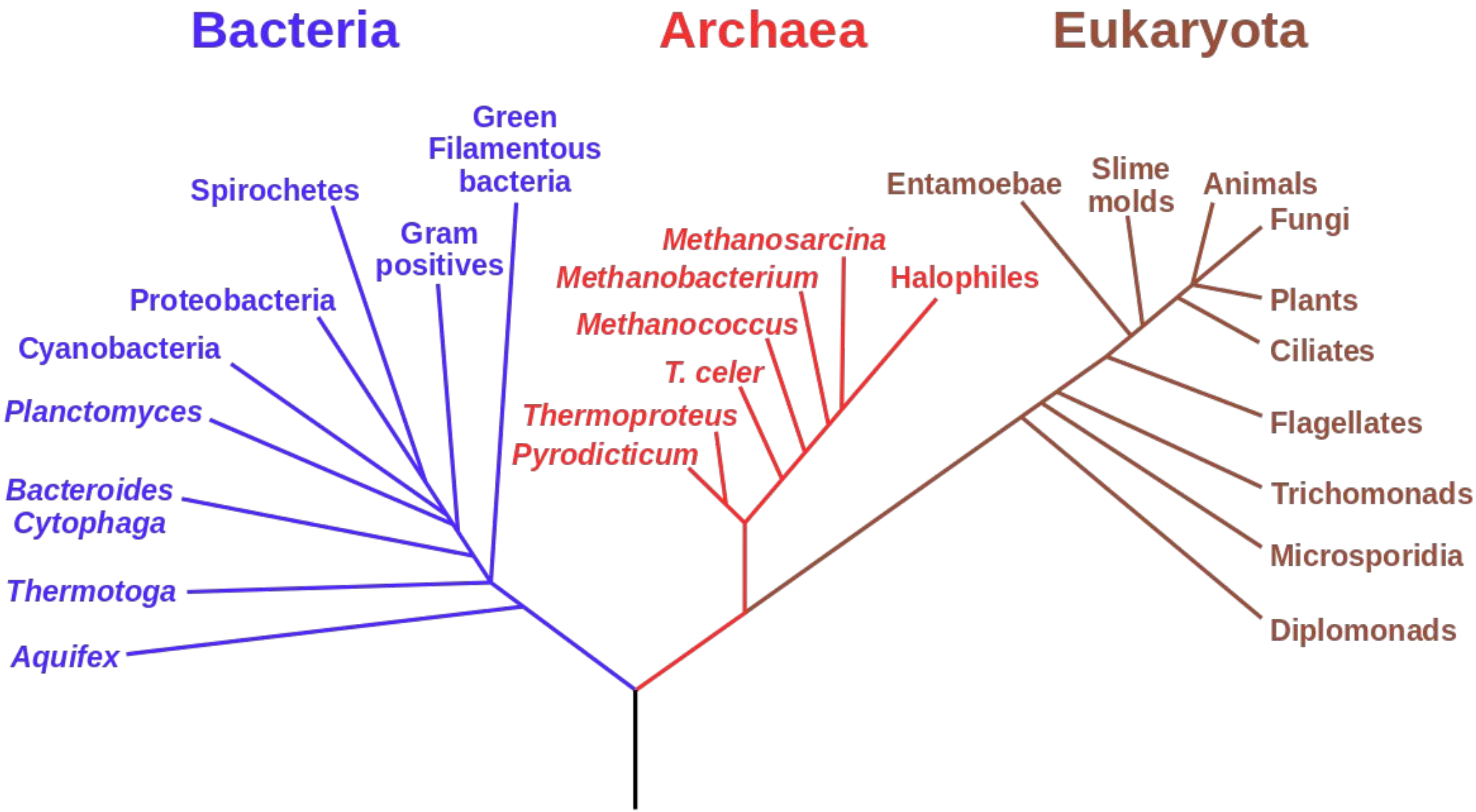
Phylogenetic Tree of Life



Phylogenetic card (cladogram and phylogenetic tree)

Learning objective

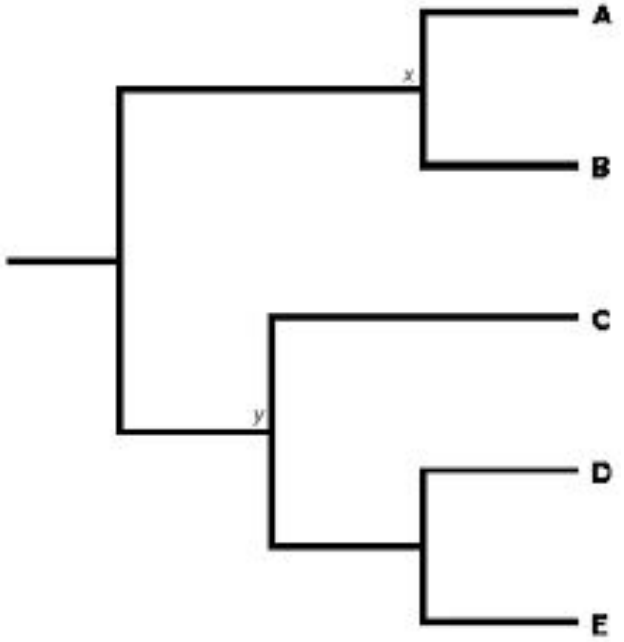
- compile and interpret phylogenetic card (cladogram and phylogenetic tree)

Success criteria

1. Apply previously obtained knowledge regarding binominal nomenclature of Carl Linnaeus.
2. Compare, analyze and find connection (links) between different taxonomic groups.
3. Constructs and interprets cladograms.

Terminology

- Domain Kingdom Phylum Class Order Family Genus Species
- Prokaryote Eukaryote
- Animalia Plantae Fungi Bacteria Protista
- Carl Woese and Carl Linnaeus
- Systemics Taxonomy
- Cladistics / cladogram
- Characteristics
- Clade / taxa
- Binominal system



Key Words

Classification — Grouping things by similar characteristics

Taxonomy — Science of grouping

Nomenclature — Naming of organisms

Systematics — Placing organism in groups

Binomial nomenclature

Each organism has two names:

(1) Language: Latin

(2) Taxa: *Genus species*

(italics), **Genus species** ***or*** **with genus abbreviated -** ***G. species***

Key Words

Species A group of closely related organisms that are capable of interbreeding and producing fertile offspring

-hybrid Two closely related organisms interbreed to produce infertile offspring

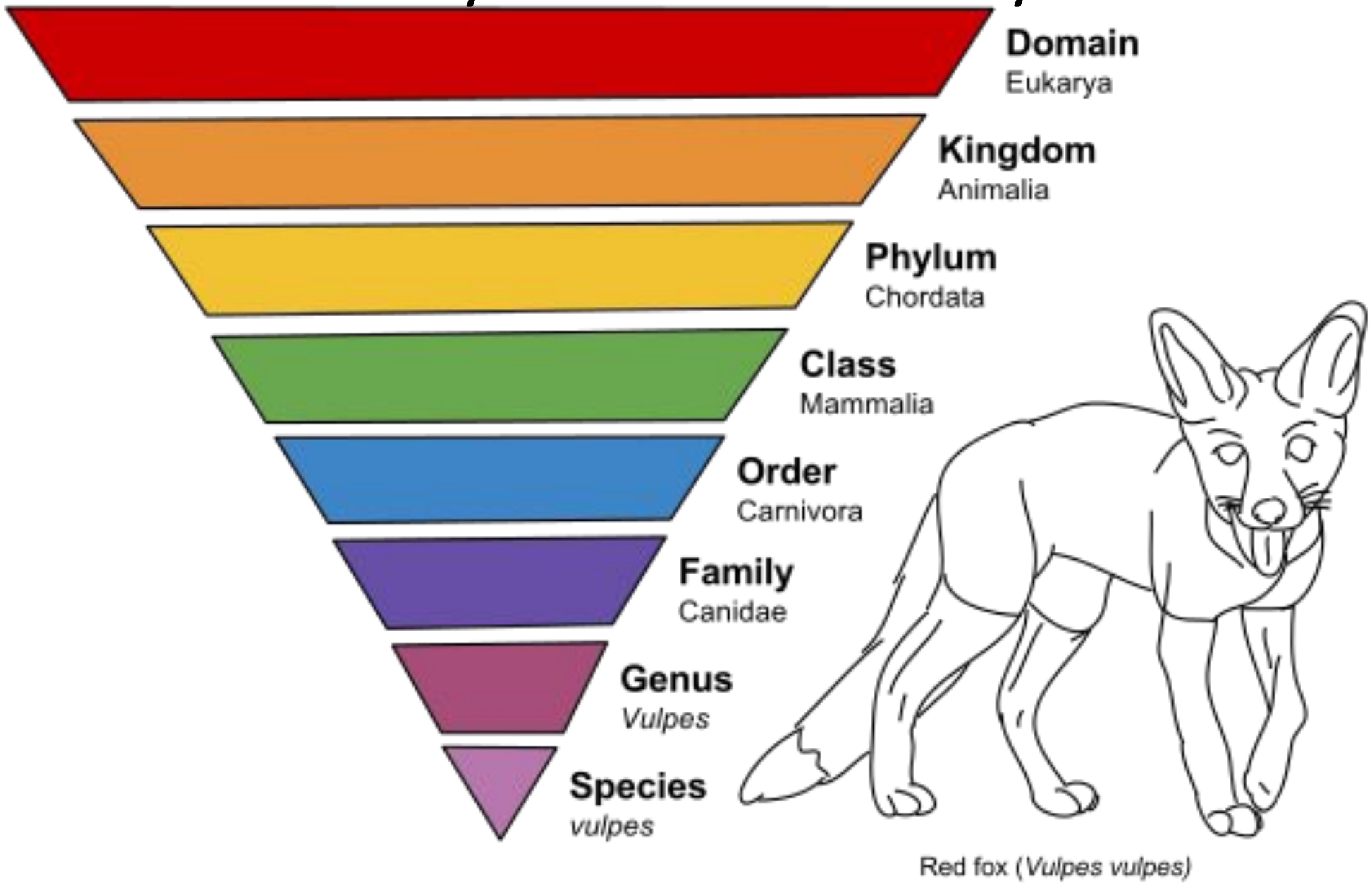
Dichotomous keys A key that uses observable features to sort organisms

