Evolution

THE EVER-CHANGING LIVING WORLD

Evolution Overview

History of Evolutionary Theory

Evidence for Evolutionary Theory

Microevolutionary Principles

- Mutation, Genetic Drift, Migration, Natural Selection

Macroevolution

- Speciation, Extinction
- Adaptive Radiation, Coevolution, Convergent Evolution

Phylogenetic Trees

Biological Classification / Taxonomy

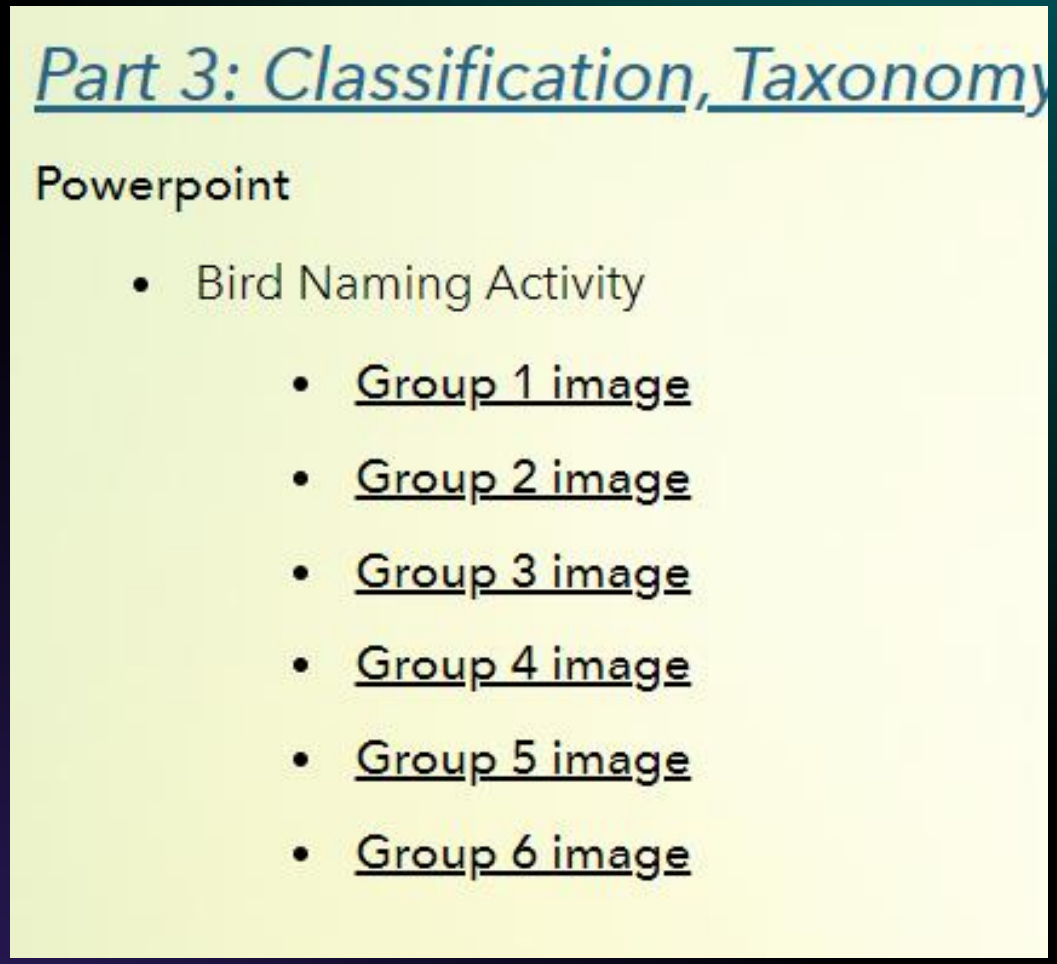
Taxonomy

15-1: WHY CLASSIFY?

15-2: BIOLOGICAL CLASSIFICATION

15-3: TAXONOMY TODAY

Warm-up Activity



Directions:

1. Go to website and click on your group's image.
2. With your group, come up with a *name* for your bird that:
   a) Describes its main features
   b) Could be used to communicate about that type of bird with scientists in Oxford
3. Share your bird name with the class.

Song sparrow (*Melospiza melodia*)

Red-winged blackbird (*Agelaius phoenicieus*

Pacific Wren (*Troglodytes pacificus*)

Dr. Darren Irwin (UBC)

Winter Wren (*Troglodytes hiemalis*)

Names are Important

- Same species can look very different (male vs female)
- Different species can look alike
- Want to be sure you are talking about the same organism!

Warm-up Activity: Classification

1. In a group, list as many species as you are able to name.
2. How would you classify and group these species? What characteristics would you consider the most important? Least important?

First Peoples Classification (FYI)

- Adapted from “Plants of Haida Gwaii” by Nancy Turner and “Plants in Language and Classification among BC First Nations” by Carla Burton and Nancy Turner
- Note: significant plagiarism in these slides to give the best representation of First Peoples knowledge as I am not a knowledge keeper

First Peoples Classification (FYI)

- Shallow hierarchical arrangement similar to English language
- English language:
  - Broad categories like plant, animal
  - Subcategories: trees, bushes, herbs
  - Some named plants, sometimes corresponding to scientific species (e.g. dandelion, oak)

First Peoples Classification (FYI)

- Many categories recognized as living things that are not considered alive by western science
- Taxa based on large-scale morphological features (e.g. size, appearance, usefulness e.g. for construction or medicine)
- See Table 1 for examples of ranks https://www.researchgate.net/publication/271504616_Plants_in_Language_and_Classification_among_BC_First_Nations
- Some borrowing of terms between First Nations languages (e.g. if the plant does not exist in one Nation's territory)

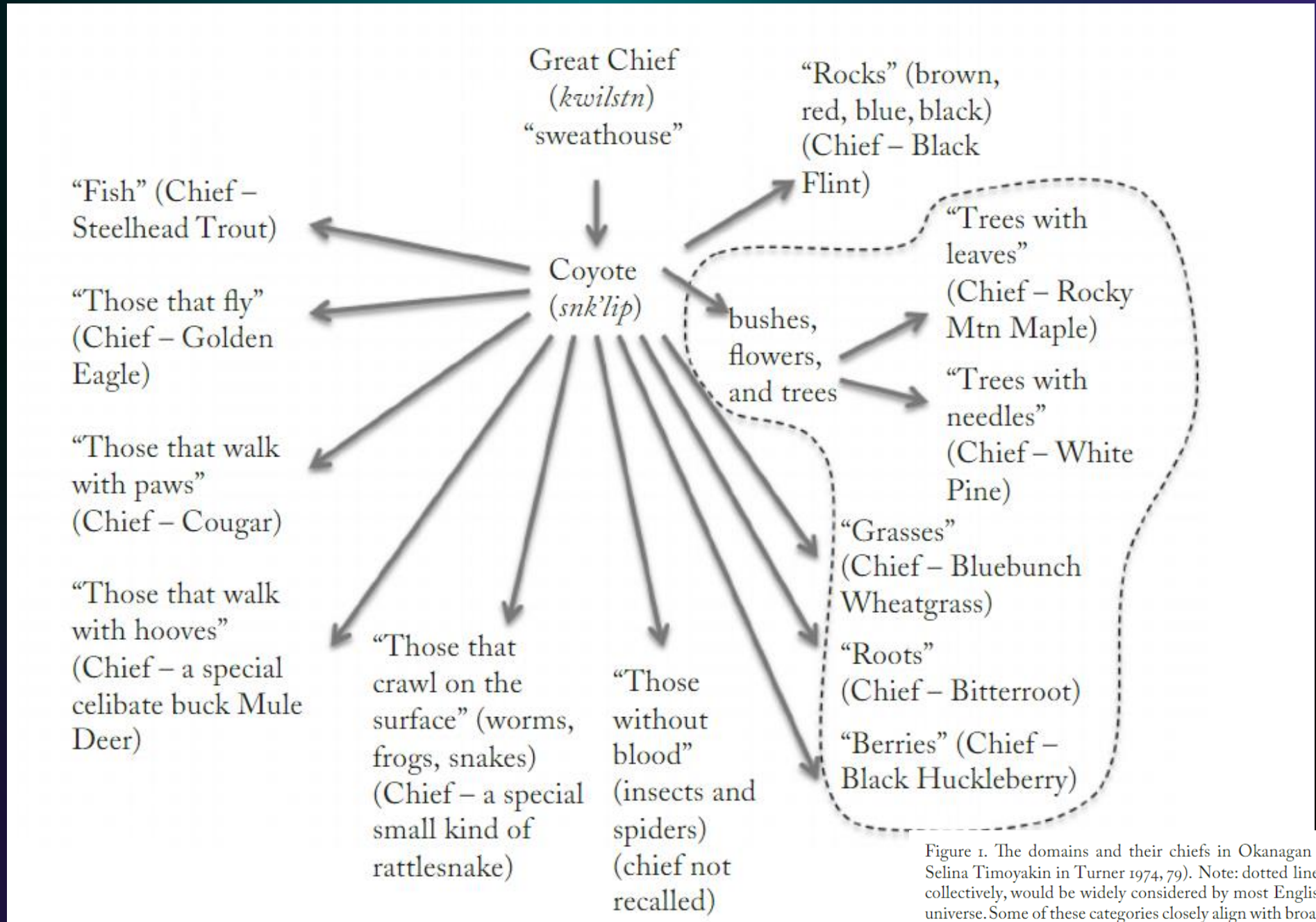


Figure 1. The domains and their chiefs in Okanagan cosmology (as contributed by Selina Timoyakin in Turner 1974, 79). Note: dotted line indicates those domains that, collectively, would be widely considered by most English speakers to be in the "Plant" universe. Some of these categories closely align with broad scientific taxa, whereas others (e.g., "Those that crawl…") include categories that are only distantly related.

