

The image features a solid green background with a vertical black bar on the left side. In the center, there is a light cream-colored, cloud-like shape. The text "UNIT 9" is written in bold black capital letters inside the top of this shape. Below it, the word "CLASSIFICATION" is written in a larger, bold black capital font, spanning across the shape and extending into the green background. At the bottom center, the word "BIOLOGY" is written in a smaller, bold black capital font.

UNIT 9

CLASSIFICATION

BIOLOGY

INSTRUCTIONS

As you read through the slides (or while listening to the lecture) remember to:

- Take notes in your guided lecture notes handout
 - Remember to write keywords and questions in the thinner left column while the “meat” of the information and answers are in the larger right column.
 - Keywords are in **BOLD**
 - Examples are provided at the beginning of the lecture guide.
- Answer the Quick Questions in provided space
- Complete the Study Guide Questions
 - These will be helpful for the test

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INTRODUCTION

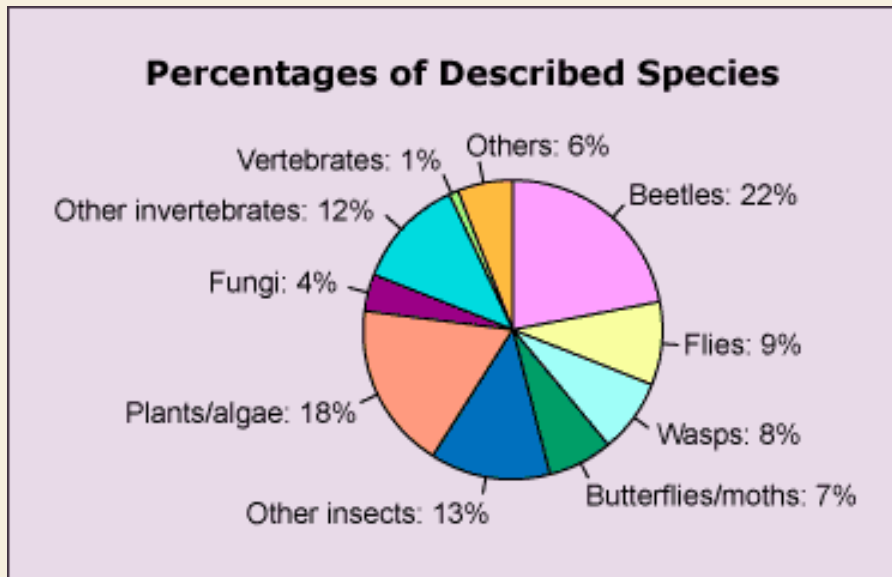
SPECIES AND THEIR ORGANIZATION

EARTH'S SPECIES

- Total number of **species** is estimated to be between 8 and 8.7 million
- Most are not studied or documented
- It may take over 1000 years to fully catalogue them all

VOCABULARY

- **Species** A group of similar organisms that can breed and produce fertile offspring
- **Sterile** an organism that has reproductive organs however does not produce viable gametes



https://evolution.berkeley.edu/evolibrary/article/side_O_0/beetles_01

ONE SPECIES



Golden retriever

+



Poodle

=



Golden Doodle

FERTILE

TWO SPECIES



Zebra

+



quarter horse

=



Zorse

STERILE

CLASSIFICATION

- **Classification** is the arrangement of organisms into orderly groups based on their similarities.
- Classification is also known as **taxonomy**
- Based on evolutionary relationships from genetic testing (DNA sequencing)

Benefits of taxonomy:

- Accurately & uniformly names organisms (one organism, one name)
- Prevents misnomers such as starfish & jellyfish that aren't really fish

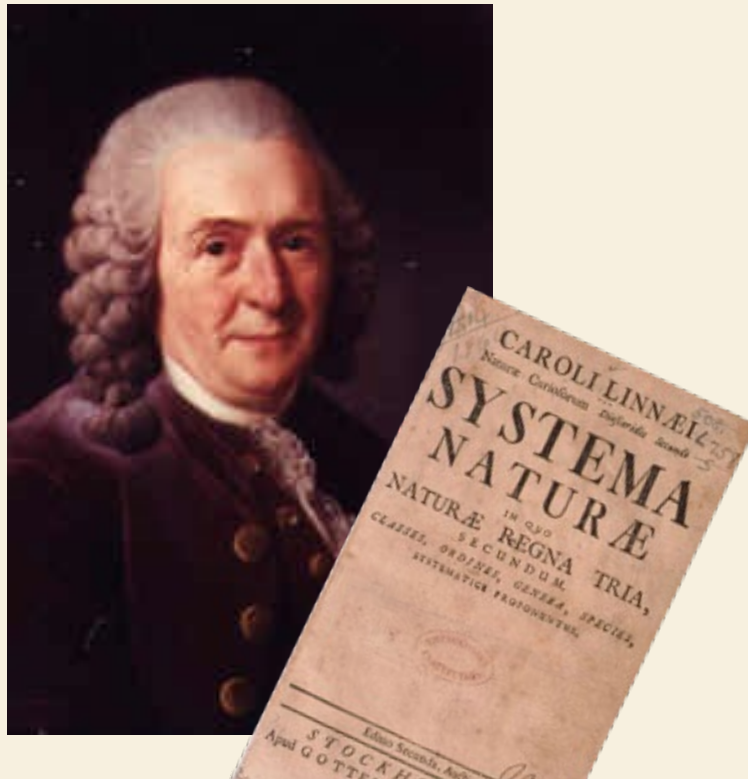
VOCABULARY

- **Taxonomy** A system of naming and classifying organisms based on shared characteristics and universal rules.



NAMING SPECIES

- All organisms described today, use the 2-word naming system by Carolus Linnaeus called **binomial nomenclature**.
 - Binomial nomenclature = **scientific name** (i.e. *Ursus maritimus*)
 - Other names = **common name** (i.e. polar bear, sea bear, ice bear, Nanuq)



Biographical Moment

Carolus Linnaeus (1707-1778)

- Swedish botanist, zoologist, and physician
- Called the “Father of Taxonomy”
- Classified organisms by their structure
- Developed the modern system of naming known as binomial nomenclature

VOCABULARY

- **Binomial nomenclature** A naming system developed by Carolus Linnaeus where each species is assigned a two-part scientific name.