leads Statement that leads a paired of contrasting, but mutual, observable features

qualitative Observable characteristics

quantitative Characteristics that may be counted or measured.

Systemics Taxonomy



History of taxonomy

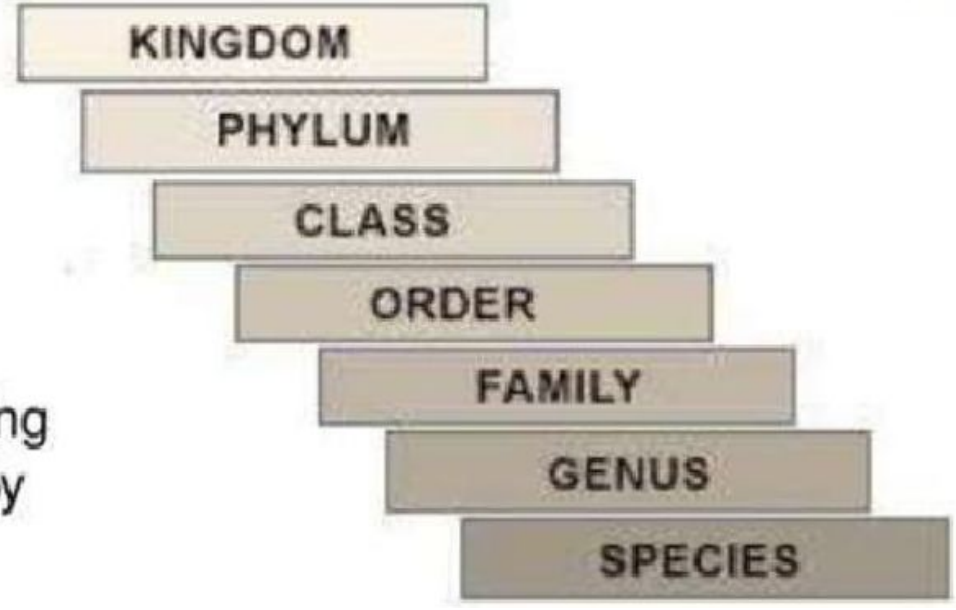
*A Swedish naturalist named **Carolus Linnaeus** is considered the **'Father of Taxonomy'** since 1700s

*His two most important contributions to taxonomy were:

- A hierarchical classification system
- The system of **binomial nomenclature**

*He proposed that there were three broad groups, called **kingdoms**, into which the whole of nature could fit. These kingdoms were **animals, plants, and minerals.**

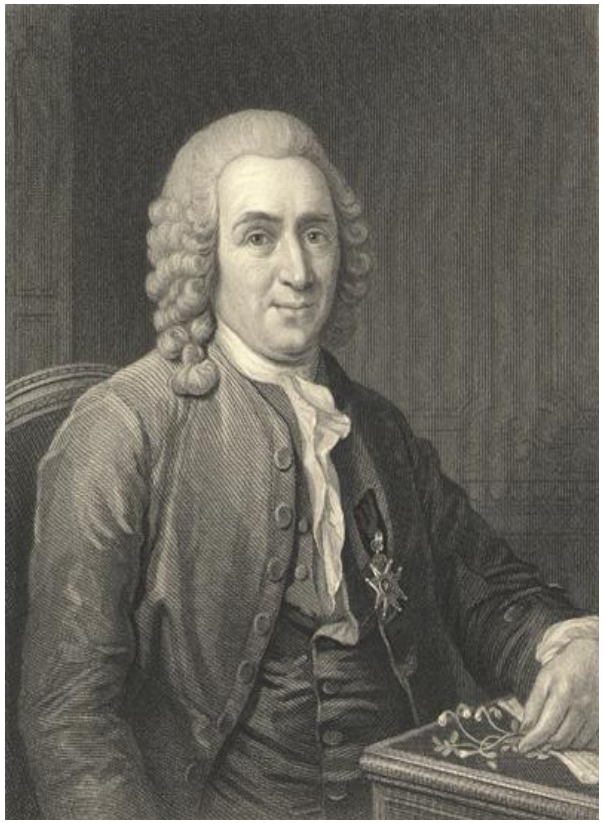
***Binomial nomenclature** meant naming species in 2 words : genus , followed by species.



Modern Classification

- ***Linnaeus*** developed a better system

- *Binomial Nomenclature*
- 2-name system
- Genus and Species
  - Ex: Homo sapiens



Taxon and Classification 1994

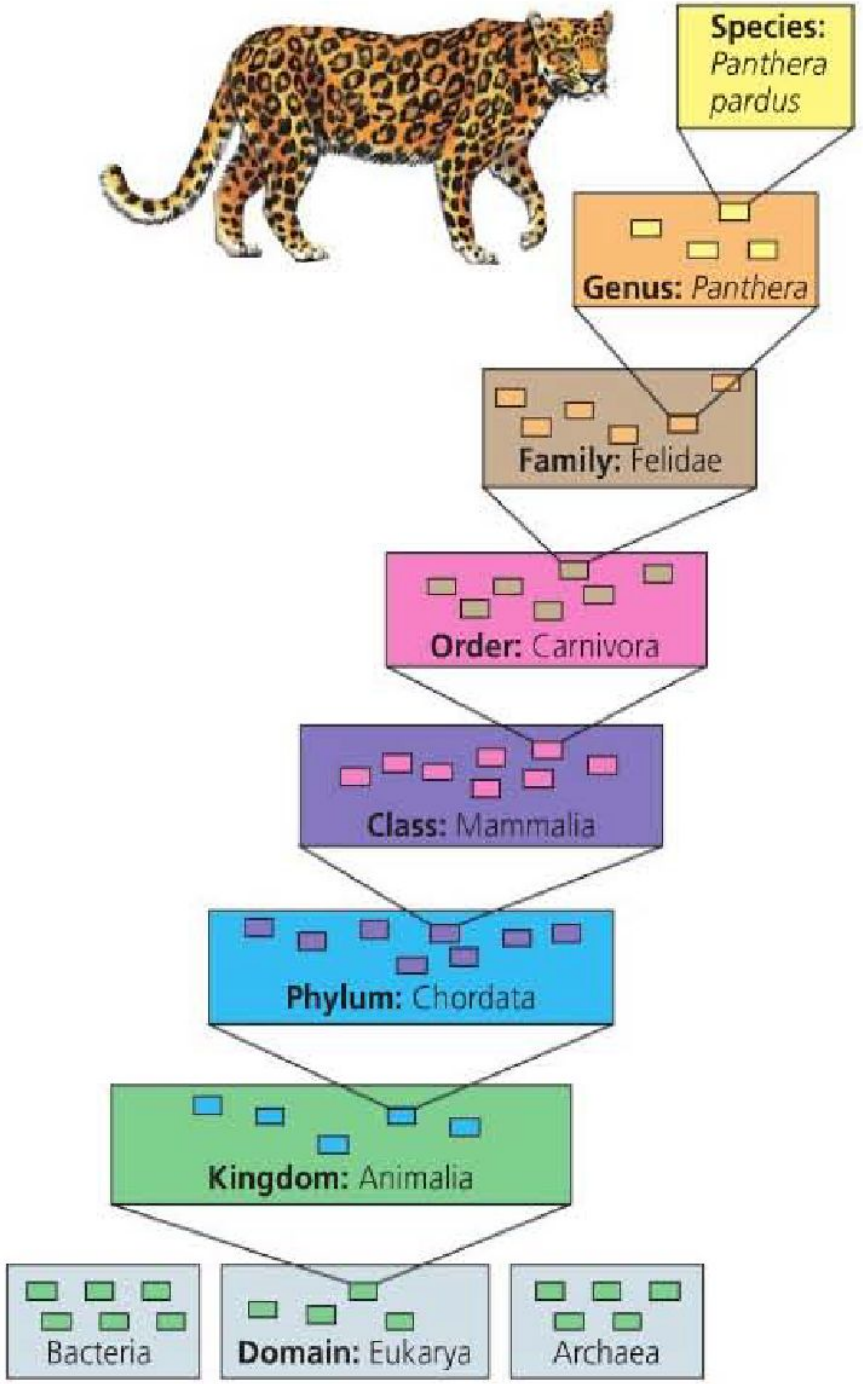
1. ***Domain** □ least specific or largest taxa
2. Kingdom
3. Phylum
4. Class
5. Order
6. Family
7. ***Genus***

most specific or smallest taxa□ 8. ***species***

A mnemonic to help remember taxon order.