First Peoples Classification (FYI)

- Usually no term for “plant” – although “plantness” is recognized and understood
- Categories of plant are implied but not explicitly named
- ***“All plants are living things, individuals, just as individual humans are beings. Therefore, each individual type of plant has its own name, just as an individual Haida; there is no need to use a broader name.”***

Haida Classification of Plants (FYI)

Some categories do exist:

- “Evergreen tree” has a number of terms (k̲aayd, k̲iid, k̲íid, hlk̲’amaál, tlaas, etc.)
- “Plants with leafy branches” are referred to as hlk̲’a7ii, hlk̲’a.aay, hlk̲’a.íi
- “Berries” are g̲aan (seen In berry names such as salmonberry sk̲’awg̲aan, saskatoon berry
- Prefix or suffix “xil” means “leaf” and “plant” and indicates that a leafy plant has medicinal properties

First Peoples Classification: Plants

- Plants with names reflect interactions with and perceptions with plant world:
  - Highly visible (trees and shrubs)
  - Culturally important (sources of food, medicine, other purposes)
  - Similar to culturally important types
  - Potentially harmful
  - Otherwise distinctive (e.g. taste, stickiness, usefulness, colour, etc.)

Introduction to Taxonomy

Crash course:

https://www.youtube.com/watch?v=F38BmgPcZ_I&ab_channel=CrashCourse

Amoeba sisters:

https://www.youtube.com/watch?v=DVouQRAKxYo&ab_channel=AmoebaSisters

Introduction to Taxonomy

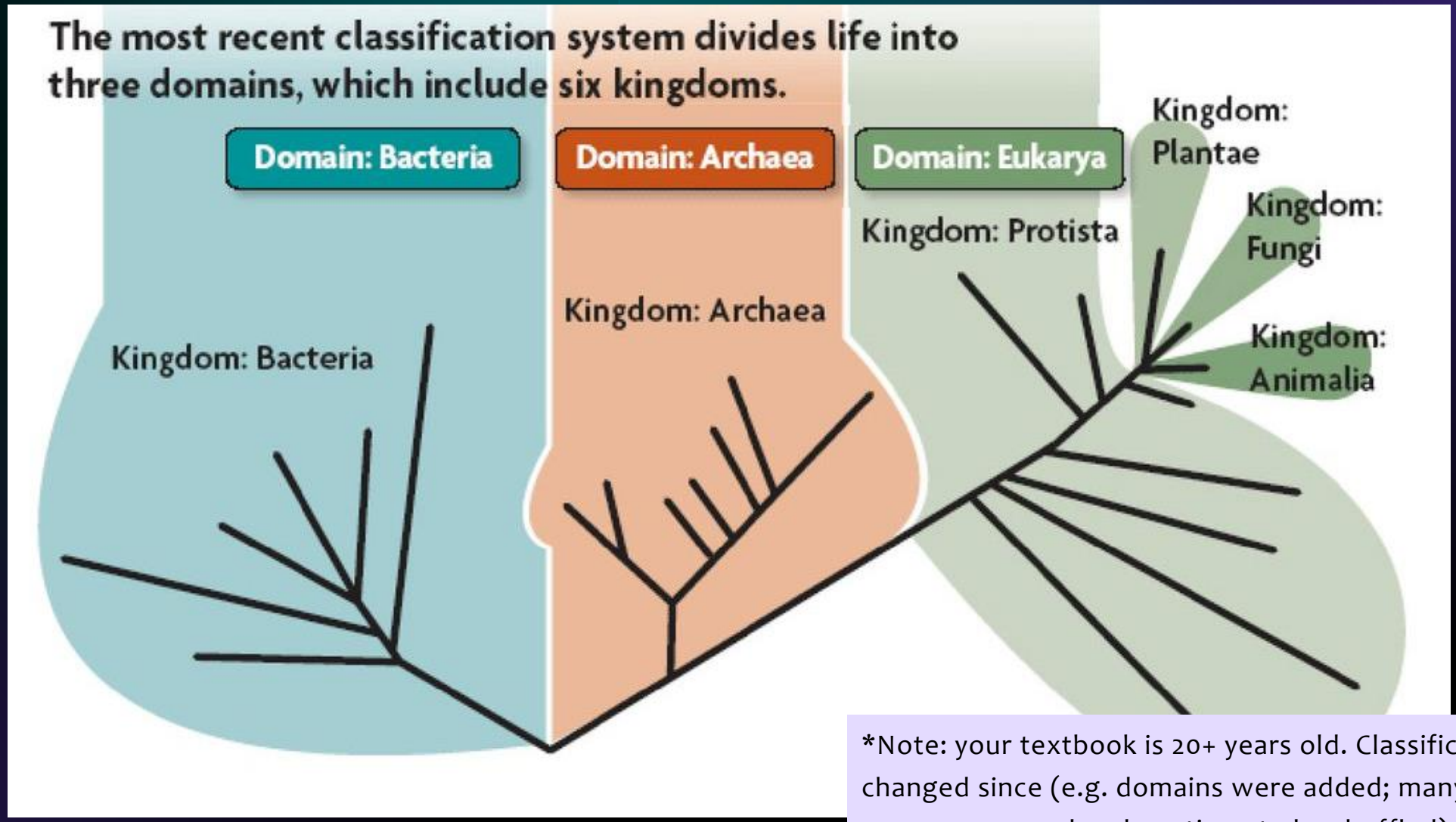
- Need to classify organisms in a logical, consistent manner
- Group organisms based on evolutionary relationships (instead of superficial similarities like ‘wings’)
- **Taxon (pl. “taxa”):** group of organisms that share important characteristics and are evolutionarily related
- **Taxonomy:** the science of naming species and grouping them into taxa

Modern Classification

- Species are assigned to nested taxa
- Evolutionary relationships and similarity can be inferred from groupings

Humans	Red fox	Creeping buttercup
Eukarya	Eukarya	Eukarya
Animalia	Animalia	Plantae
Chordata	Chordata	Spermatophyta
Mammalia	Mammalia	Dicotyledonae
Primates	Carnivora	Ranunculales
Hominidae	Canidae	Ranunculaceae
Homo	*Vulpes*	*Ranunculus*
Homo sapiens	*Vulpes vulpes*	*Ranunculus repens*

Modern Classification



*Note: your textbook is 20+ years old. Classification has changed since (e.g. domains were added; many organisms were re-grouped and continue to be shuffled).

Binomial Nomenclature

- Each species has a unique name:
  genus + specific epithet
- Formatting:
  - Capitalize genus
  - Lowercase specific epithet
  - Both words italicized
    (or underlined when hand-written)
  - Both words are in Latin (or Latinized)

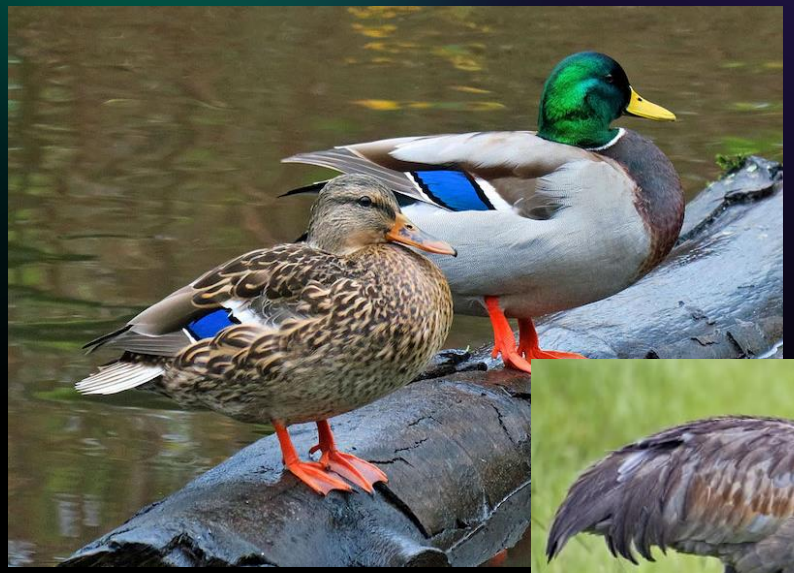
Homo sapiens

genus

specific epithet

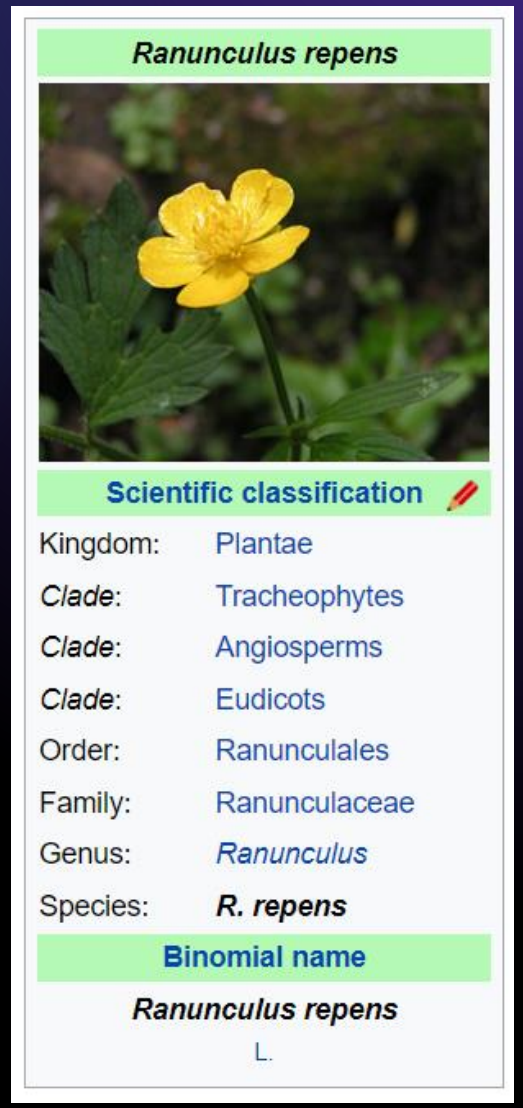
Binomial Nomenclature

- Names descriptive/informative
  - *Vinca minor* vs *Vinca major*; small vs large periwinkle flowers
  - *Anas platyrhynchos* (Mallard); "platy" means flat/broad while "rhynchos" means nose
  - *Antigone canadensis* (sandhill crane); native to Canada