NAMING SPECIES

- **Rules** for Scientific Names using binomial nomenclature
 - Usually uses Latin (some exceptions, especially in species part)
 - *Genus species*
 - Capitalize *Genus*, but NOT *species*
 - Italicized in *print*
 - Underline when writing



Polar Bear
Ursus maritimus

↑ ↑
Genus species



Grizzly
Ursus arctos



American Black Bear
Ursus americanus



Koala Bear
Phascolarctos cinereus

VOCABULARY

- **Binomial nomenclature** A naming system developed by Carolus Linnaeus where each species is assigned a two-part scientific name.

Quick Questions

1. Who is most closely related? Who is not?
2. Why could a common name make organizing species confusing?

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TAXA

STRUCTURE OF CLASSIFICATION

CLASSIFYING GROUPS

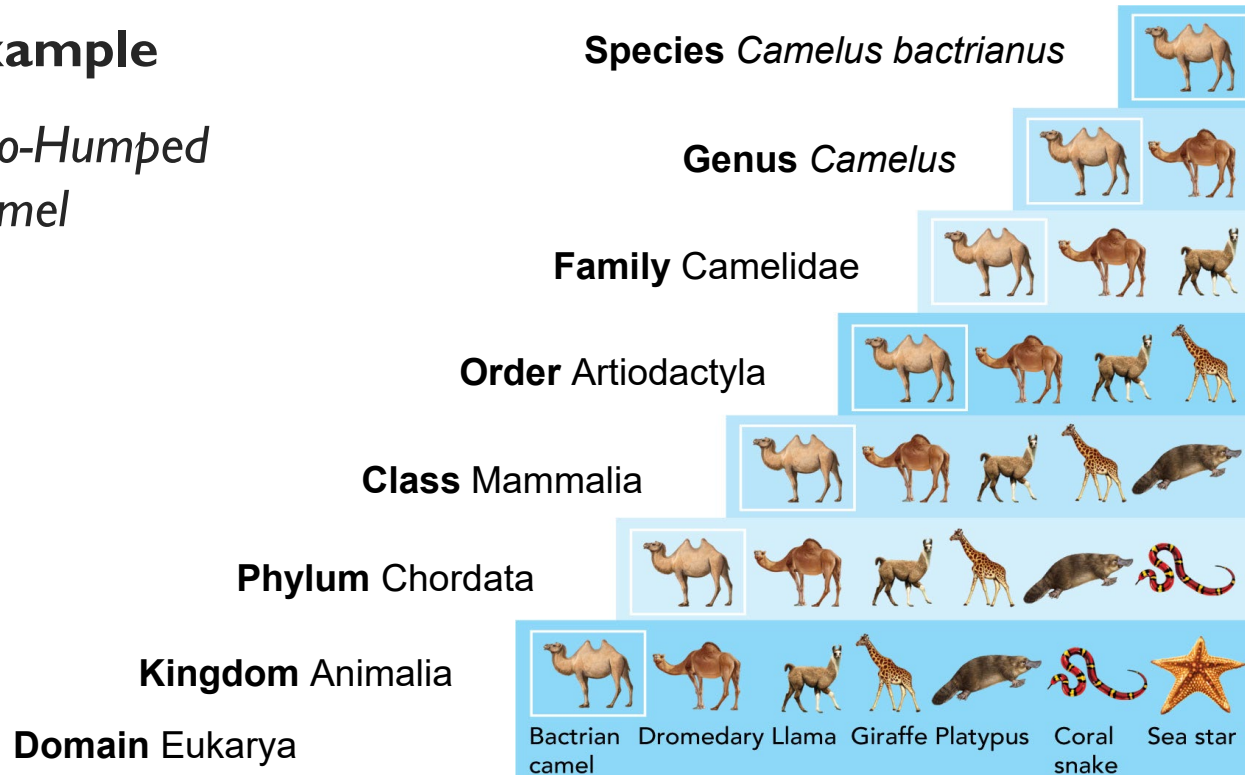
- There is a hierarchy of *groups (taxa)* from broadest to most specific
 - Domain, Kingdom, Phylum, Class, Order, Family, Genus, species
- ↑ *broadest* ↑ *most specific*

VOCABULARY

- **Taxon** (plural: taxa) a general term for group or level of organization into which organisms are classified

Example

Two-Humped Camel

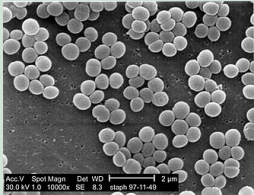



Quick Questions

3. Why do the organisms from the bottom not appear at the top?
4. How many levels of organization are there?
5. Can you create your own mnemonic for remembering the taxa order?

TAXA | DOMAIN

- Broadest taxa or group
- All life is classified into 3 domains based on common characteristics:

Domain	Bacteria	Archaea	Eukarya
Cell Type	prokaryotes	prokaryotes	eukaryotes
Description	“true” bacteria	extremophiles	everyone else
Example(s)	Pathogens  <i>Staphylococcus</i> <i>Staph infection</i>	 <i>Hot springs</i> <i>Sulfur-Oxidizing</i> <i>bacteria</i>	<i>plants, animals,</i> <i>fungi, protists</i>

VOCABULARY

- **Extremophiles**
organisms that are able to live in extreme environments like volcanoes, ice, deep sea hydrothermal vents.

Quick Questions

6. What is the main/first characteristic that divides the domains?
7. What would be the next group or taxa an organism would be categorized in? (Hint: see last slide)

TAXA | KINGDOM

- The first model of kingdoms just separated plants and animals
- As technology developed, so did the number of kingdoms
- The table below outlines the development of current kingdom categories:

First Introduced	Name of Kingdoms				
1700s	Plantae				Animalia
Late 1800s	Protista		Plantae		Animalia
1950s	Monera	Protista	Fungi	Plantae	Animalia
1990s	eubacteria	archaeobacteria	Protista	Fungi	Plantae

Current Kingdoms

VOCABULARY

- **Protist** any eukaryote that is not an animal, plant, or fungus who do not form a natural group, or *clade*, since they exclude certain eukaryotes with whom they share a common ancestor

Quick Questions

8. Why would the taxa or number of groups change?
9. How many kingdoms do we currently have?

TAXA | KINGDOM

- Characteristics of the different kingdoms*:

Domain	Bacteria	Archaea	Eukarya			
Kingdom	Eubacteria	Archaeobacteria	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 (carbohydrate like lobster shells)	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	Most multicellular; some green algae unicellular	Multicellular
Mode of Nutrition	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
Examples	<i>Streptococcus</i> , <i>E. coli</i>	Methanogens, halophiles	Amoeba, paramecium, slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants, conifers	Sponges, coral, worms, insects, mammals, birds, fish

VOCABULARY

- Autotroph** organisms that make their own food via photosynthesis or chemosynthesis
- Chemosynthesis** production of food from inorganic compounds (i.e. methane or hydrogen)
- Heterotroph** organisms that gain energy from other sources like carnivores or herbivores
- Peptidoglycan** polymer of sugars and amino acids that forms the cell wall of some bacteria
- Cellulose** carbohydrate that is the primary component of a plant's cell wall
- Halophiles** organisms that thrive in high salt concentrations

*You will need to be able to determine an organism's kingdom based on given characteristics.