Did **K**ing **P**edro **C**ome **O**ver **F**or ***G***ood ***s***oup DKPCOFGs

- **Order of classification:**
- Kingdom Animalia
- Phylum Choradata
- Class Mammalia
- Order Carnivora
- Family Felidae
- Genus *Lynx*
- Species *Lynx rufus*
  - *Bobcat*



Comparing Species
How closely related are these?

Diverge = Speciation

- Domain: Eukaryota
- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Primata
- Family: Hominidae
- Genus: *Homo*
- Species: *Homo sapien*

DIVERGE

- Domain: Eukaryota
- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Xenarthra
- Family: Dasypodidae
- Genus: *Dasypus*
- Species: *Dasypus novemcinctus*

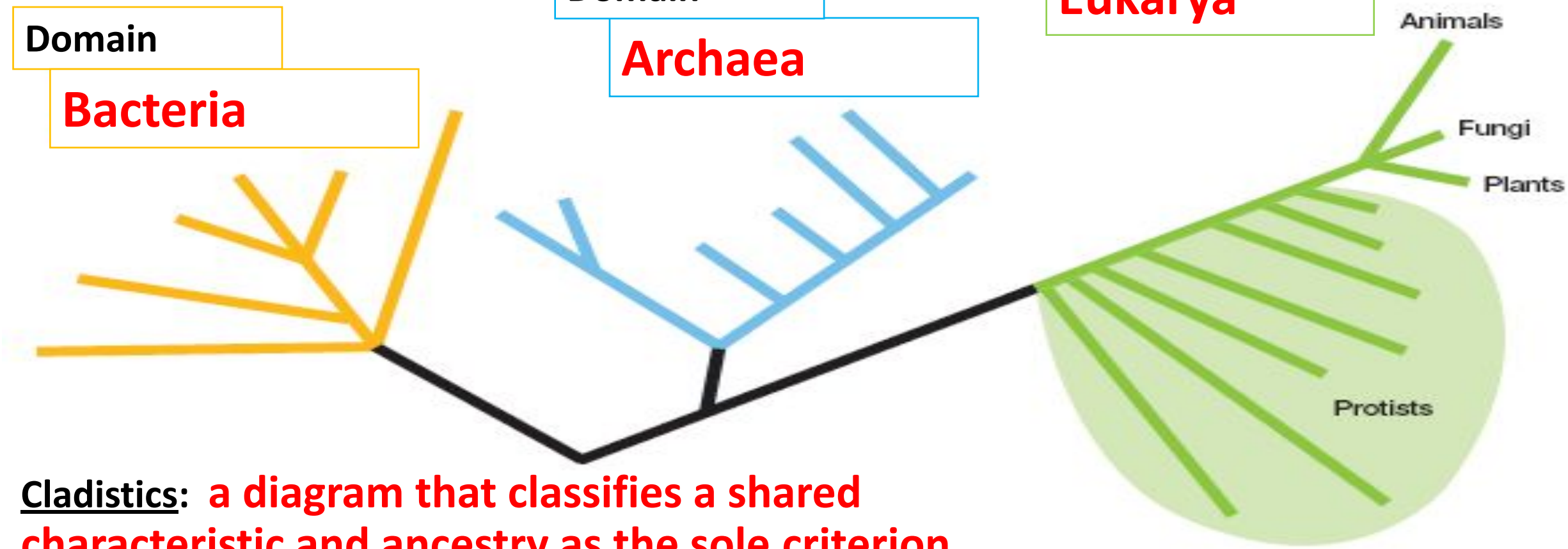
Three Domains of Life

is larger than a Kingdom

Domain
Bacteria

Domain
Archaea

Domain
Eukarya

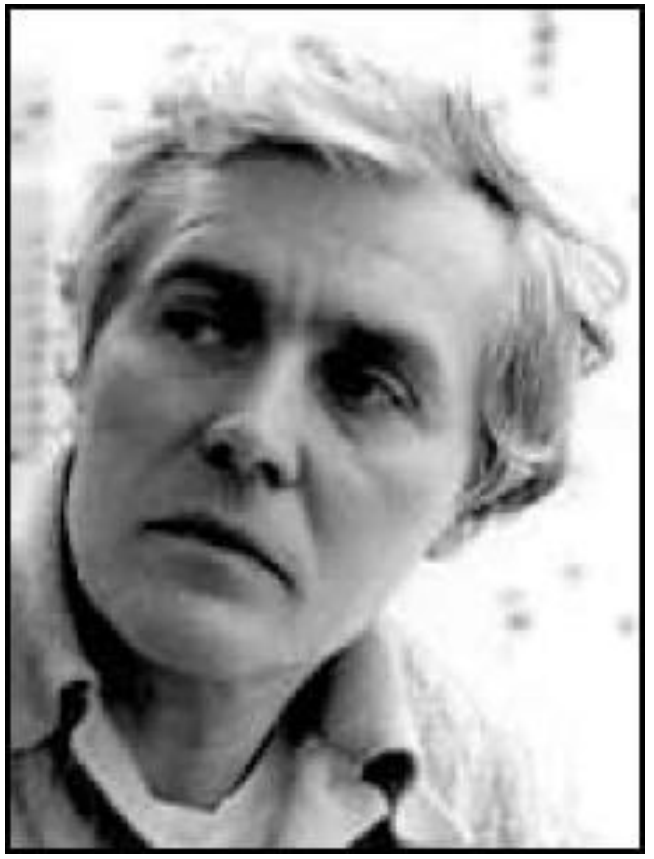


Cladistics: a diagram that classifies a shared characteristic and ancestry as the sole criterion