Binomial Nomenclature

- Every species can be identified with only two words, worldwide
- Names generally stable:
  - Latin is a ‘dead language’
  - Newly discovered species are given new names that do not overlap with existing species



Activity: Name a Fish

See worksheet

Group Activity: Make a Poster

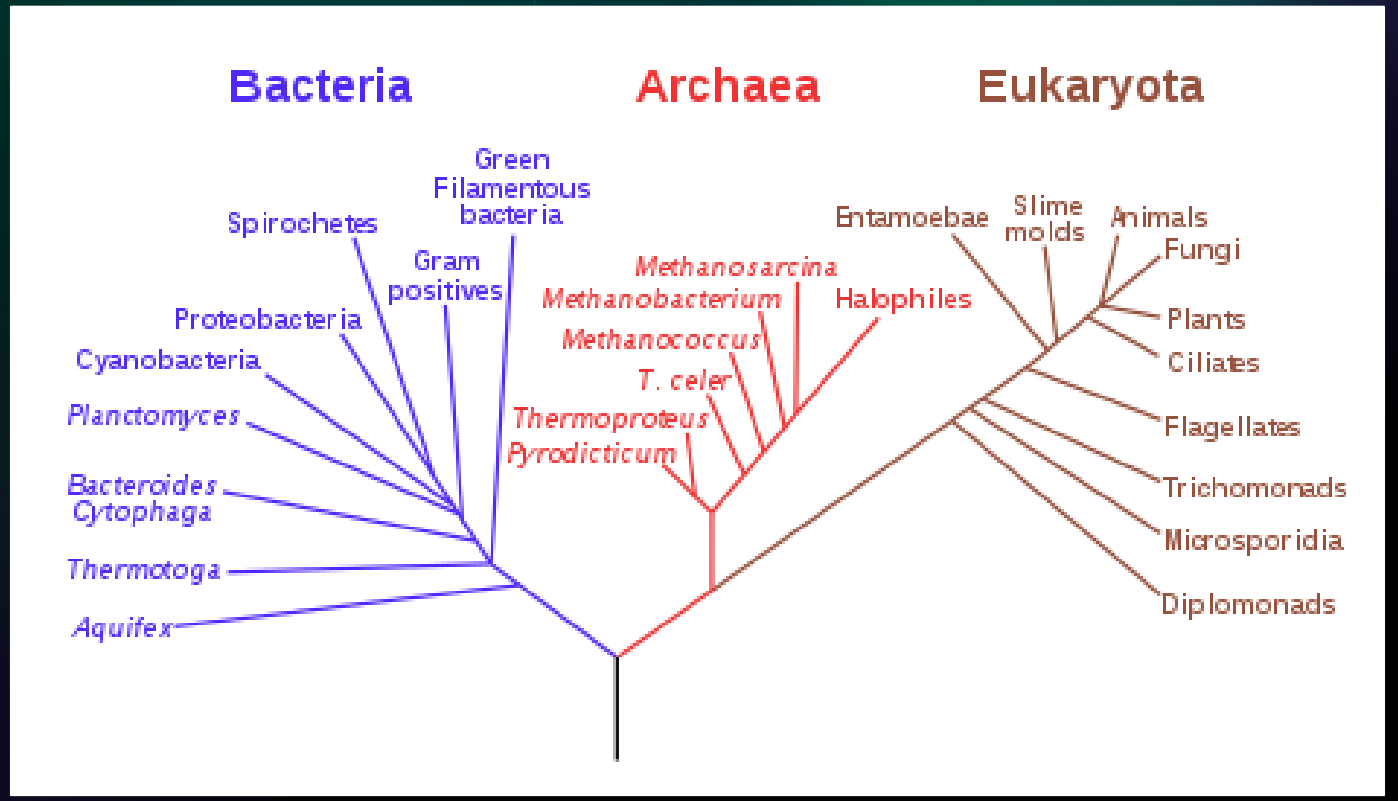
1. Select a species of your choice. (Tip: pick one that won't be too hard to draw!)
2. Research. Which taxa does your species belong to? (DKPCOFGS)
3. For each taxon:
   a) Research key characteristics of species in that group.
   b) Determine other examples of species in that group.
      (genus – 1 example;
      kingdom and domain – 3 examples;
      everything else – 2 examples)