REMAINING TAXA

- Each kingdom can be broken down into more and more specific levels based on shared characteristics
- Contemporary systematics uses genetic testing to determine relationships between organisms



Candiru (“can-deer-u”) tiny parasitic fish that attach to Amazonian catfish gills. Rumor has it that they swim up the urethra of humans and holdfast with barbs on their fins.

VOCABULARY

- **Systematics** The science of naming and grouping organisms whose goal is to put living things into groups that have biological meaning.

Taxonomic Level	Example Types	Candiru
Domain	see previous slides	Eukarya
Kingdom		Animalia
Phylum	Annelida, arthropoda, cnideria, Mollusca, porifera	Chordata
Class	There are <i>many</i> sub groups of classes	Actinopterygii
Order	suffix “-(i)forms” is used for the orders of birds/fishes, and “-ales: is for plants/fungi/algae	Siluriformes
Family	End in “-dae”	Trichomycteridae
Genus	Capitalized, usually describe the location/habitat	<i>Vandellia</i>
species	Unique, poor taste to name a species after yourself	<i>V. cirrhosa</i>

Quick Questions

10. What current technology do scientists use to determine relationships between organisms? (Hint: “You are NOT the father...”)
11. What could future discoveries mean for the organization and number of taxonomic groups?

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DIAGRAMS

HOW TO READ DIFFERENT TAXONOMIC
DIAGRAMS

DICHOTOMOUS KEYS

- **Dichotomous key** is a series of steps that lead to a classification of an organism that use *physical characteristics*.
- How to Read a Dichotomous Key:
 - Consists of paired statements that are “either/or”
 - Start with STEP 1
 - Your answer should tell you which step to go to next
 - You are finished once you get to the name of the organism

Example Dichotomous Key

Step	Characteristics	Result
1a	Tentacles present	Go to 2
1b	Tentacles absent	Go to 6
2a	Eight Tentacles	<i>Octopus</i>
2b	More than 8 tentacles	Go to 3
3a	Tentacles hang down	Go to 4
3b	Tentacles upright	<i>Sea Anemone</i>
4a	Balloon-shaped body	<i>Jellyfish</i>
4b	Body NOT balloon-shaped	Go to 5
5a	Transparent	<i>Ctenophore</i>
5b	Opaque	Go to 6
6a	Round	<i>Beach ball</i>
6b	Square	<i>Comb</i>