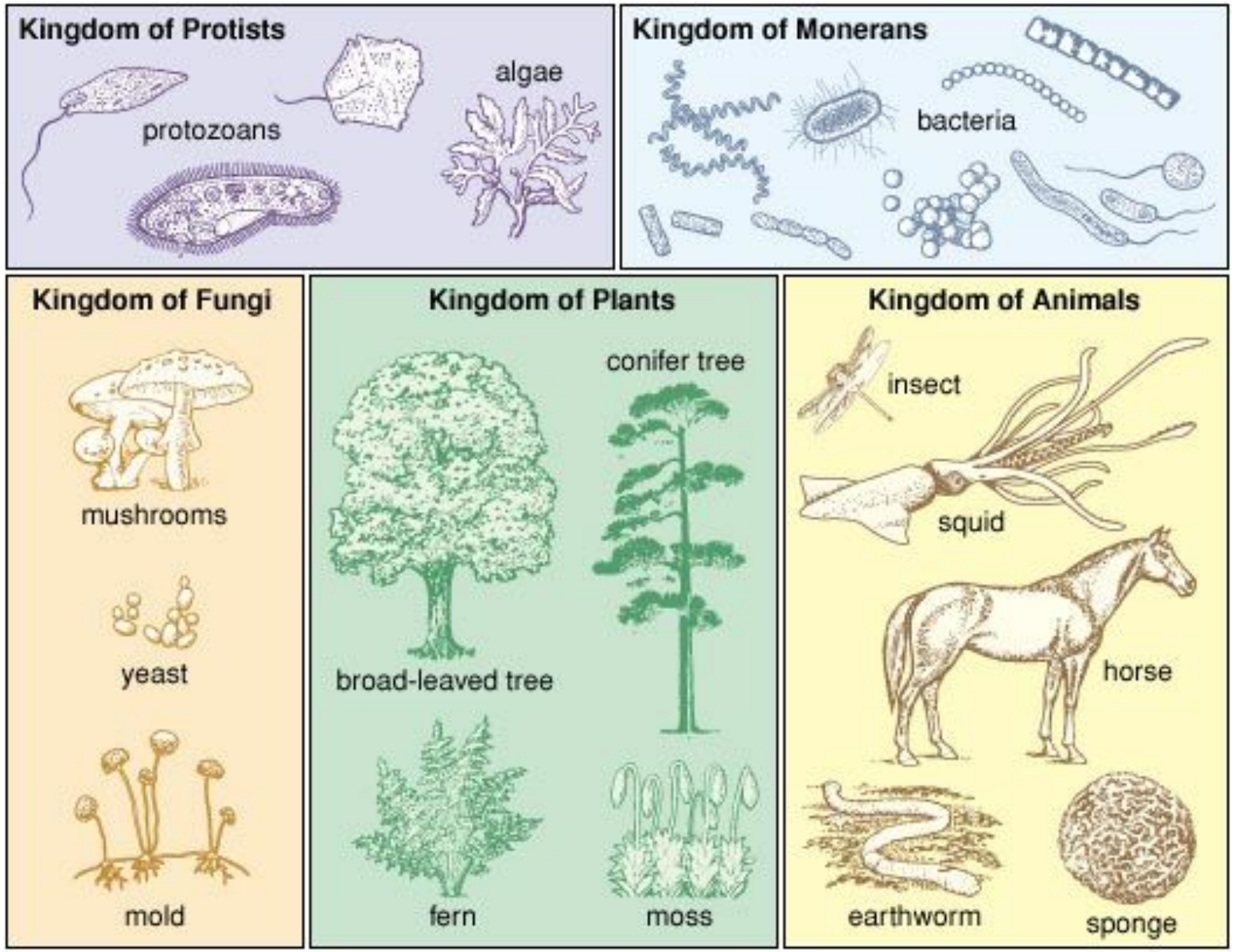
Carl Woese

Three Domain System

- The Three Domain System, developed by Carl Woese, is a system for classifying biological organisms.
- Over the years, scientists have developed several systems for the classification of organisms.
- From the late 1960's, organisms had been classified according to a Five Kingdom system.
- This classification system model was based on principles developed by Swedish scientist Carolus Linnaeus, whose hierarchical system groups organisms based on common physical characteristics.



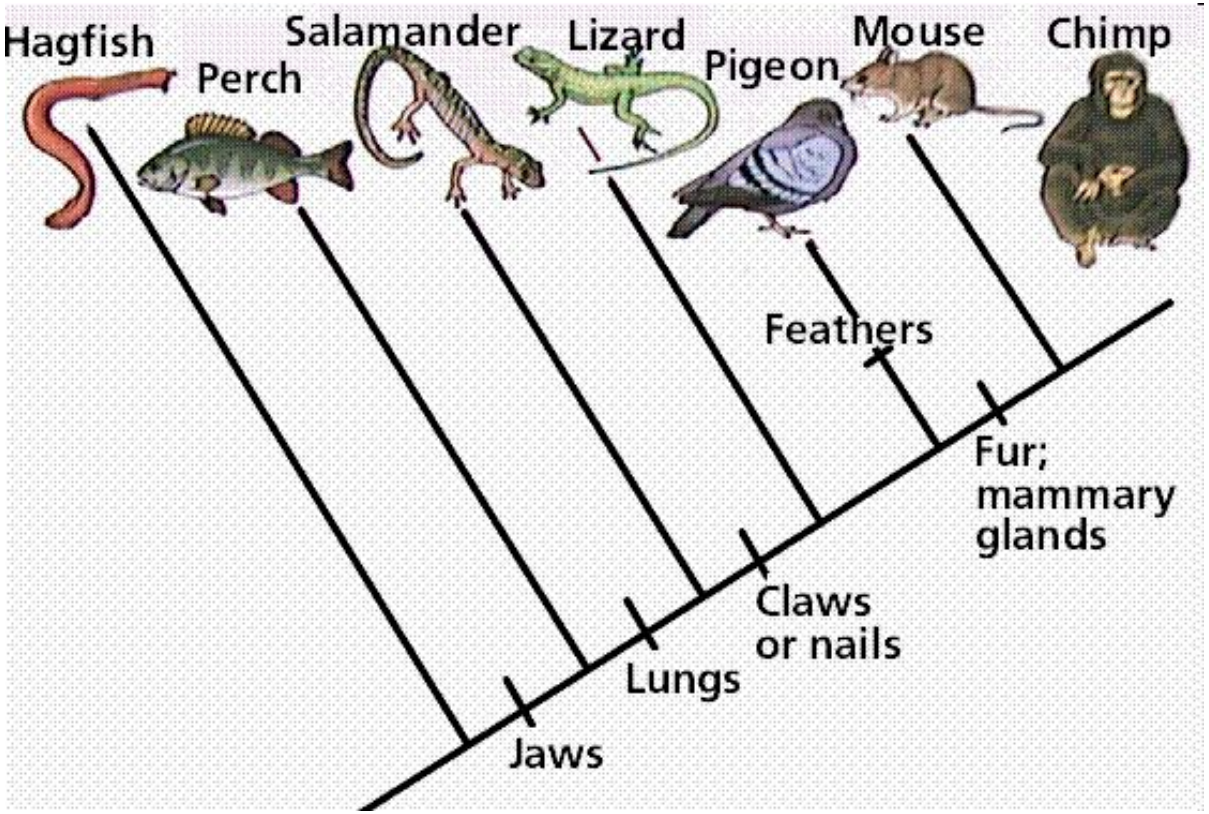
Five kingdoms of living organisms



Kingdoms	Characteristics					
	Domain	**Cell Type**	**Cell Arrangement**	**Nutrition**	**Cell Wall**	
Bacteria	Bacteria Archae	Prokaryote	Unicellular only	Autotroph Heterotroph chemotroph	Eubacteria-peptidoglycan Archaebacteria-psuedobacteria	
Protist	Eukarya	Eukaryote	Both uni / multi	Mostly hetero Some autotroph	Some poysaccharide, some silica, some none	
Fungi	Eukarya	Eukaryote	Both uni/multi	Hetertrophic by decompostion	chitin	
Plant	Eukarya	Eukaryote	Mostly multi	autotroph	cellulose	Non motile / sessile
Animal	Eukarya	Eukaryote	Mostly multi	heterotroph	none	Motile

Using Taxons in Evolution

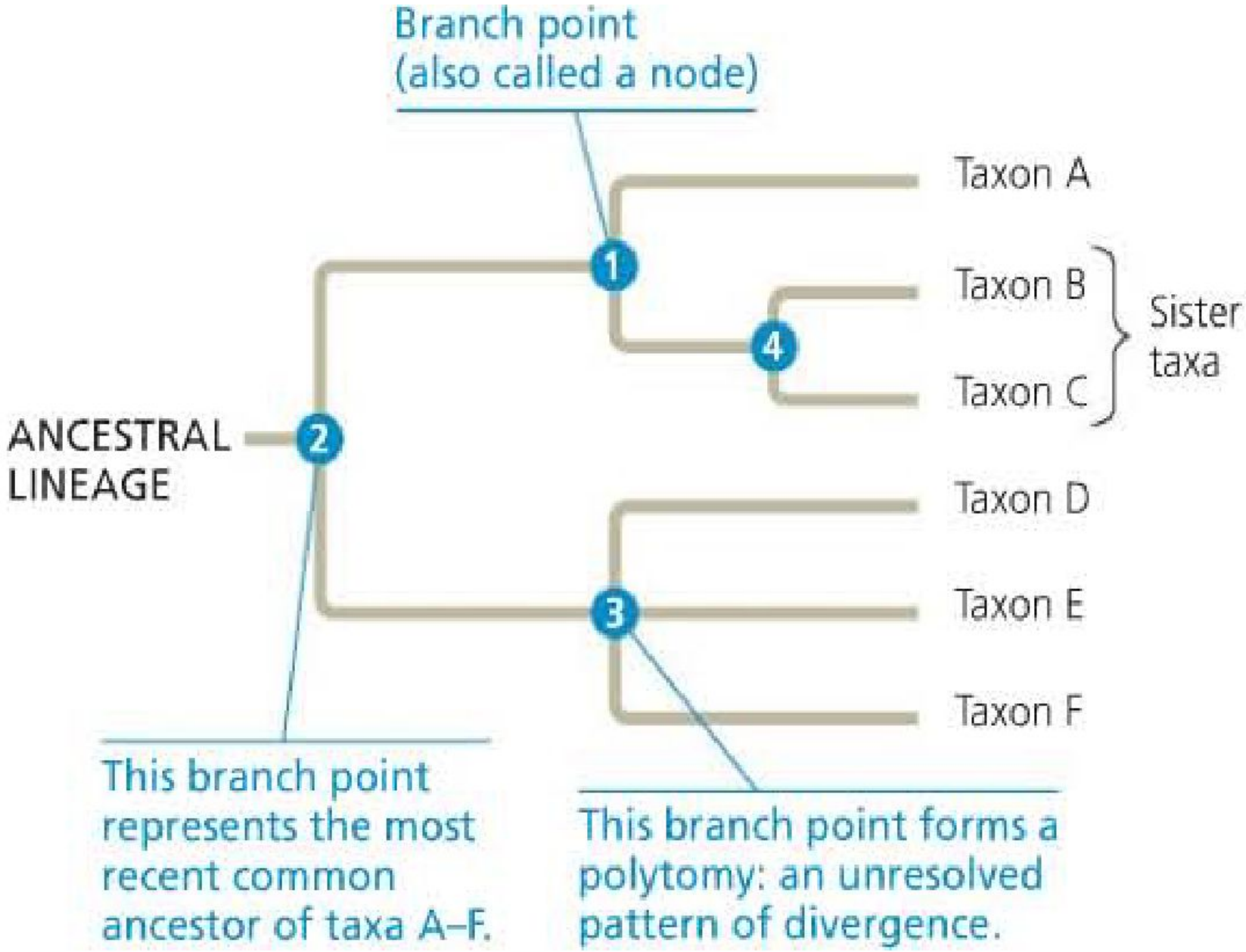
- Phylogeny:
  - The evolutionary history of a species
- Cladistics:
  - The study of that evolutionary past – derived from common ancestor