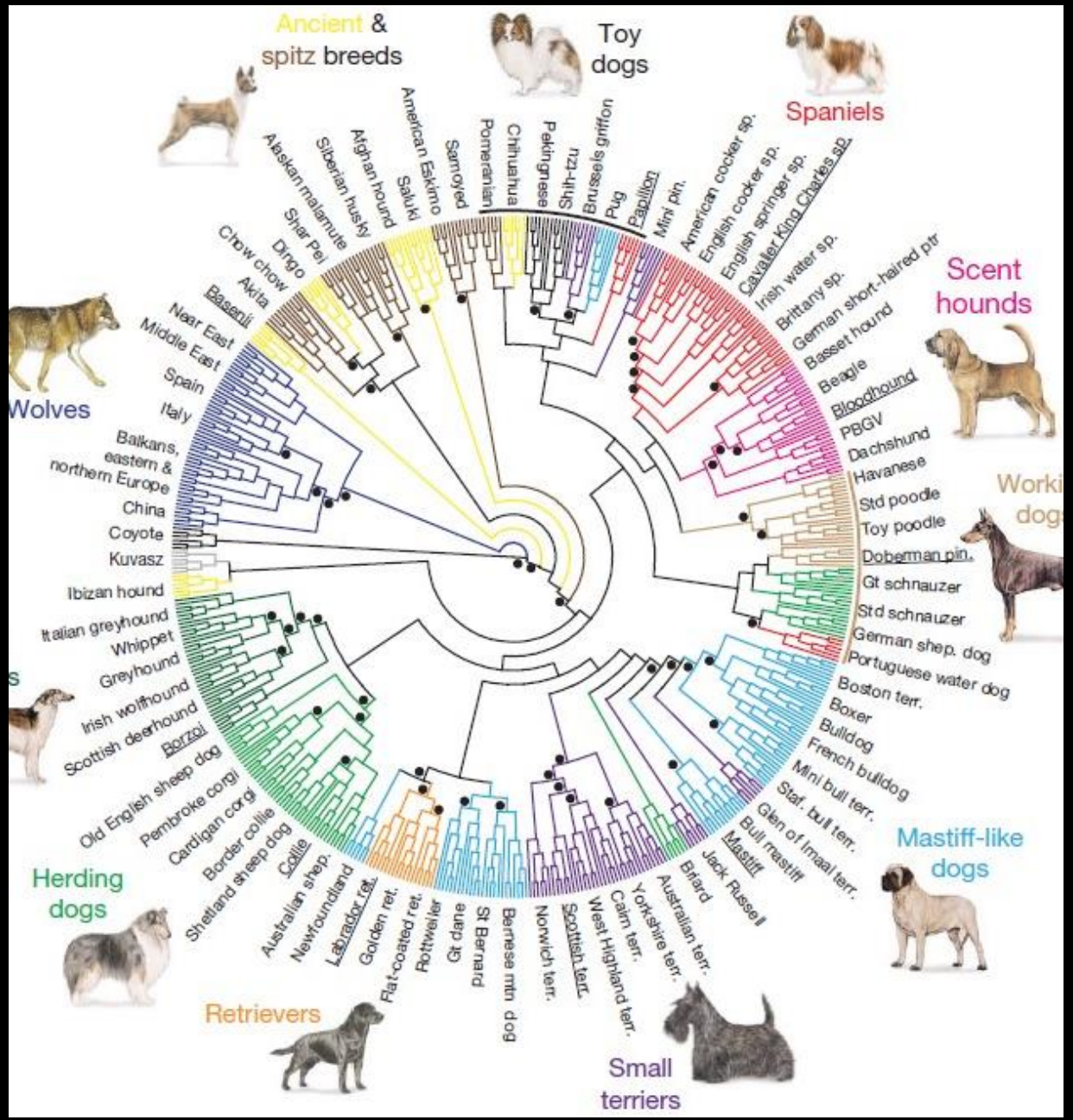
Phylogenetic Trees

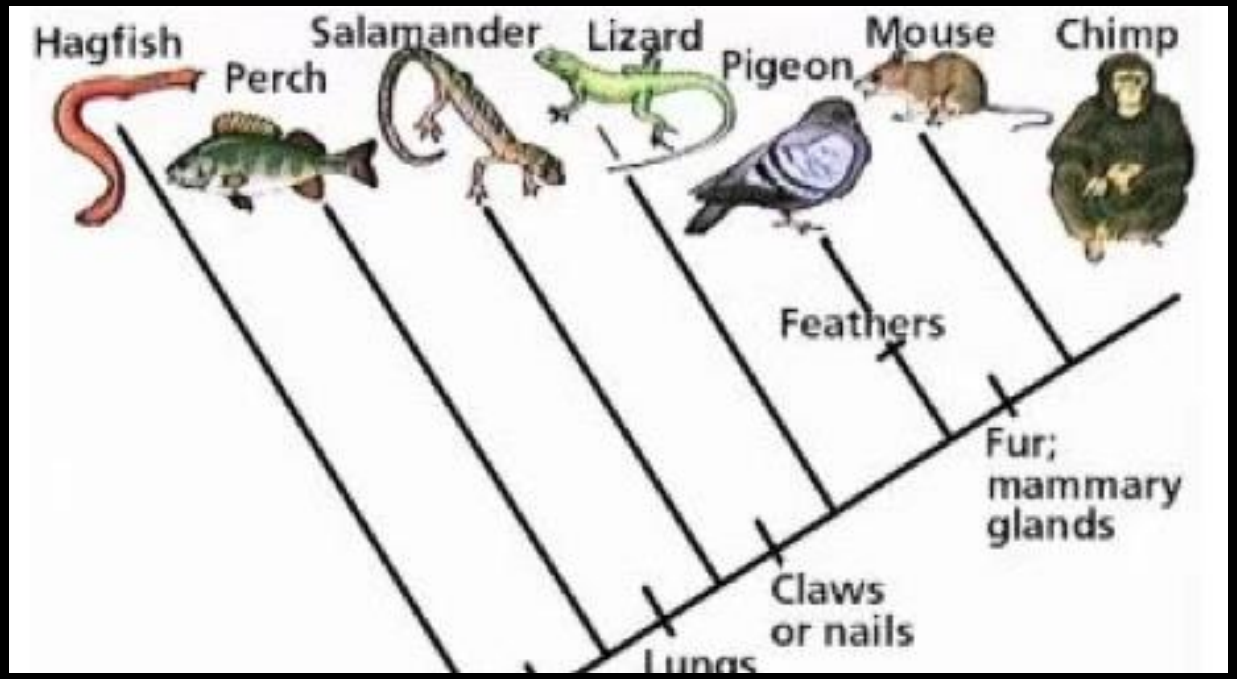
NO TEXTBOOK SECTION

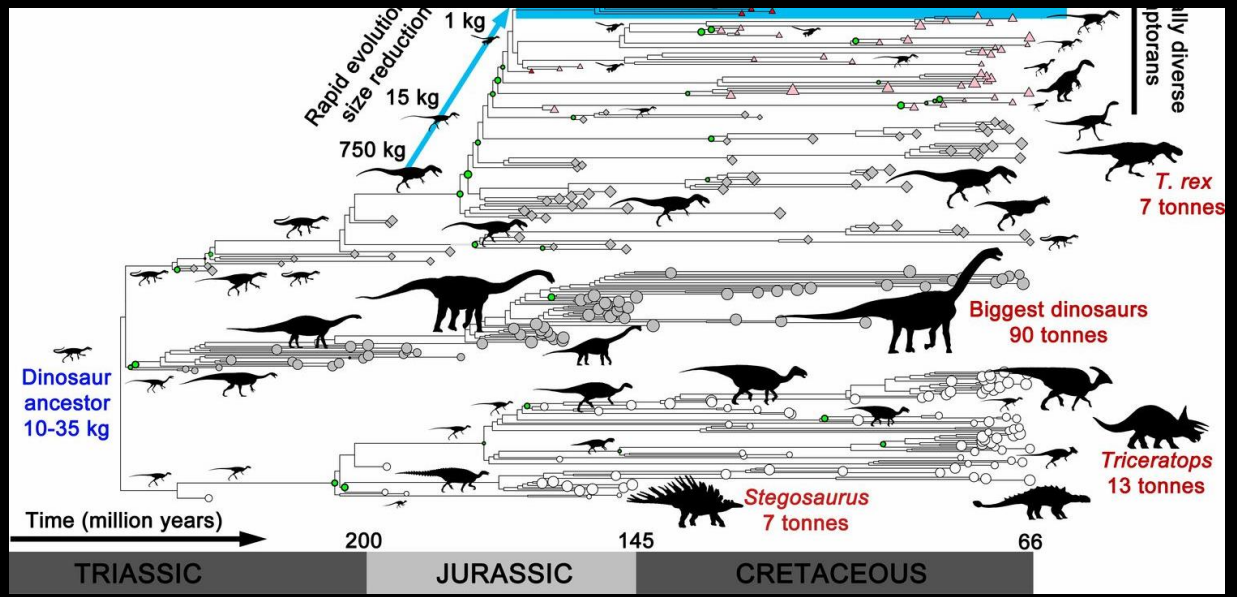
Phylogenetic Trees

Phylogenetic tree: visual representation of the hypothesized evolutionary relationships between different species or groups over time




Ancient & spitz breeds
Toy dogs
Spaniels
Scent hounds
Wolves
Herding dogs
Retrievers
Small terriers
Mastiff-like dogs
Dingo
Shar Pei
Alaskan malamute
Siberian husky
Afghan hound
Saluki
American Eskimo
Samoyed
Pomeranian
Chihuahua
Pekingnese
Shih-tzu
Brussels griffon
Pug
Papillon
Mini pin.
American cocker sp.
English cocker sp.
English springer sp.
Cavalier King Charles sp.
Irish water sp.
Brittany sp.
German short-haired ptr
Basset hound
Beagle
Bloodhound
PBGV
Dachshund
Havanese
Std poodle
Toy poodle
Doberman pin.
Gt schnauzer
Std schnauzer
German shep. dog
Portuguese water dog
Boston terr.
Boxer
Bulldog
French bulldog
Mini bull terr.
Staf. bull terr.
Glen of Imaal terr.
Bull mastiff
Mastiff
Jack Russell
Briard
Australian terr.
Yorkshire terr.
Cairn terr.
West Highland terr.
Scottish terr.
Norwich terr.
Bernese mtn dog
St Bernard
Gt dane
Rottweiler
Flat-coated ret.
Golden ret.
Labrador ret.
Newfoundland
Australian shep.
Collie
Shetland sheep dog
Border collie
Cardigan corgi
Pembroke corgi
Old English sheep dog
Borzoi
Scottish deerhound
Irish wolfhound
Greyhound
Whippet
Italian greyhound
Ibizan hound
Kuvasz
Coyote
China
Balkans, eastern & northern Europe
Spain
Italy
Middle East
Near East
Basenji
Akita
Chow chow


Hagfish
Perch
Salamander
Lizard
Pigeon
Mouse
Chimp
Feathers
Fur; mammary glands
Claws or nails
Lungs