12



13



14

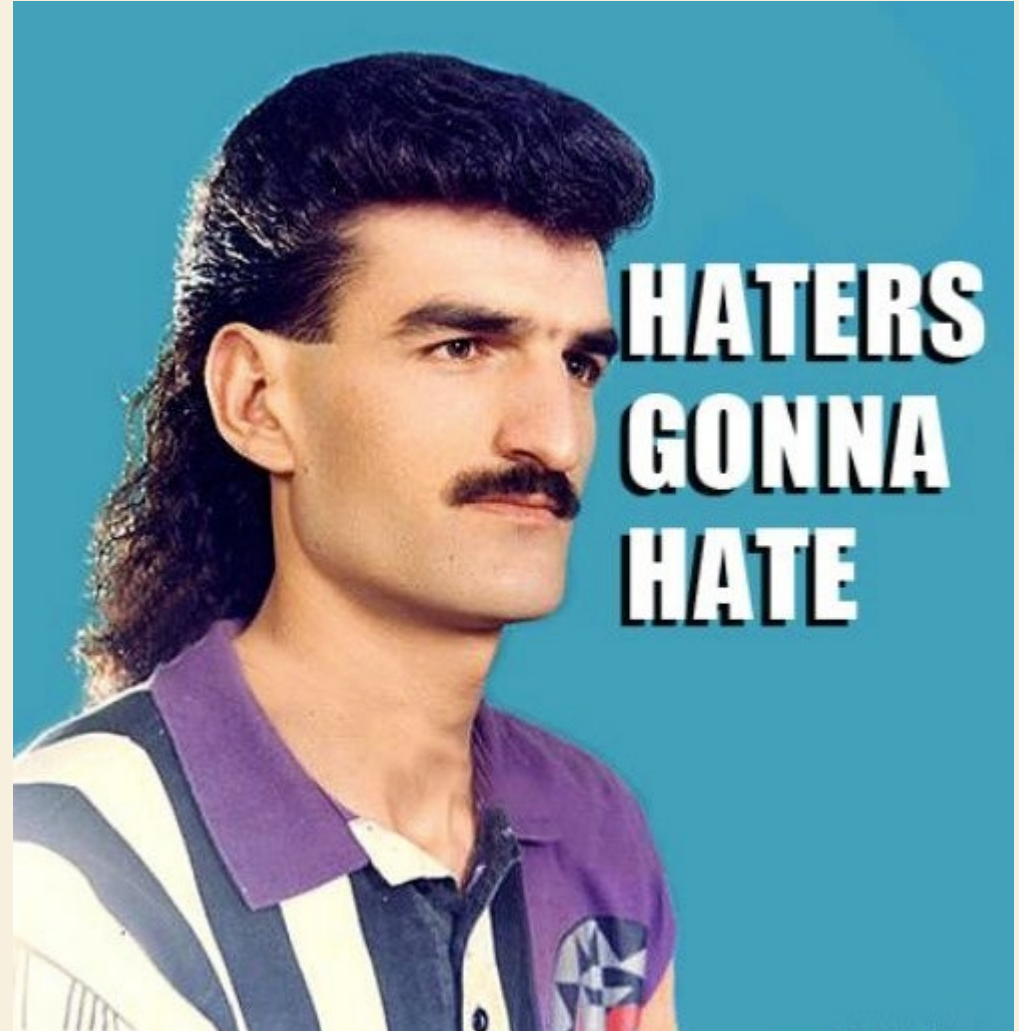


Quick Question

Use the provided dichotomous key to correctly identify images 12-14

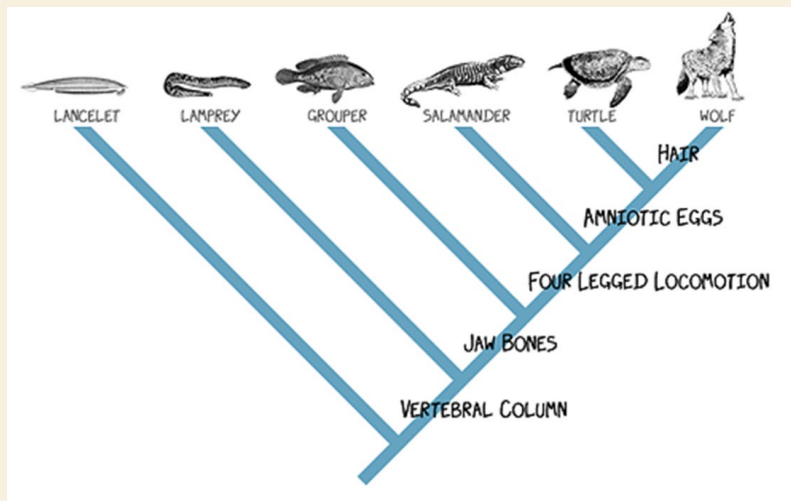
ACTIVITY 1 | MULLET DICHOTOMOUS KEY

- Use the key provided to label the different “mullet” hairstyles.
- Go with your gut on these. If it looks greasy, it is.
- Remember: it’s all business in the front, but a party in the back.

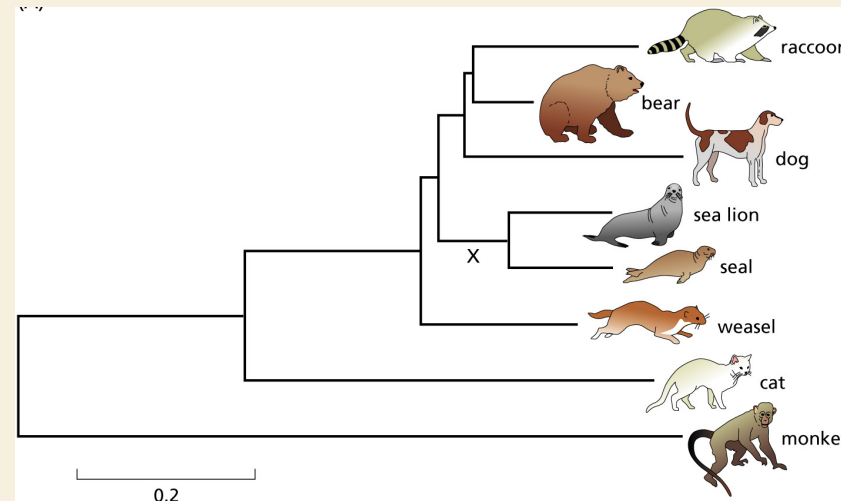


CLADOGRAMS

- Diagram showing how organisms are related based on shared, derived characteristics such as feathers, hair, or scales
- **Derived characteristic** is a trait that arose in the most recent common ancestor and was passed along to its descendants
- Cladograms are a type of *evolutionary tree* like **phylogenetic trees** except they do not estimate the time between the development of species.



cladogram



phylogenetic tree

VOCABULARY

- **Clade** Evolutionary branch of a cladogram that includes a single ancestor and all its descendants
- **Phylogeny** The evolutionary history of lineage. Represented via evolutionary trees.

Quick Question

15. Compare evolutionary trees, phylogenetic trees and cladograms.

CLADOGRAMS

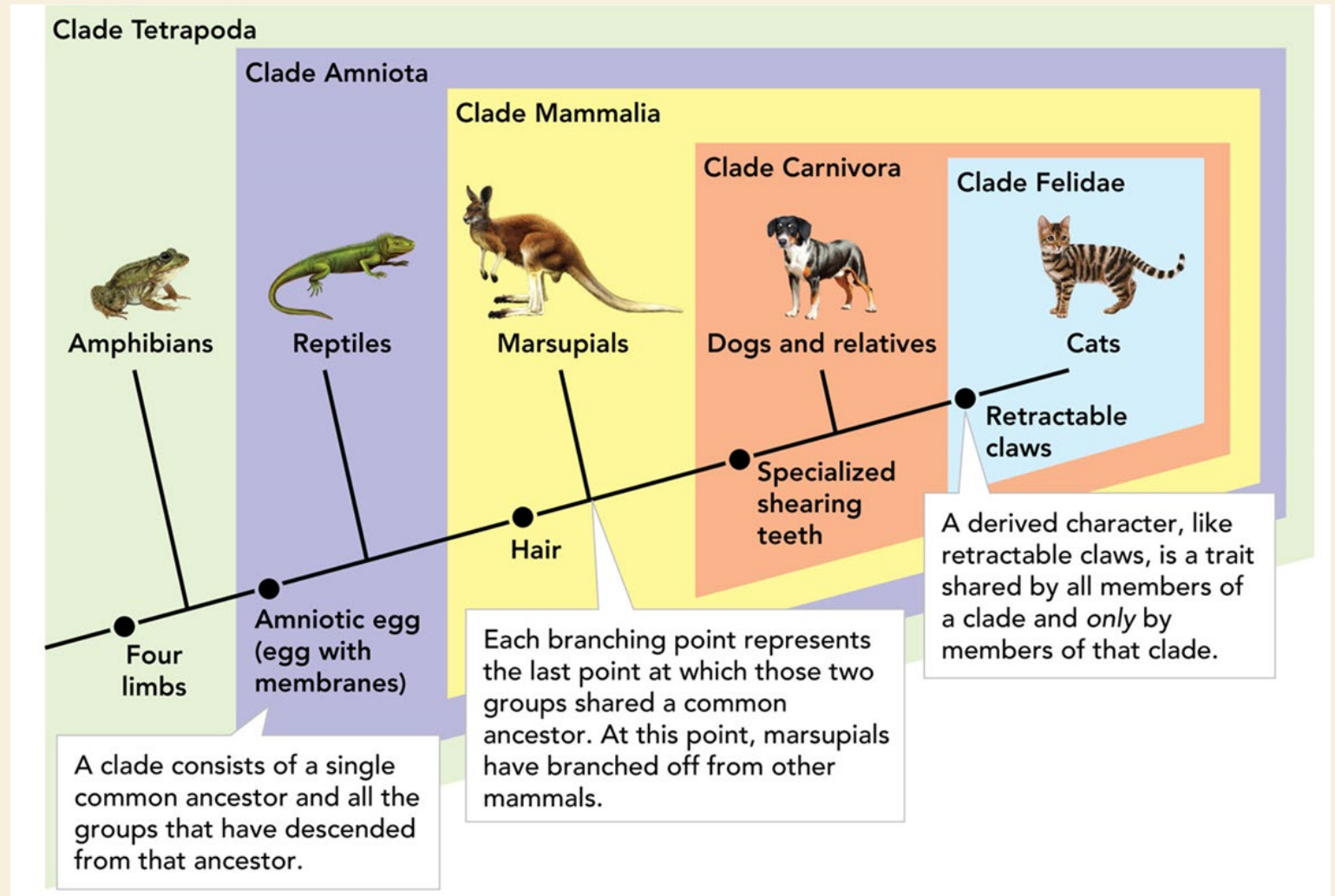
How to Read a Cladogram:

- Read left to right
- Organisms have the traits to the left of them

(i.e. reptiles have amniotic eggs AND four limbs)

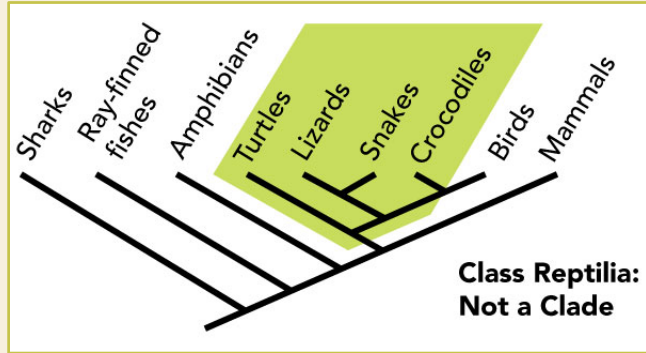
Quick Questions

16. What do cats have that dogs do not?
17. Do marsupials have all the same traits as reptiles and amphibians? What do they have that is different?
18. What clade are amphibians apart of?

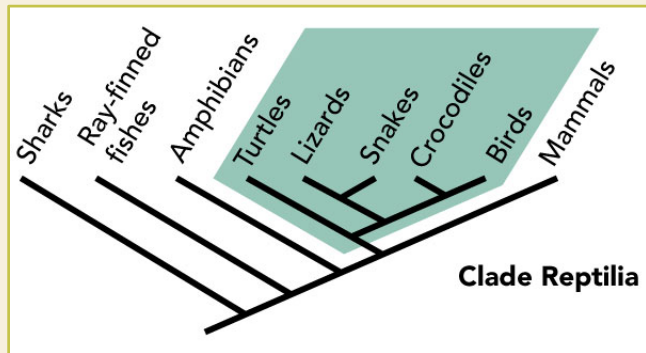


CLADOGRAMS

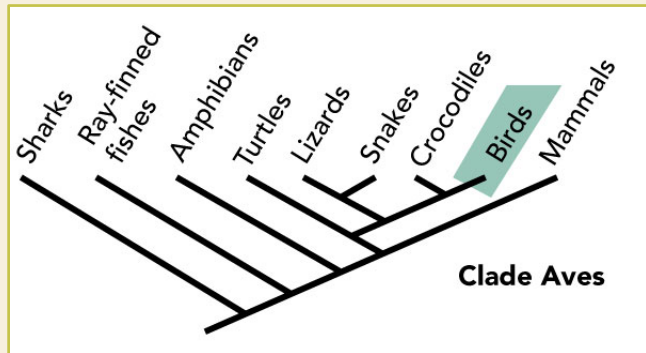
A



B



C



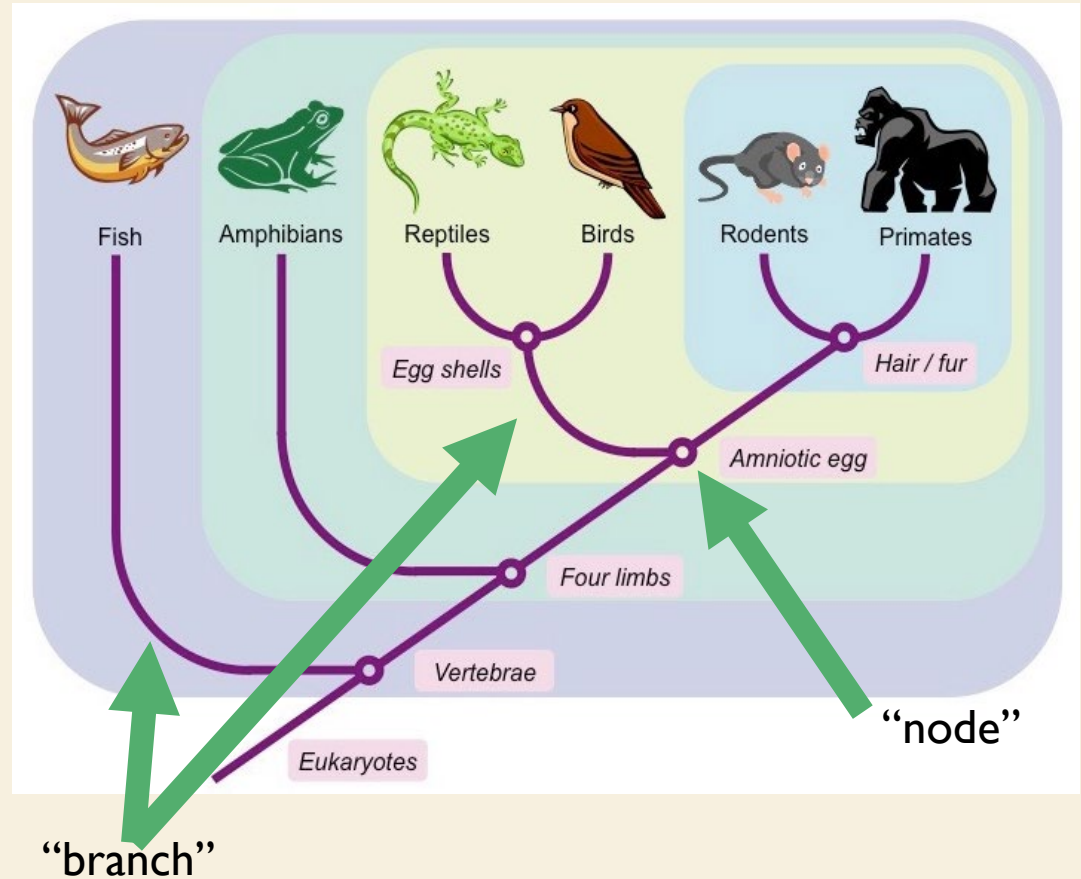
Quick Questions

19. Why does diagram A not represent a clade while diagram B does?
20. Would lizards have the **same** derived traits as mammals?