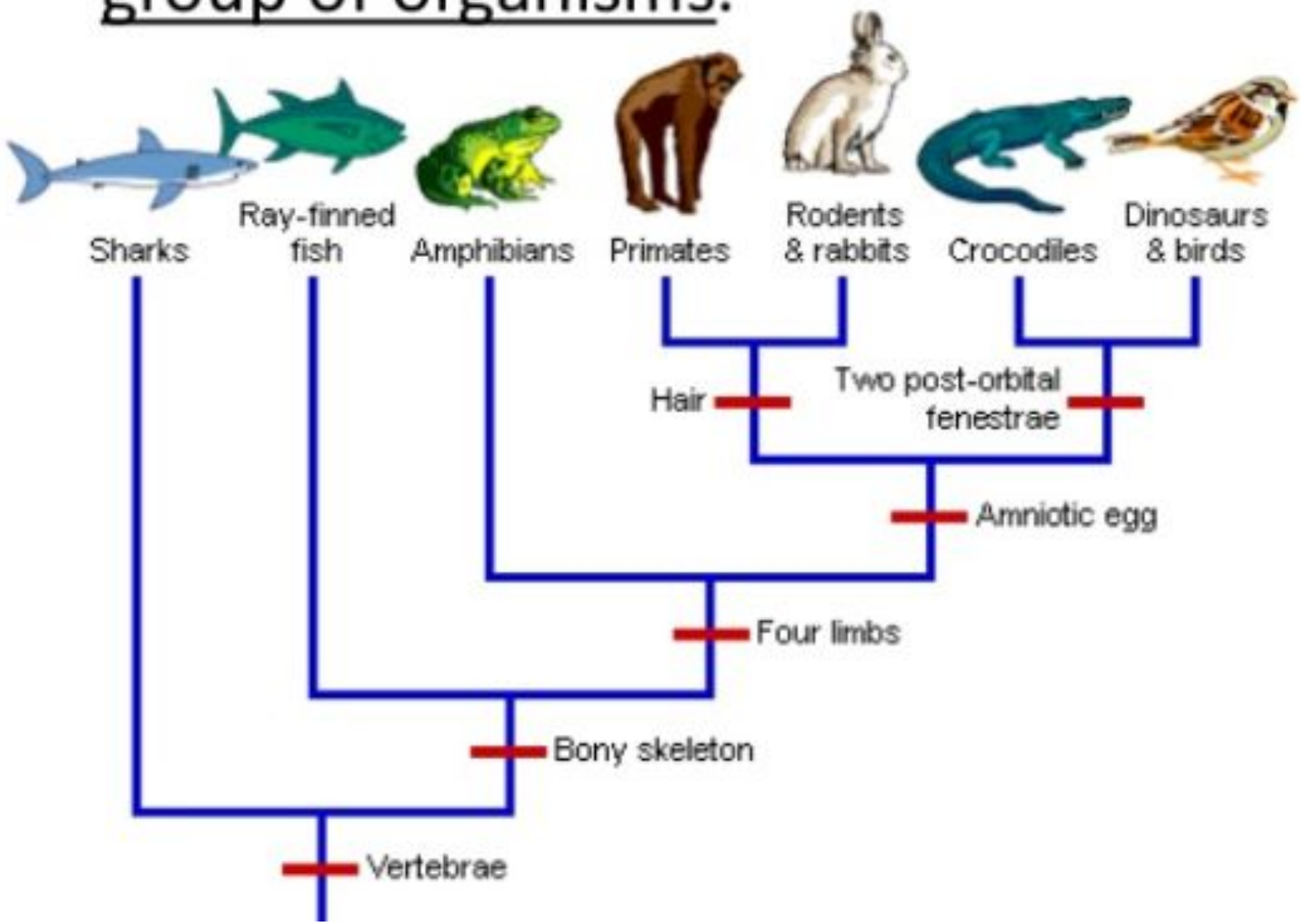
Cladograms

- What is a **cladogram**?
  - Diagram that depicts evolutionary relationships among groups
  - Based on phylogeny
    - AKA: The evolutionary history of a species!