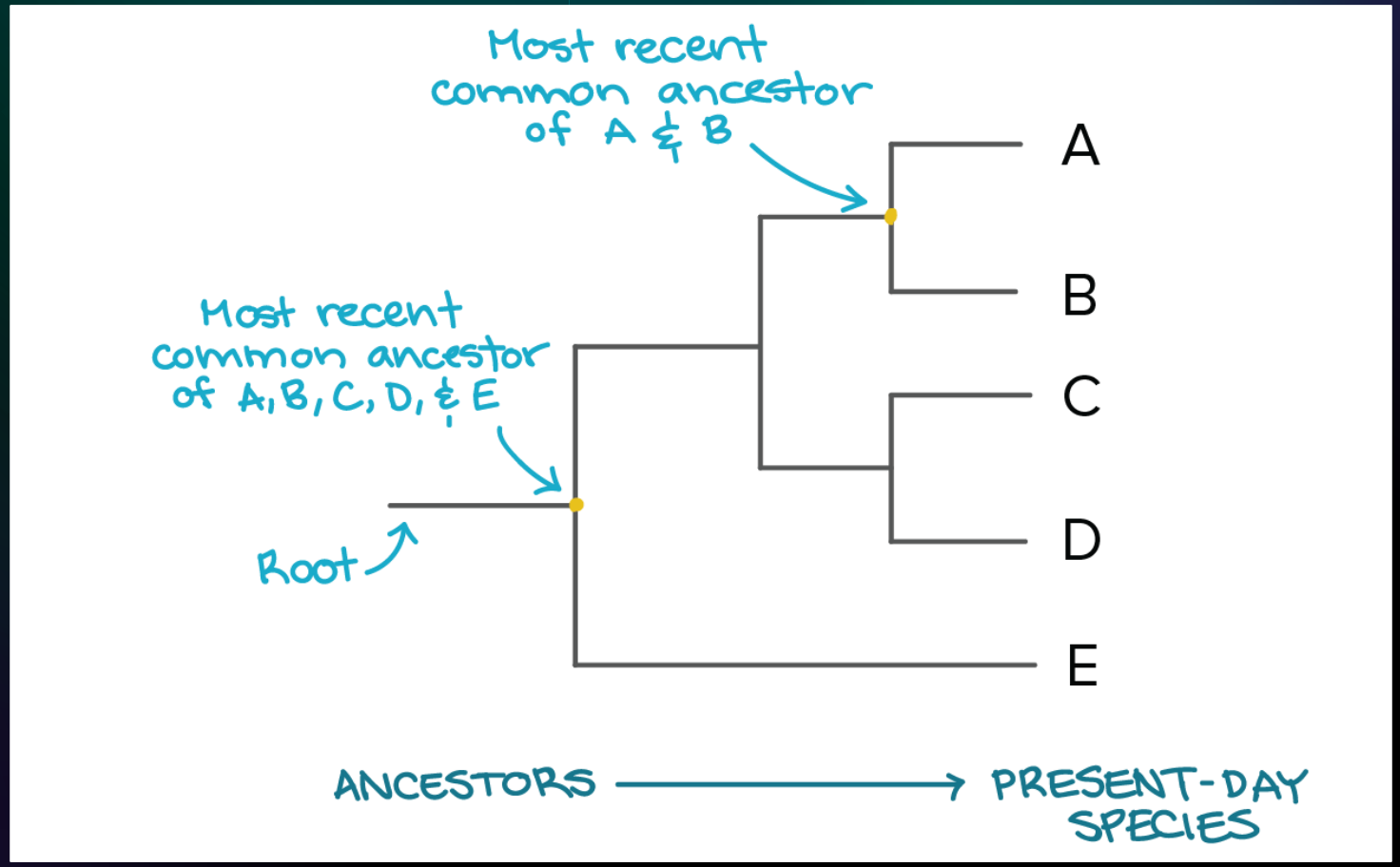

Rapid evolution size reduction
1 kg
15 kg
750 kg
T. rex
7 tonnes
Biggest dinosaurs
90 tonnes
Dinosaur ancestor
10-35 kg
Triceratops
13 tonnes
Stegosaurus
7 tonnes
Time (million years)
200
145
66
TRIASSIC
JURASSIC
CRETACEOUS

Phylogenetic Tree Components

- **Root:** starting branch of your tree
- **Clade:** group of species including one common ancestor and all its descendants
- **Branch:** represents evolutionary 'journey' of a species or clade
- **Node:** branch point representing common ancestor; branches can be rotated around node
- **Derived traits:** traits that are newly evolved compared to common ancestor; are found in descendants past this point

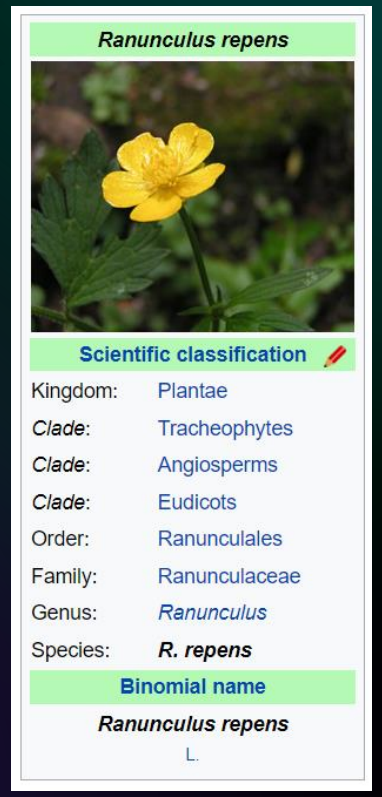
Phylogenetic Tree Components

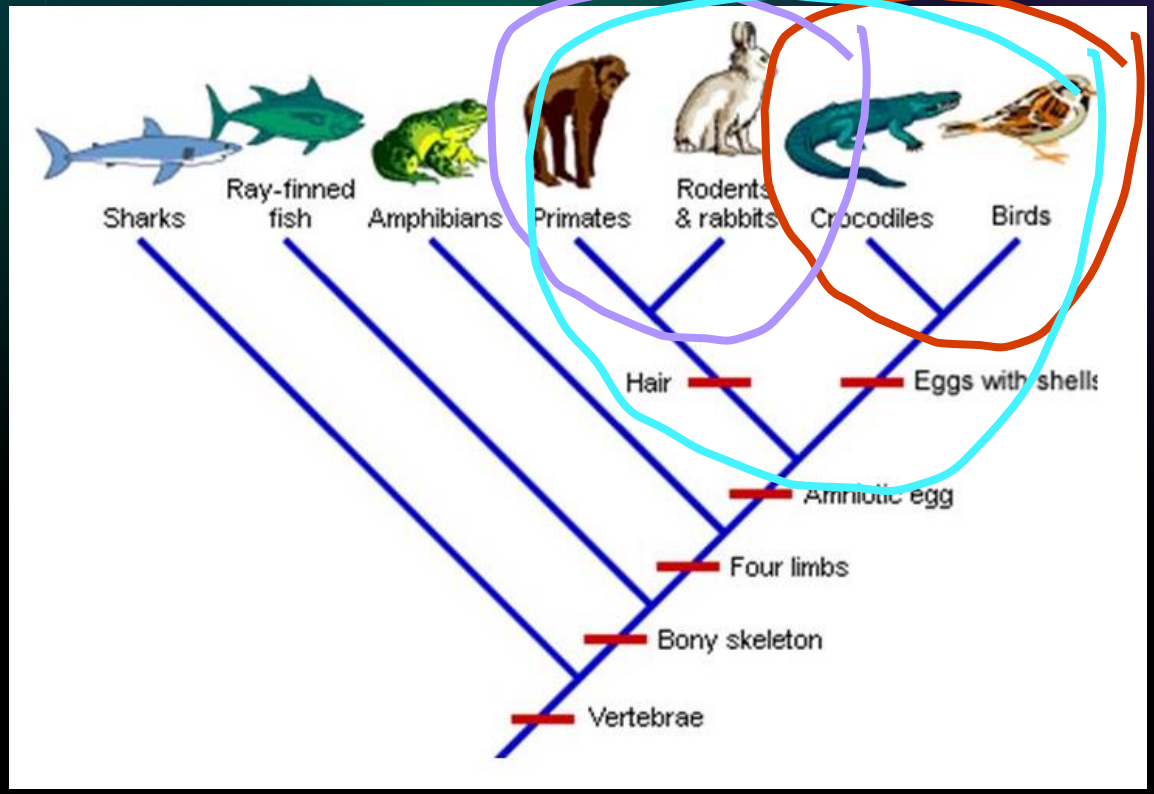
Root: starting branch of your tree



Phylogenetic Tree Components

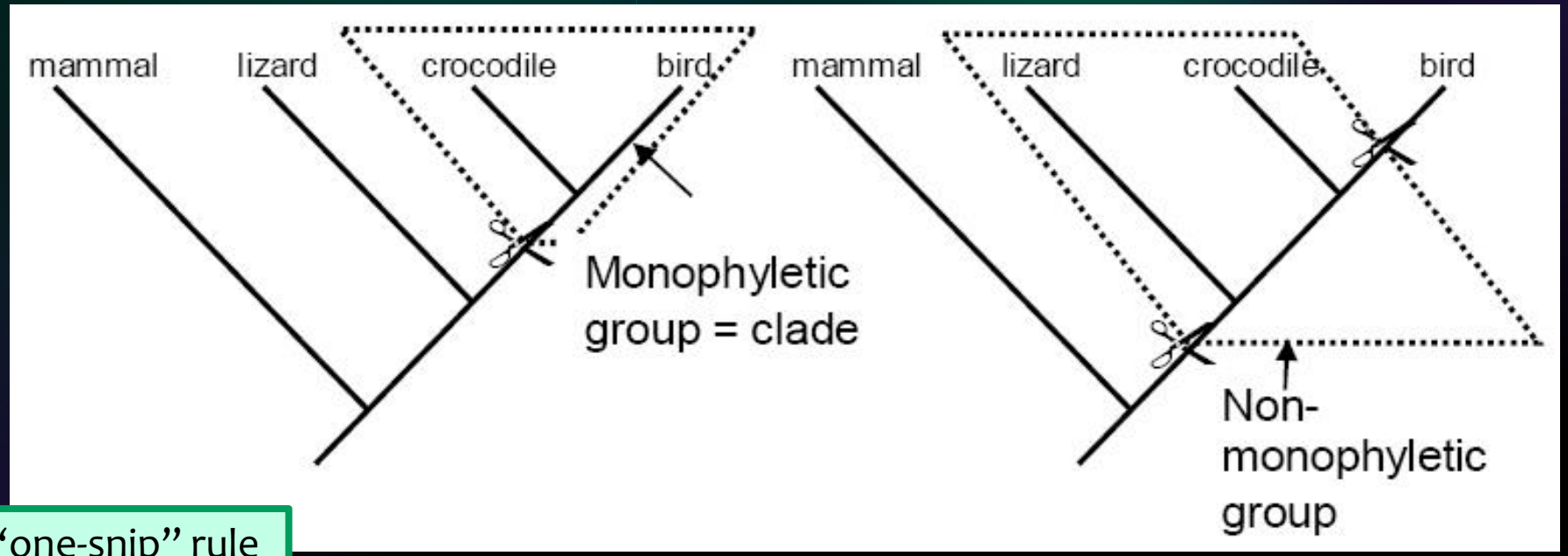
Clade: group of species including one common ancestor and all its descendants