CLADOGRAMS

How to Read a **Branching** Cladogram :

- *Remember:* Read left to right and organisms have the traits to the left of them
- Branching cladograms include more information where a linear cladogram does not
- Example:
 - BOTH the reptile/birds group AND rodents/primates group HAVE amniotic eggs (both fork from that node)
 - HOWEVER reptiles and birds have egg shells while rodents and primates have hair/fur



ACTIVITY 2 | CLADOGRAMS

- Complete the handout provided in your packet.
- If you have any questions, please ask.

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ANSWER KEY

QUICK QUESTIONS
& STUDY GUIDE QUESTIONS

QUICK QUESTIONS

1. All the “bears” with Ursus are closely related (same Genus), Koala is a misnomer and not a bear at all, so least related.
2. Like the koala, common names don’t accurately describe the organism and it’s relationship to other organisms. Plus, there can be many common names for a single species.
3. The organisms are removed from the pyramid as you move up because they are not apart of that taxon. Like the seastar, it is in the phyla Echinodermata meaning “*spiny skin*”, these animals do not have a notochord or backbone.
4. 7
5. Kinky – Patty – Came – Over – For – Great – Spaghetti
6. Cell type, nucleus (eukaryote) or no nucleus (prokaryote)
7. Kingdom
8. As technology developed, we understood that newly discovered organisms were different than plants and animals, thusly have just the two kingdoms wasn’t an accurate representation of their relationships.
9. 6
10. DNA sequencing / genetic testing

QUICK QUESTIONS

- 11. Groups could be reorganized, removed, divided and new groups created
- 12. Jellyfish
- 13. Sea anemone
- 14. Comb
- 15. Evolutionary tree: shows evolutionary relationships between species, phylogenetic tree: type of evolutionary tree but estimates the amount of time between the speciation of a new organism, cladogram: type of evolutionary tree that shows the development of derived characteristics
- 16. Retractable claws
- 17. Yes, hair
- 18. Tetrapoda
- 19. Diagram A doesn't include the entire fork (with birds) while B does.
- 20. Yes, and then some.

Remember: fork = branches (lines) and the node (point where both branches meet)

REVIEW TOPICS

**PREVIOUS BIOLOGY TOPICS ALREADY
COVERED**

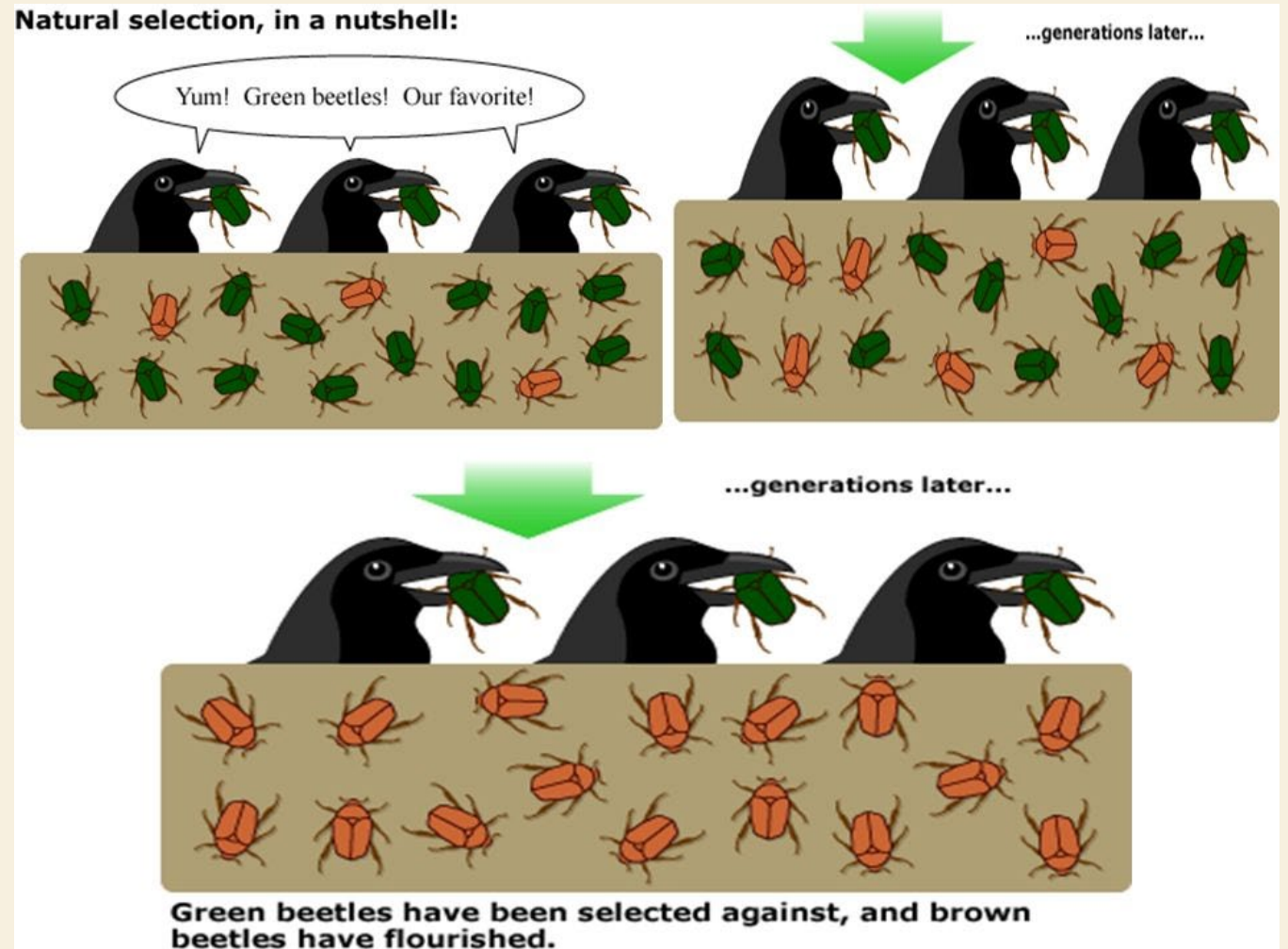


EVOLUTION

PHYLOGENETIC TREES, HOMINID
EVOLUTION AND ORIGIN THEORIES

NATURAL SELECTION

- Process where organisms in nature with variations most suited to their environment survive and make more offspring