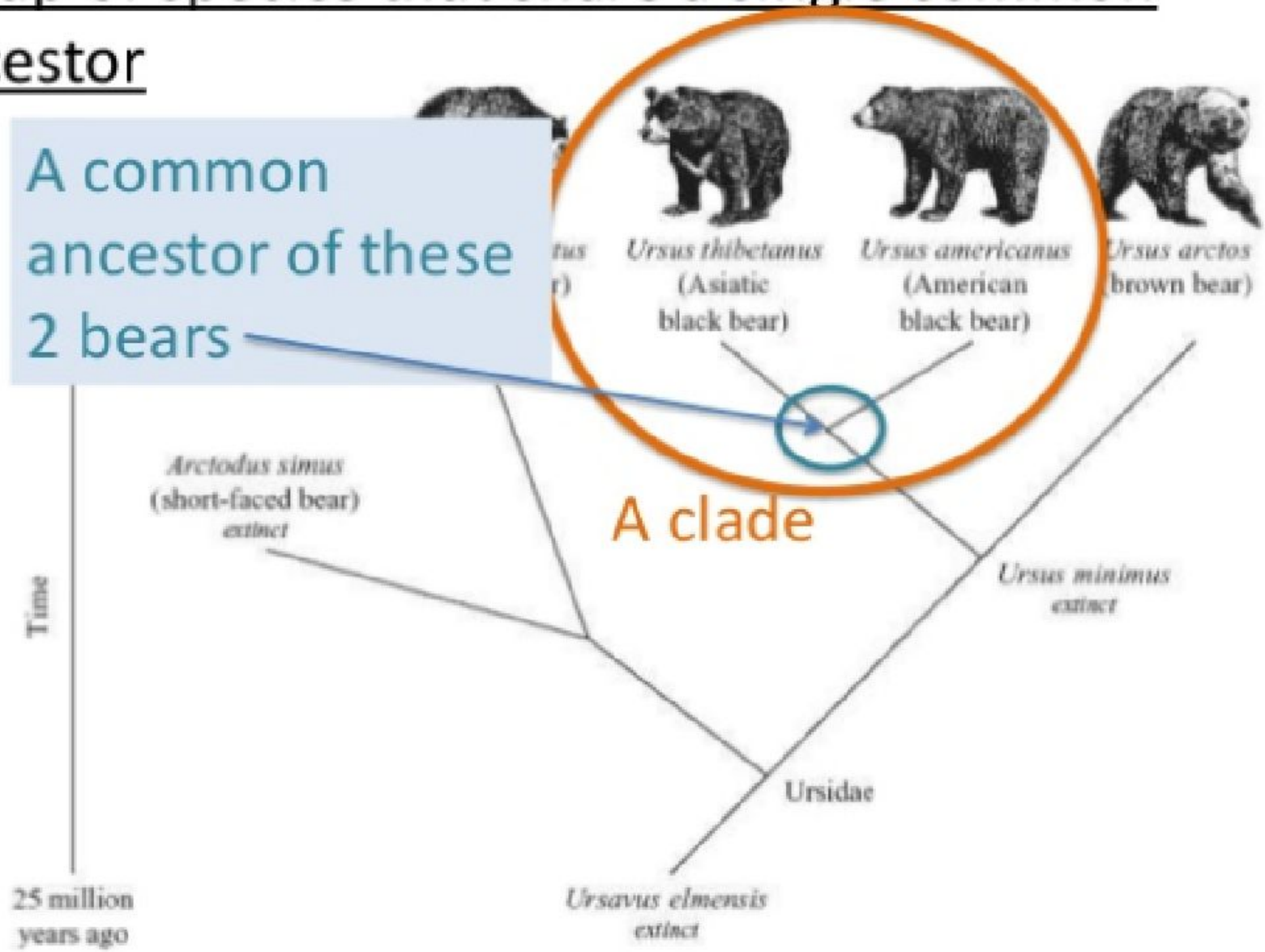
How to read a phylogenic trees



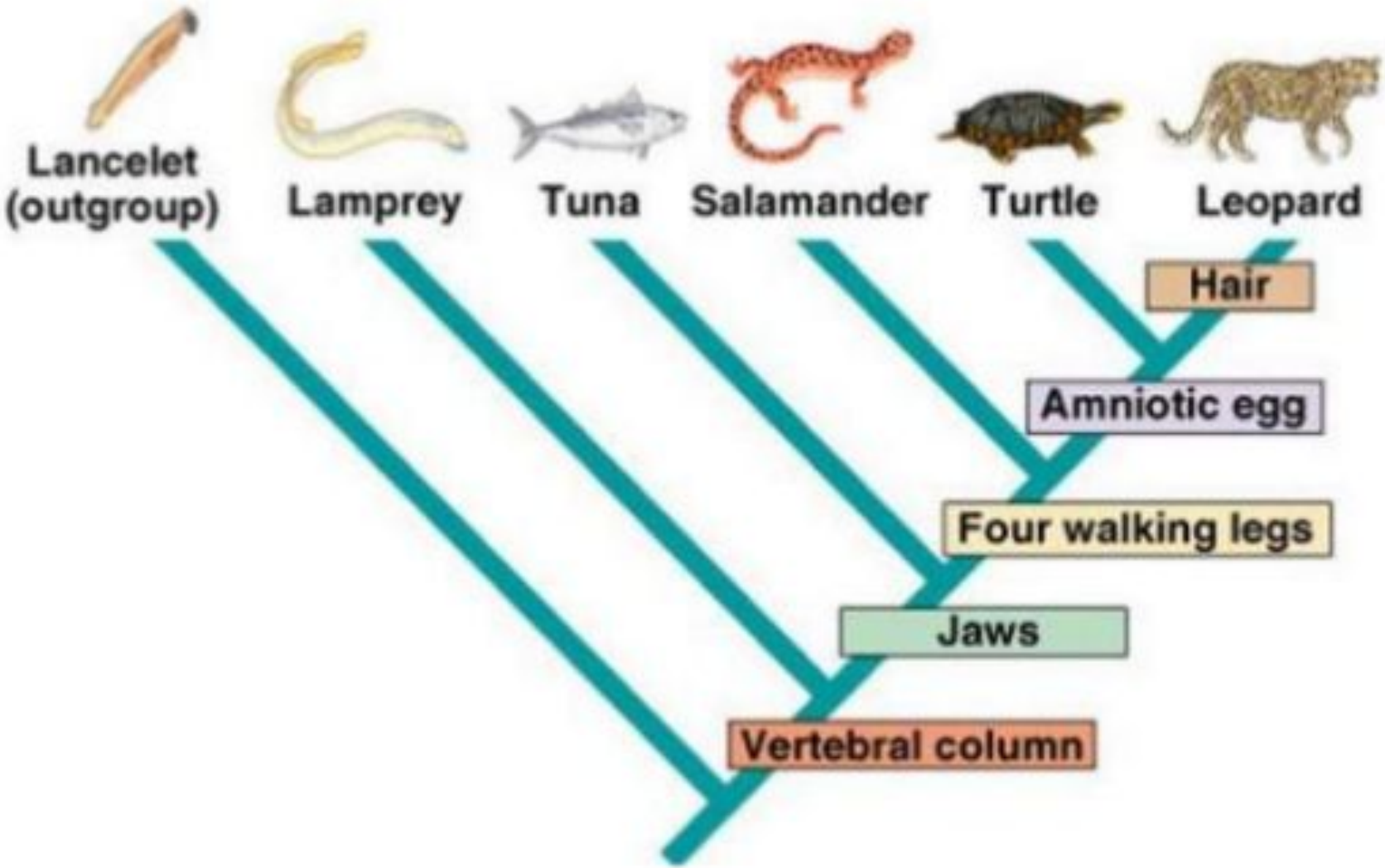
Cladograms are diagrams that show the evolutionary relationships among a group of organisms.

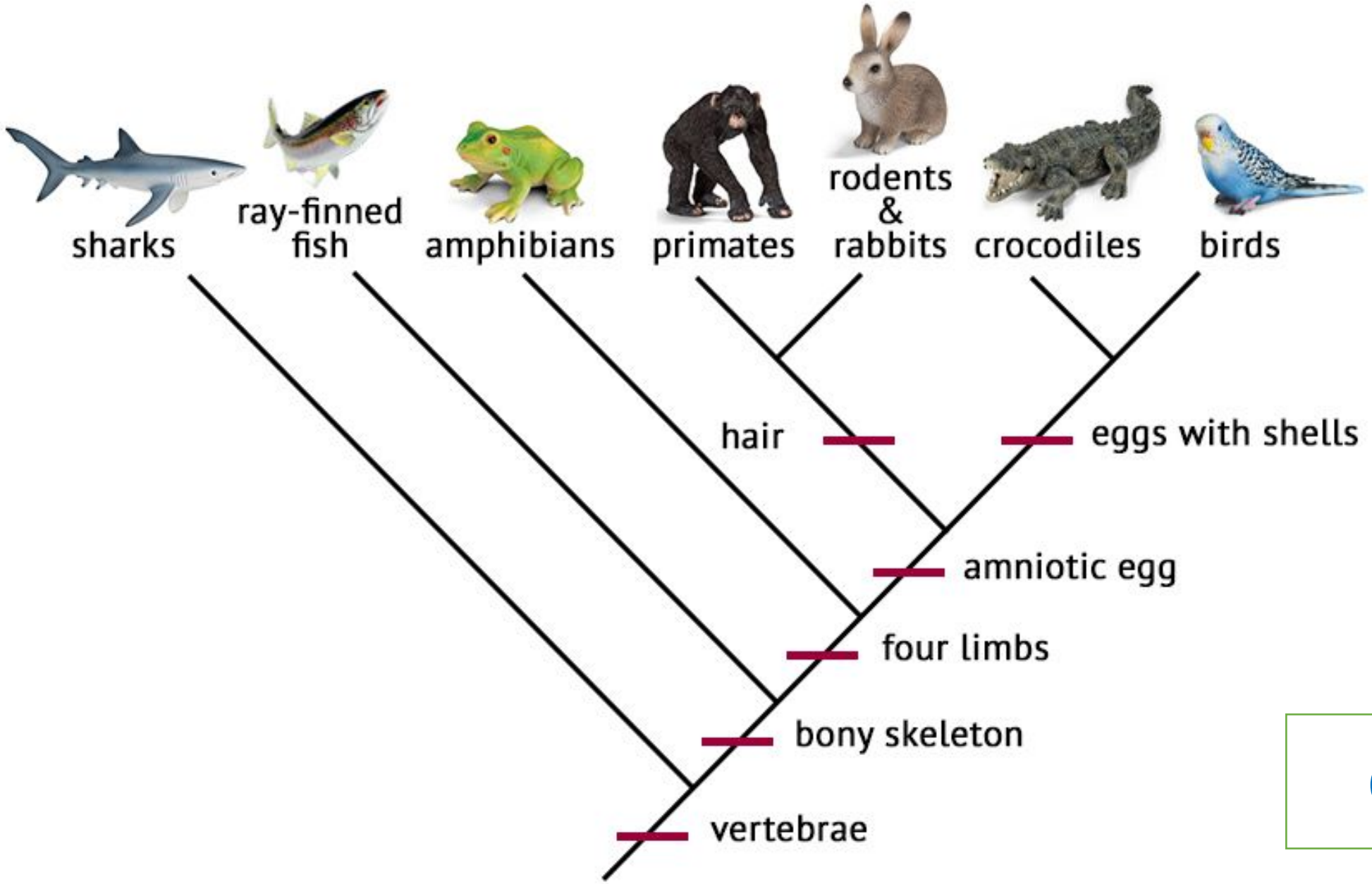


- **Clade** =<u>one branch on the diagram showing a group of species that share a single common ancestor</u>



- **Derived characteristic** = a trait that arose in the common ancestor of a particular lineage and was passed along to its descendants