Phylogenetic Tree Components

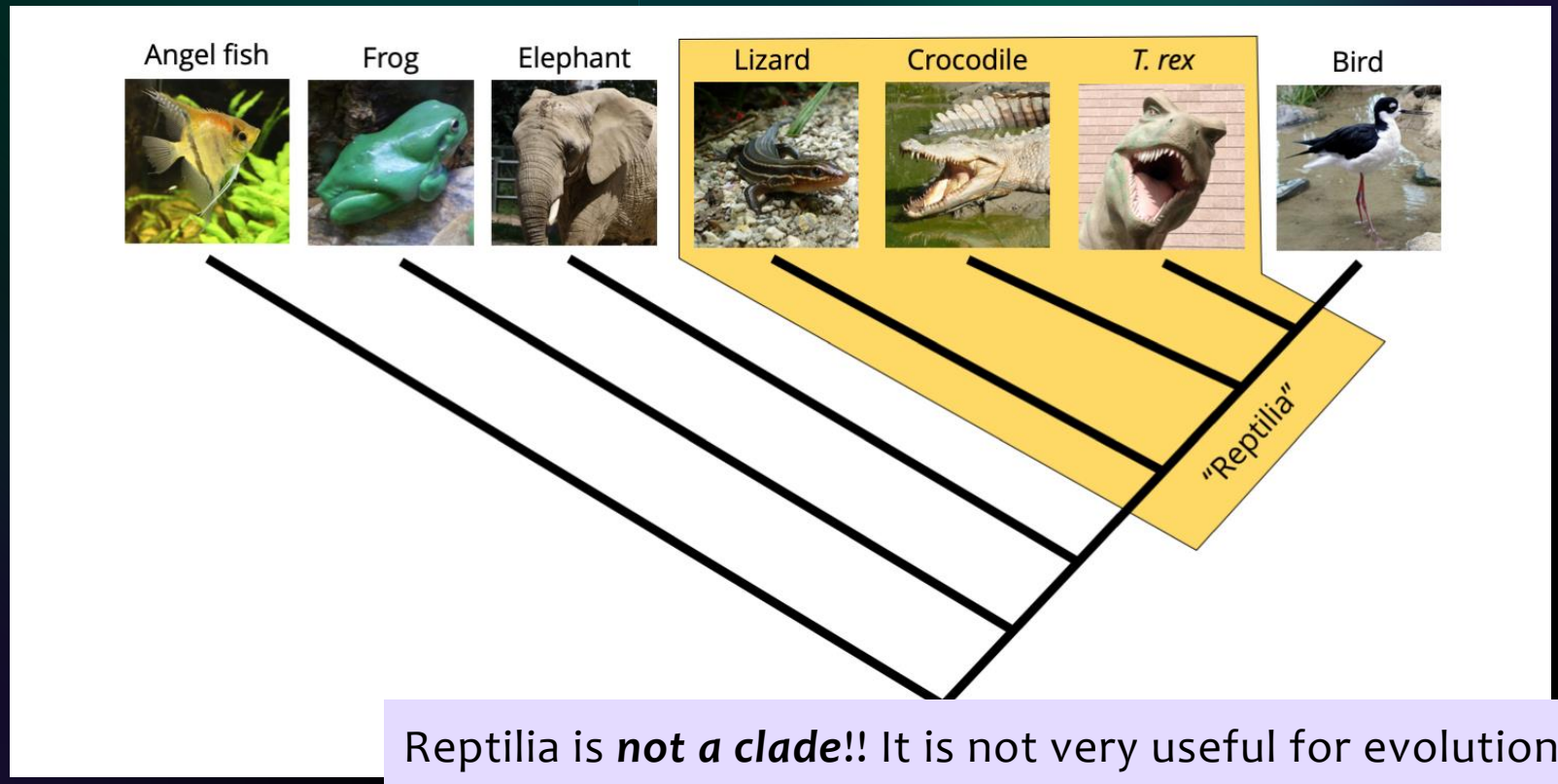
Clade: group of species including one common ancestor and all its descendants



"one-snip" rule

Phylogenetic Tree Components

Clade: group of species including one common ancestor and all its descendants

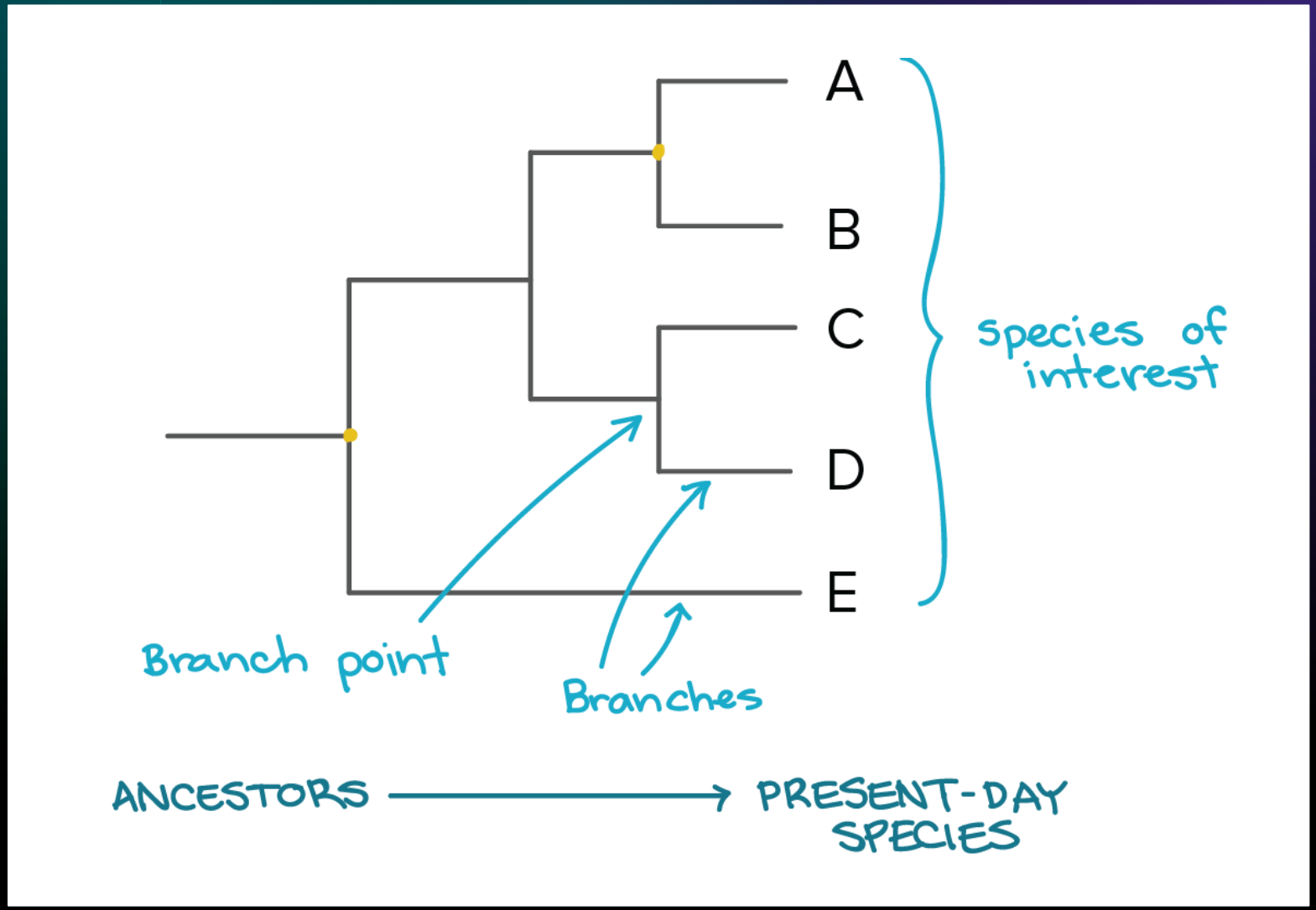


Reptilia is ***not a clade***!! It is not very useful for evolutionary classification.

Phylogenetic Tree Components

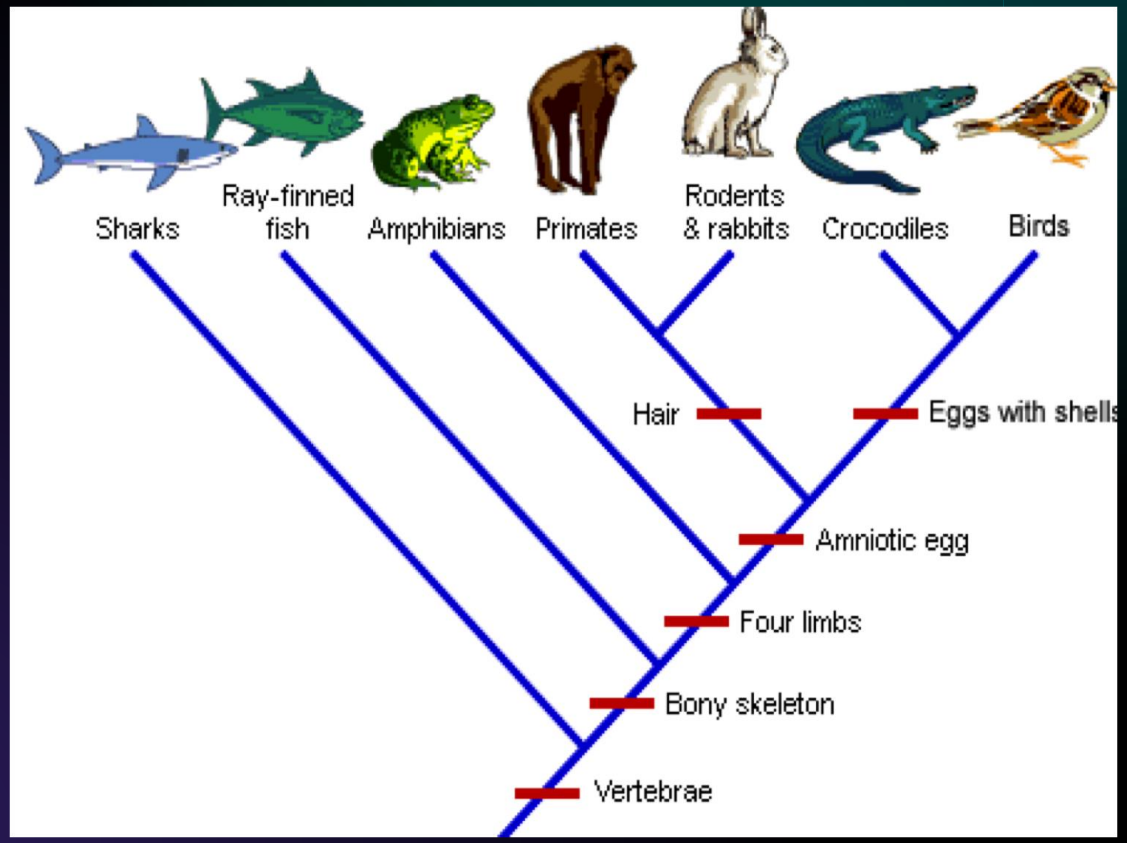
Branch: represents evolutionary 'journey' of a species or clade