EVIDENCE OF EVOLUTION

I. Fossil Record

- The fossil record reveals a history of the types of organisms that have lived on Earth (including those that are extinct) and the ages of those fossils



EVIDENCE OF EVOLUTION

2. Biogeography

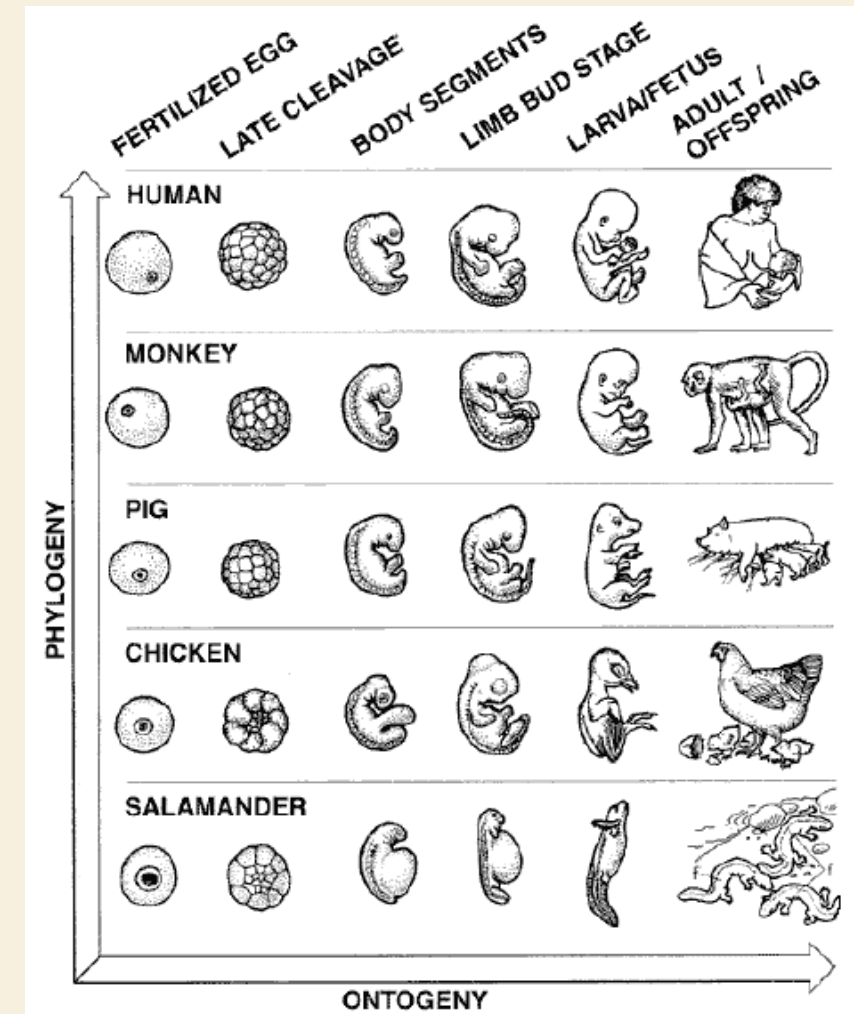
- Island species most closely resemble the nearest mainland species (not the species on similar islands on the other side of the ocean)



Florida Gopher Tortoise



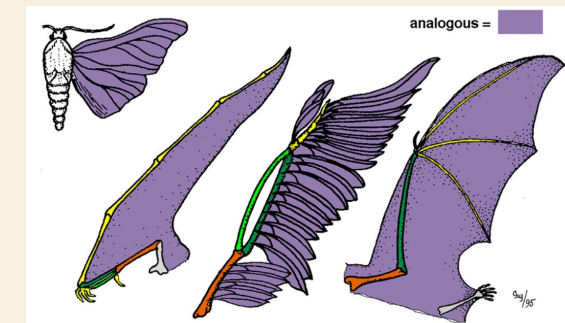
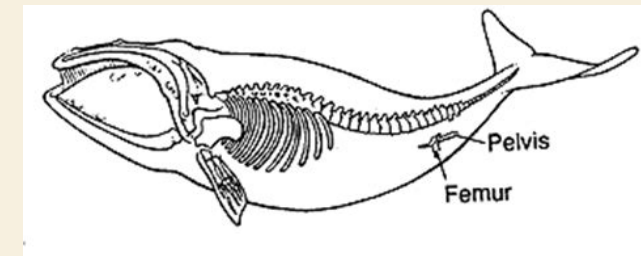
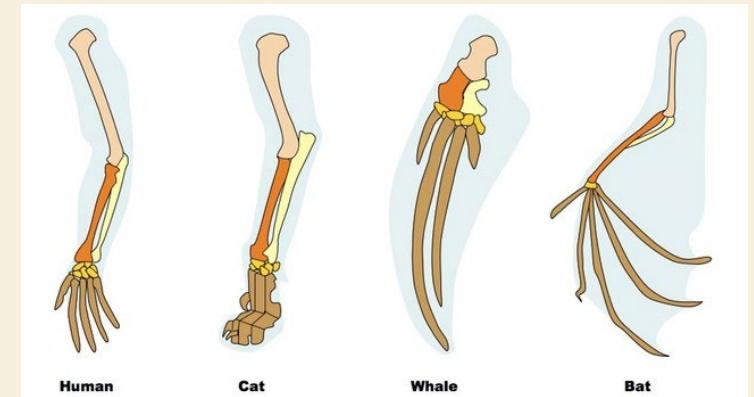
Galapagos Tortoise



EVIDENCE OF EVOLUTION

4. Comparative Anatomy

- **Homologous Structures** - similar characteristics resulting from common ancestry.
 - Same structure, different function
 - The greater the numbers of shared structures between two species, the more closely the species are related.
- **Vestigial Organs** - structures with little or no function to the organism.
 - Remnants of structures that had important functions in ancestors of the species.
 - Ex. Ostrich's have wings but can't fly
- **Analogous structures**: similar function, different structure
 - Evolved similar structures due to living in similar environments, not due to ancestral relatedness