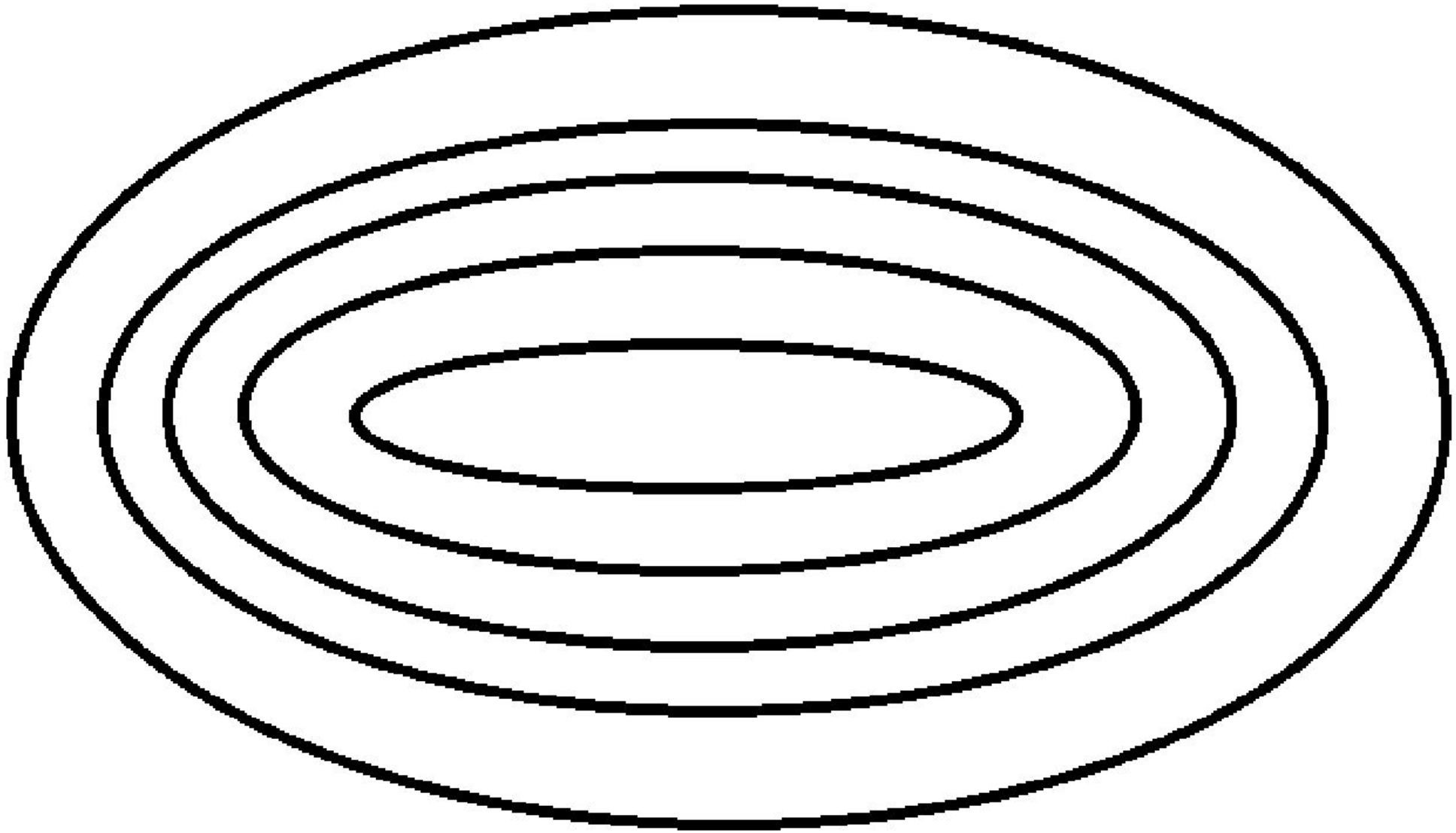

sharks
ray-finned fish
amphibians
primates
rodents & rabbits
crocodiles
birds
hair
eggs with shells
amniotic egg
four limbs
bony skeleton
vertebrae

Cladogram

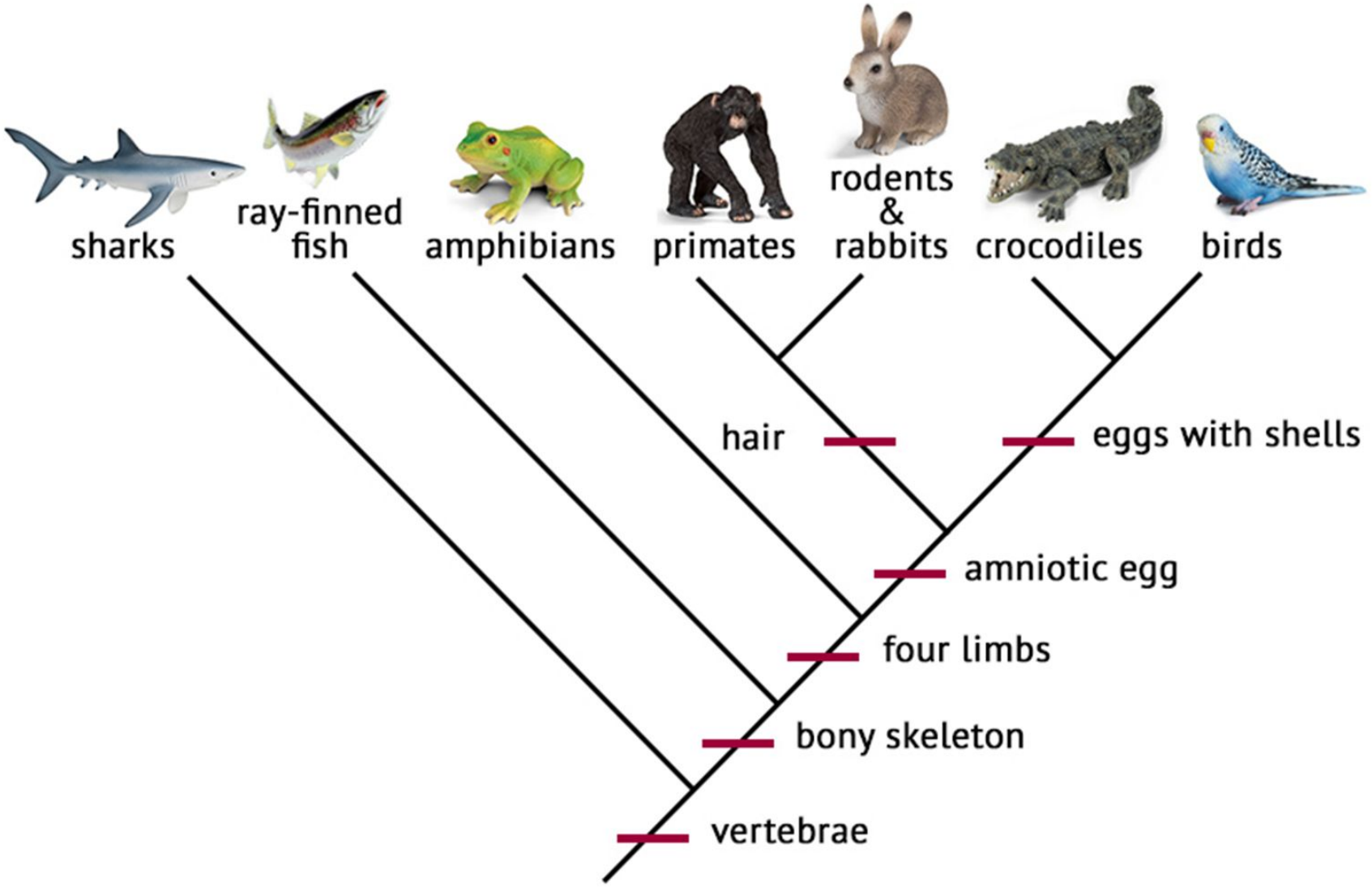
How to create a cladogram

Animals	***Vertebrae***	***Bony skeleton***	***Four limbs***	***Amniotic egg***	***Egg with shells***	***Hair***
Shark						
Ray – fish						
Amphibians						
Crocodiles						
Birds						
Rabbits						

Create a Venn diagram



Create a cladogram



How to Build a Cladogram

step 1 – make a table to compare characteristics

	Lizard	Rabbit	Dog	Cat
4 Legs	X	X	X	X
Fur				
Carnivore				
Retractable claws				

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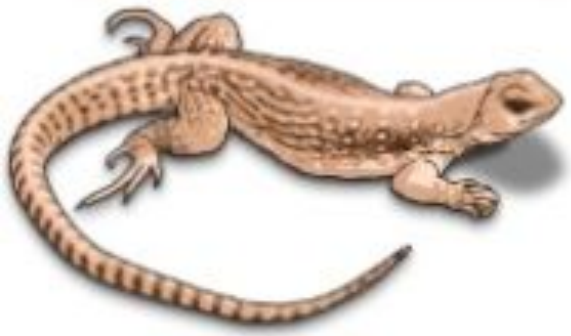
4 Legs	X	X	X	X
Fur		X	X	X
Carnivore				
Retractable claws				