Node: branch point representing common ancestor; branches can be rotated around node



Phylogenetic Tree Components

Derived traits: traits that are newly evolved compared to common ancestor; are found in descendants past this point

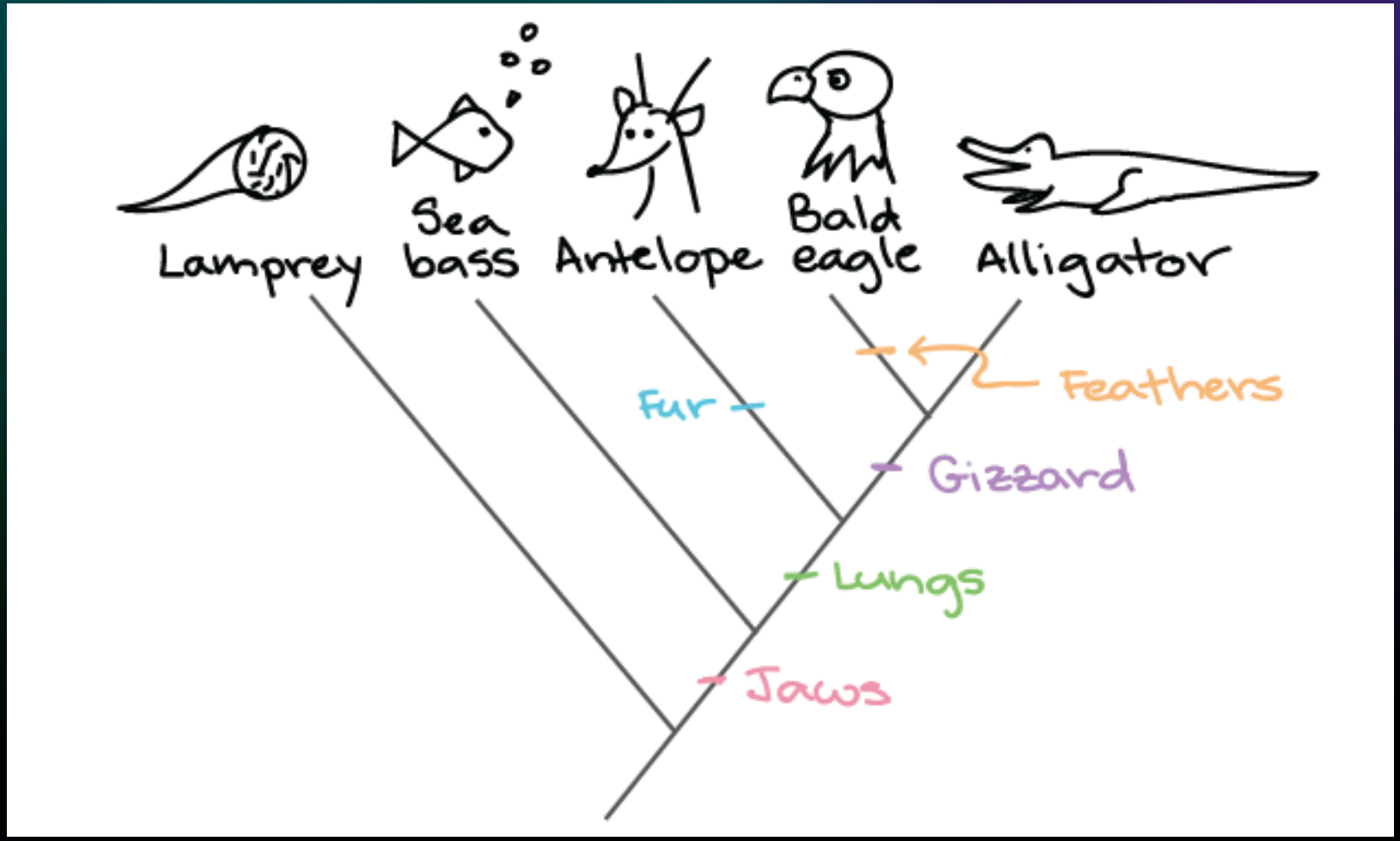


Interpretation examples:

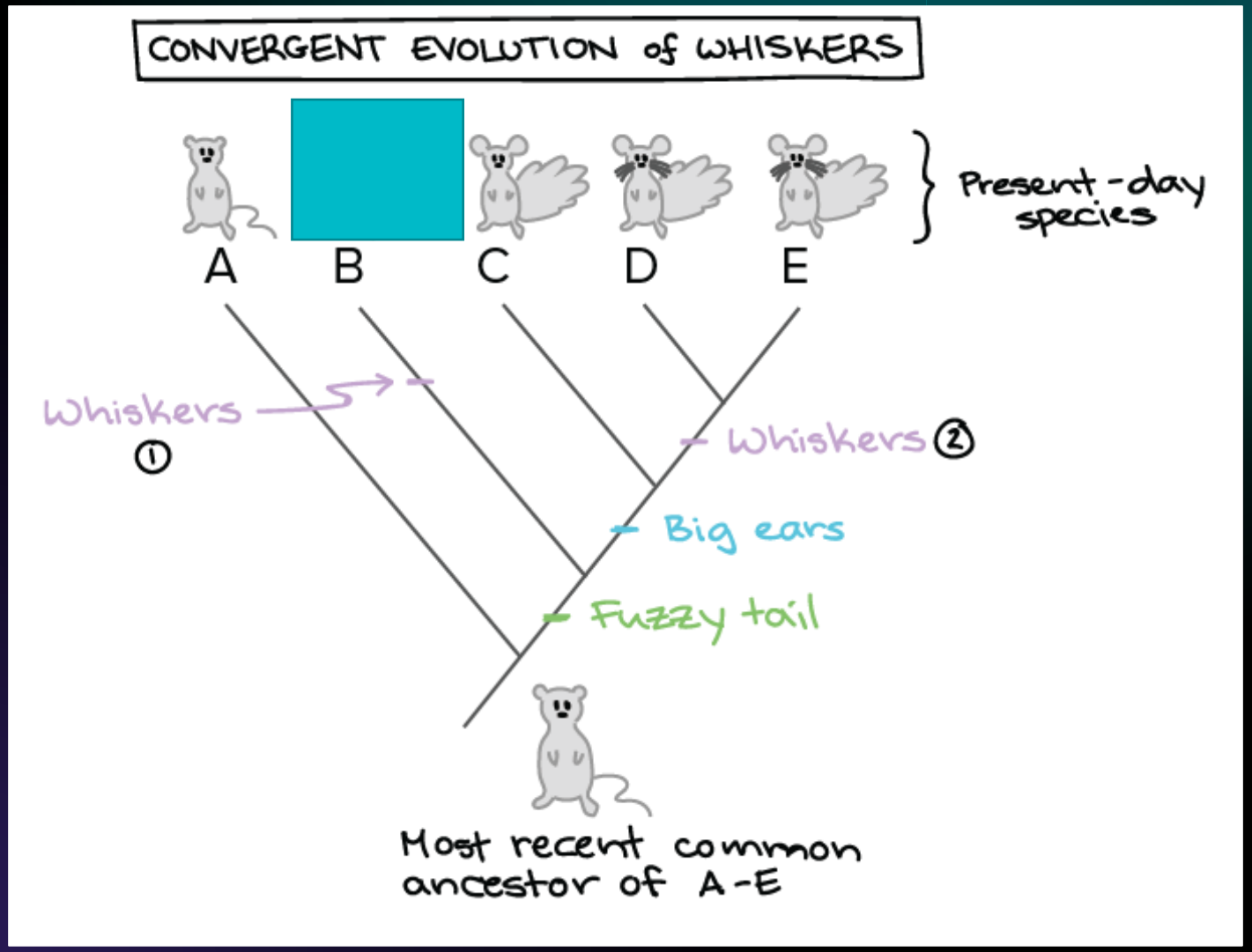
- Crocodiles and birds have eggs with shells; primates do not.
- Amphibians, primates, rodents/rabbits, crocodiles, and birds all have four limbs; fish and sharks do not.
- All listed taxa have vertebrae. Only the listed taxa have vertebrae; more distant relatives do not.

Practice with Phylogenies

Describe the traits of each of the groups shown in this phylogenetic tree.