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4 Legs	X	X	X	X
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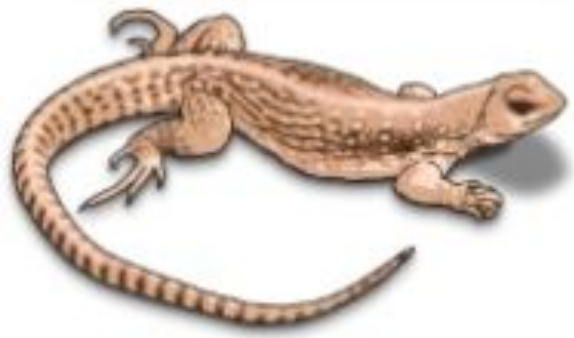
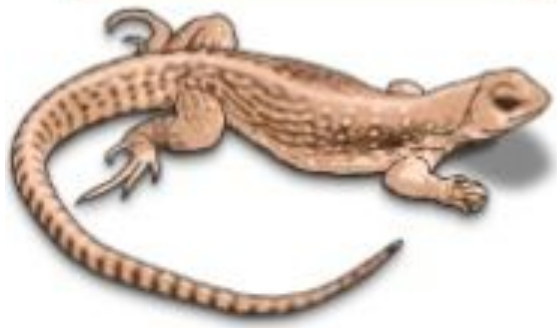
Carnivore			X	X
Retractable claws				

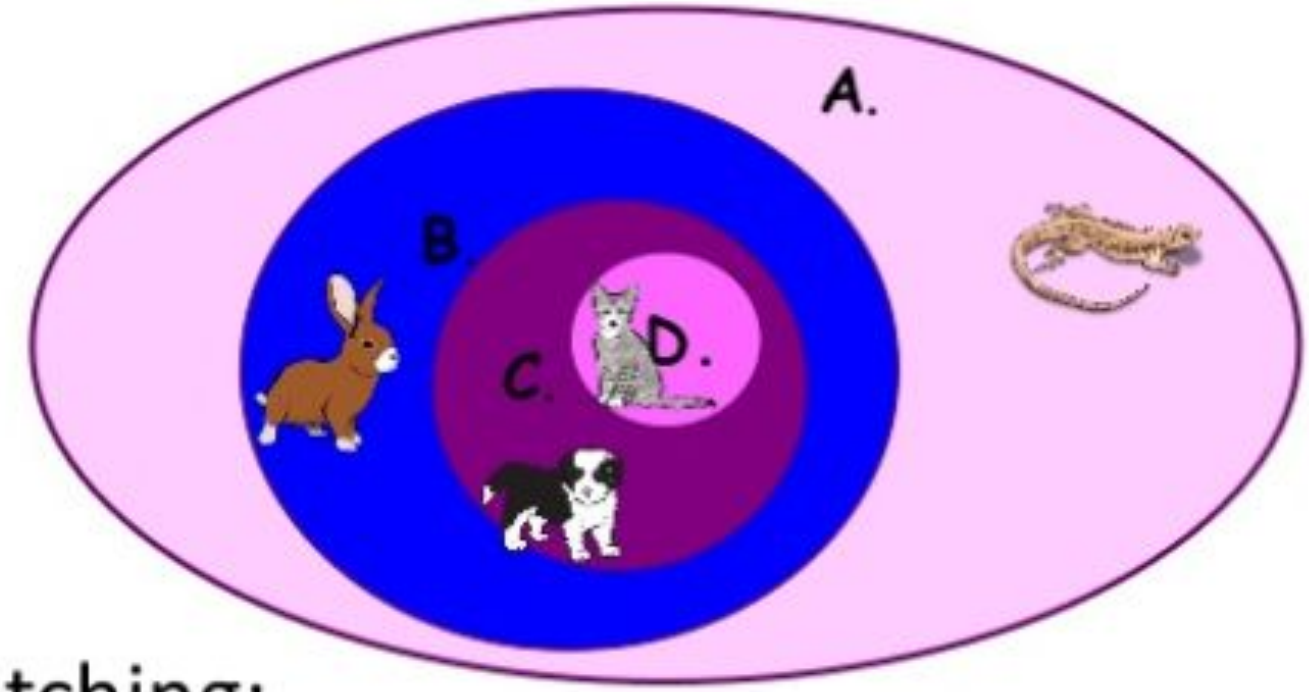


How to Build a Cladogram

step 1 – make a table to compare characteristics

	Lizard	Rabbit	Dog	Cat
4 Legs	X	X	X	X
Fur		X	X	X
Carnivore			X	X
Retractable claws				X

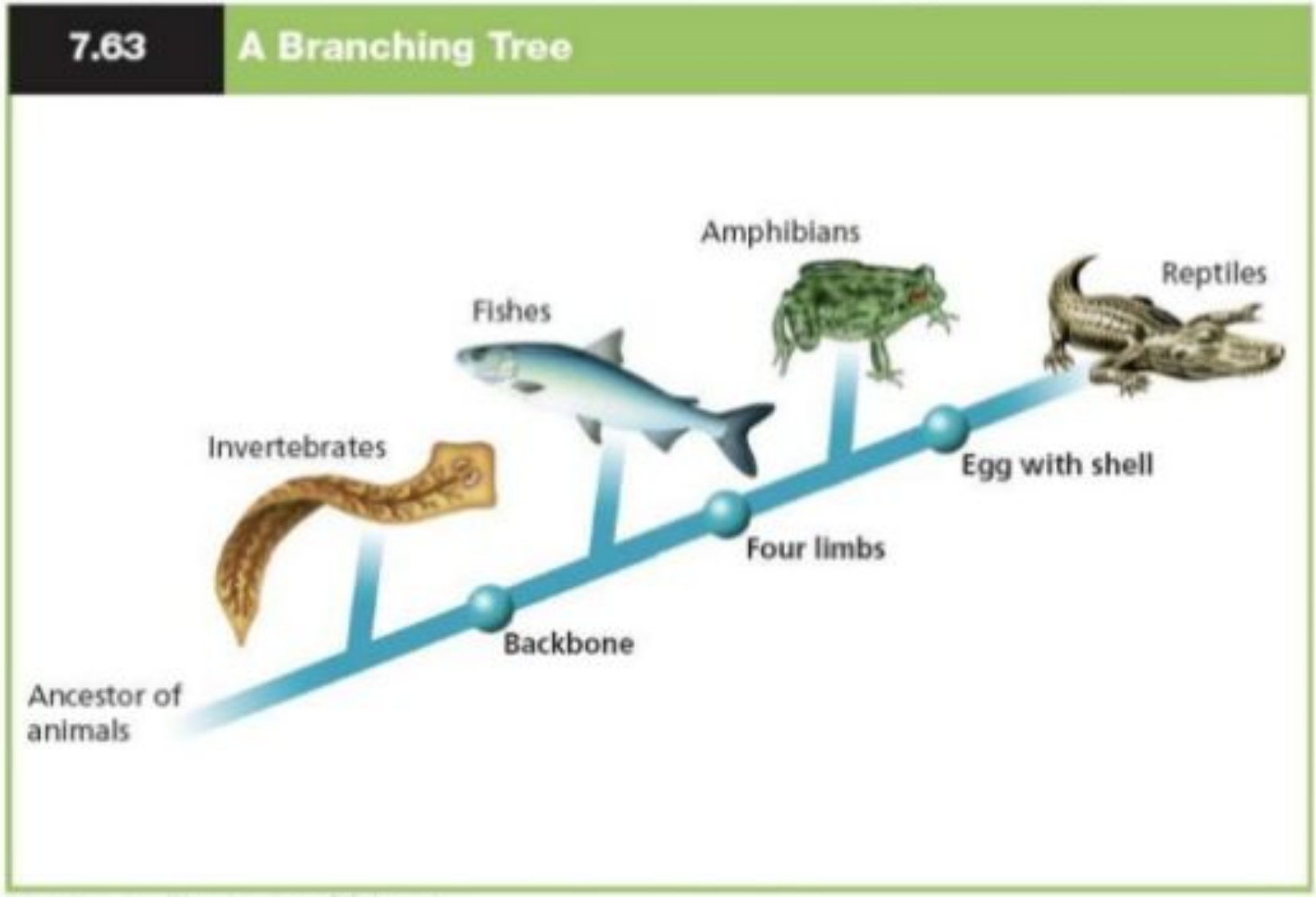




Matching:

- Animals with 4 legs **A**
- 4-legged animals with fur **B**
- Animals with fur that are carnivores **C**
- Carnivores with retractable claws **D**

Step 3: arrange the characteristics and organisms in a branching diagram



Success criteria

1. Apply previously obtained knowledge regarding binominal nomenclature of Carl Linnaeus.
2. Compare, analyze and find connection (links) between different taxonomic groups.
3. Constructs and interprets cladograms.

Draw a phylogenetic tree based on the first five characters in the table below.
Place hatch marks on the tree to indicate the origin(s) of each of the six characters.

Character	SPECIES						
	Lancelet (outgroup)	*Lamprey*	*Tuna*	*Salamander*	*Turtle*	*Leopard*	*Dolphin*
Backbone	0	1	1	1	1	1	1
Hinged jaw	0	0	1	1	1	1	1
Four limbs	0	0	0	1	1	1	1*
Amniotic egg	0	0	0	0	1	1	1
Milk	0	0	0	0	0	1	1
Dorsal fin	0	0	1	0	0	0	1

*Although adult dolphins have only two obvious limbs (their flippers), as embryos they have two hind-limb buds, for a total of four limbs.