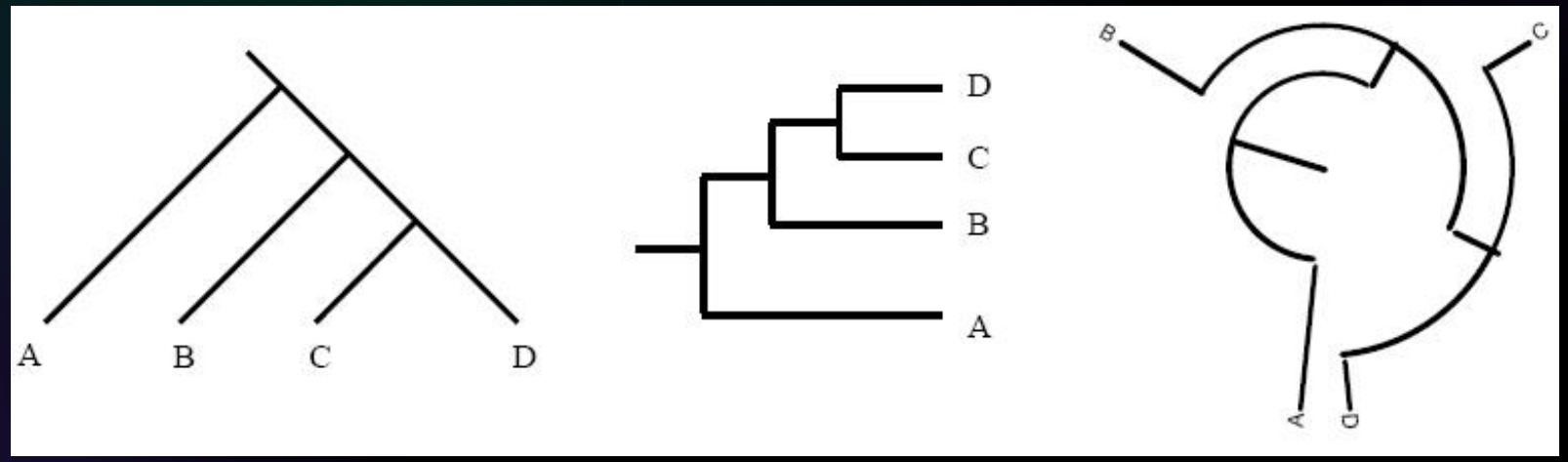
Practice with Phylogenies



1. How many clades can you form that include species C?
2. Draw species B.
3. Where is the common ancestor of species C and D located on the tree? Draw the common ancestor.

Creating Phylogenetic Trees

1. Create a table of traits for all the species of interest.
2. Common traits are likely to have evolved earlier.
   Uncommon traits are likely to have evolved later.
3. Create a phylogenetic tree.



Creating Phylogenetic Trees

Feature	Lamprey	Antelope	Bald eagle	Alligator	Sea bass
Lungs	0	+	+	+	0
Jaws	0	+	+	+	+
Feathers	0	0	+	0	
Gizzard	0	0	+	+	
Fur	0	+	0	0	

https://www.khanacademy.org/science/ap-biology/natural-selection/phylogeny/a/building-an-evolutionary-tree

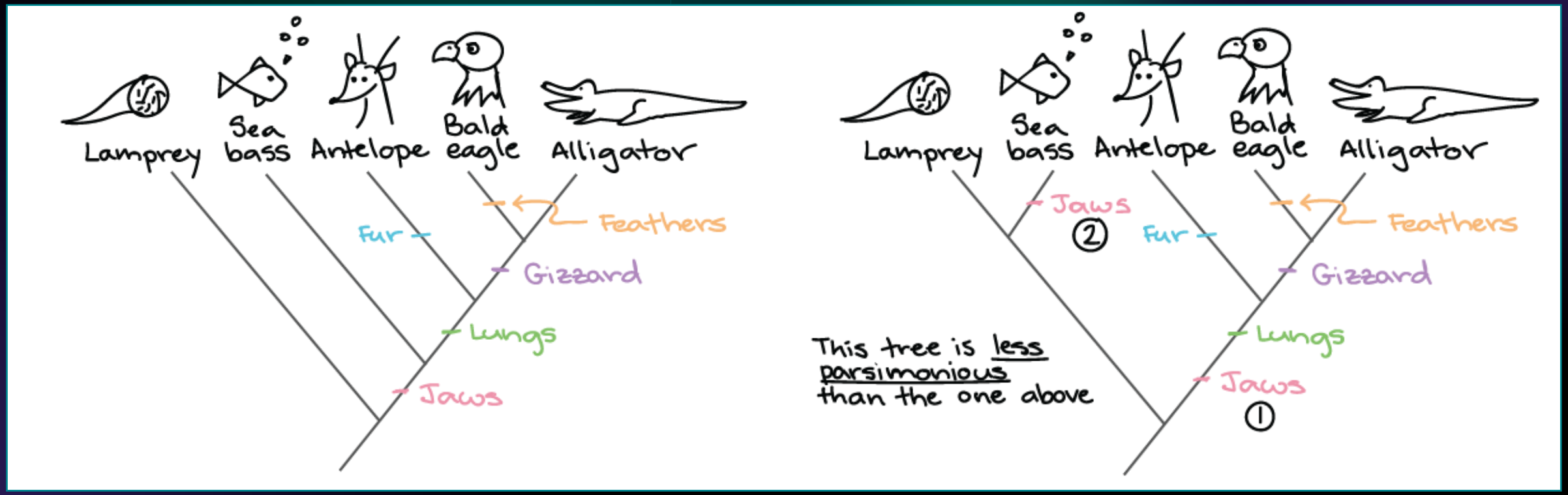
Parsimony

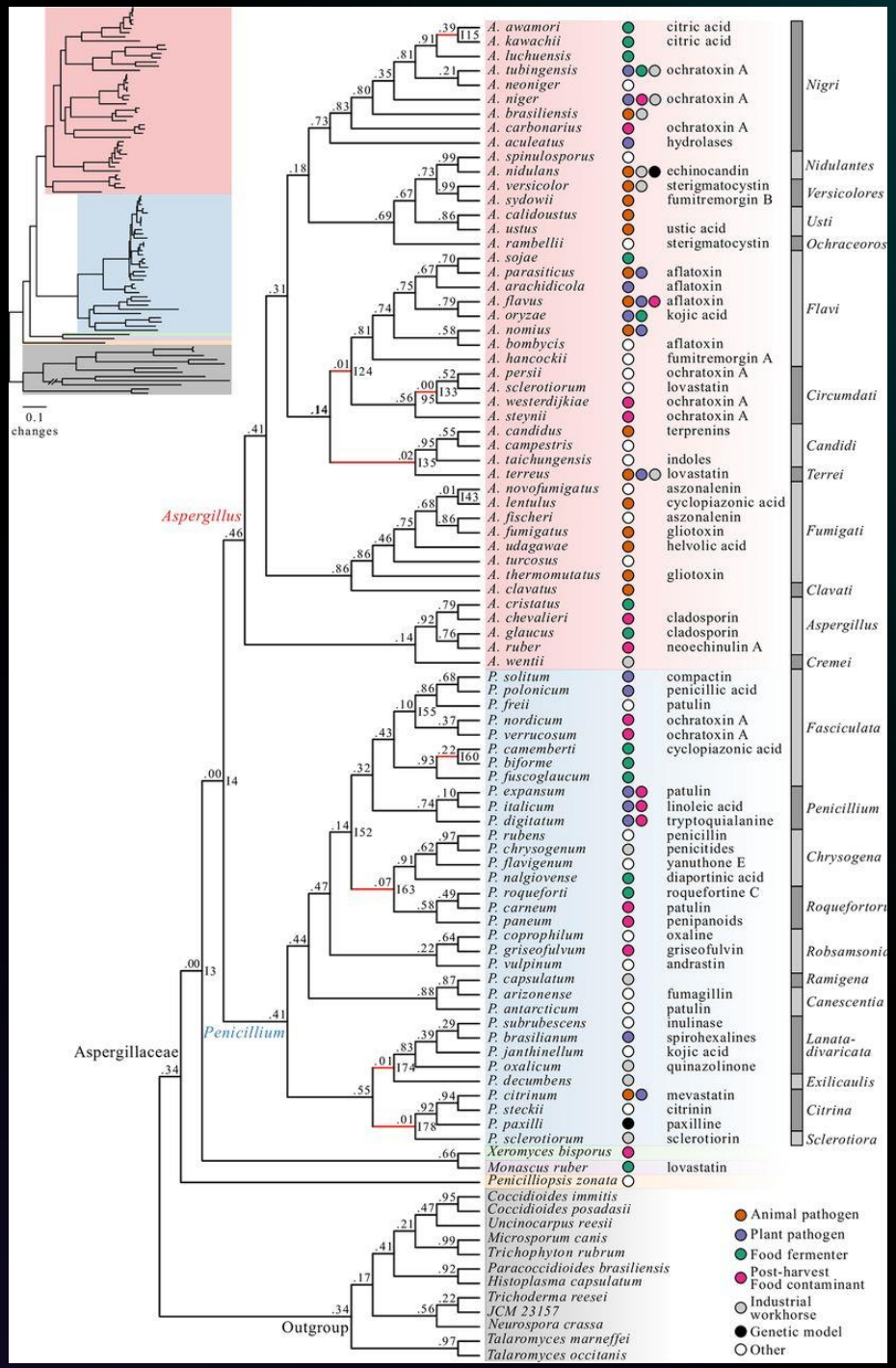
- Remember: phylogenetic trees are ***hypotheses*** about how species evolved. You can't know "for sure" (unless you have a time machine).
- **Parsimony:** the simplest explanation is the most likely to be correct

Ockham chooses a razor

Parsimony

The most parsimonious tree is the one with the fewest total appearances and disappearances of traits





Modern Phylogenetic Trees

The more traits you map, the longer it takes but the higher the accuracy

Modern genetic analysis:

- Computer-generated
- Uses DNA differences instead of observable traits
- Estimate time scales