EVIDENCE OF EVOLUTION

5. Biochemistry

- DNA and Proteins: Comparing similarities in the DNA and A.A. sequences in different species to find common ancestry
- Two closely-related organisms will have similar DNA sequences.
- Represented using phylogenetic trees

DNA COMPARISON



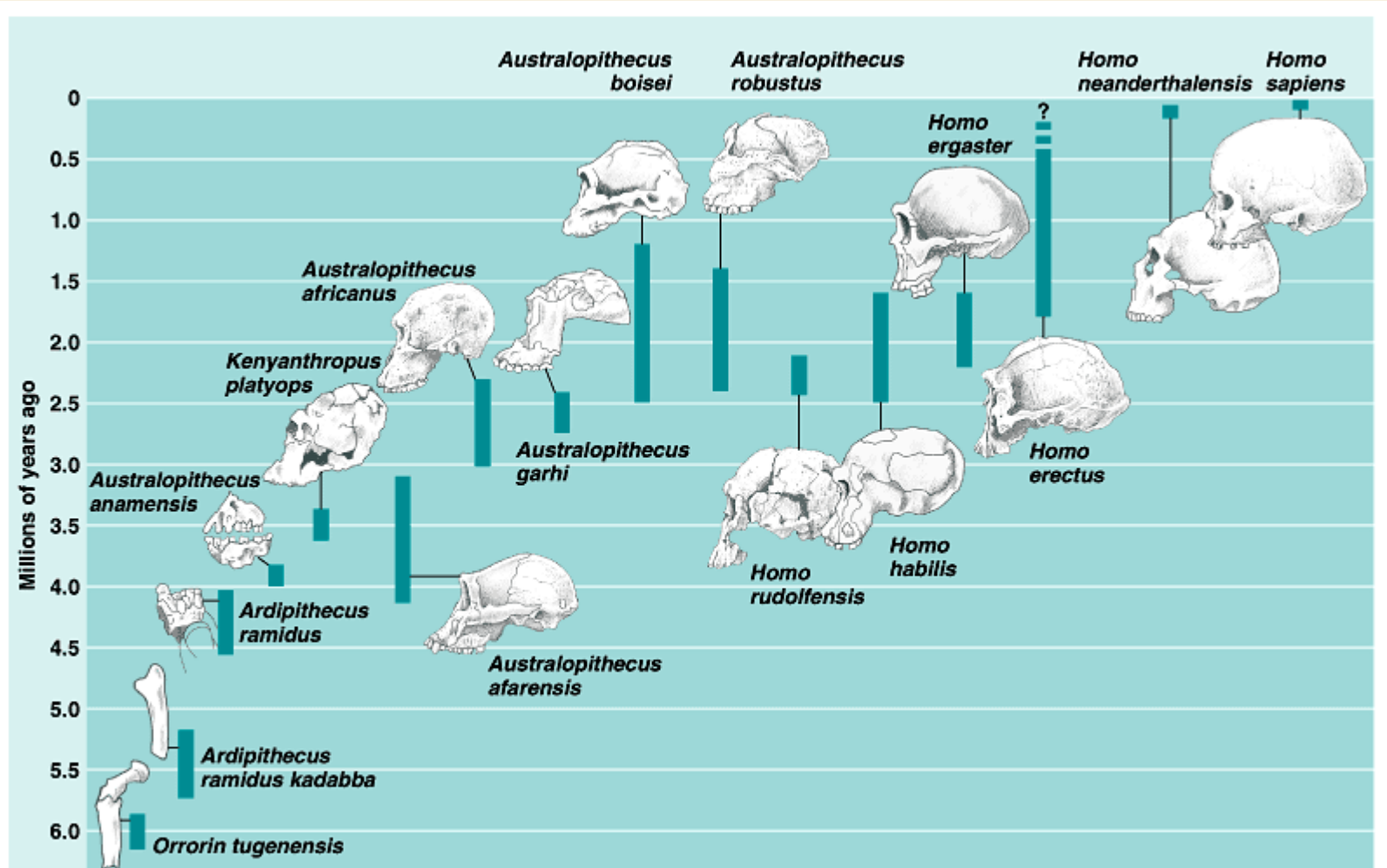
TCC TGGCA GTCCA GTGGT

CCC TGGCA GTGCA GTGCT



HOMINID EVOLUTION

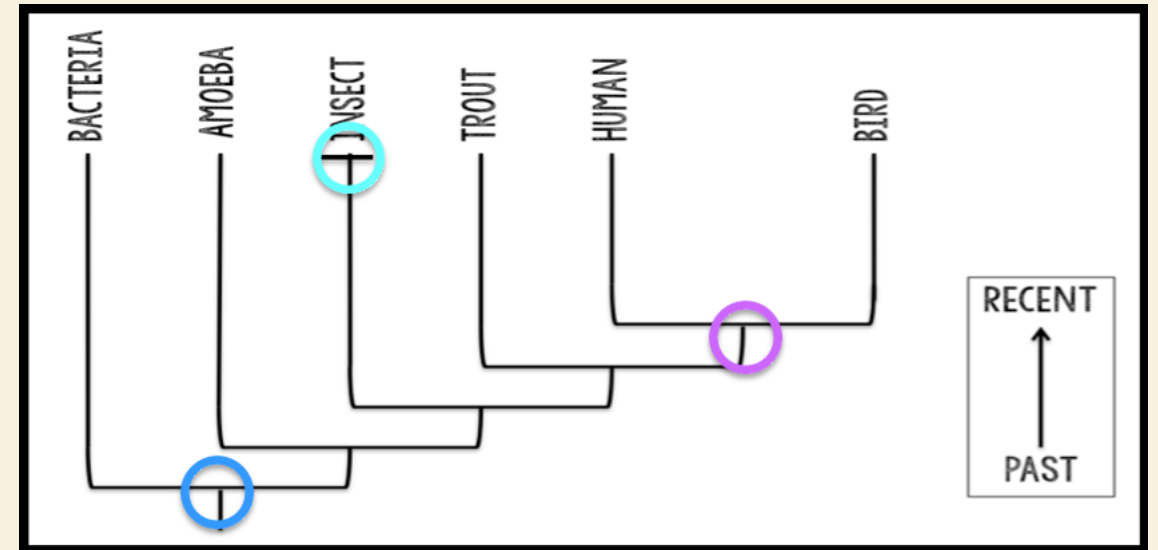
- Humans are the only living species in the genus
- Humans evolved to have:
 - bipedal locomotion
 - smaller jaw size
 - larger brain size
 - language



PHYLOGENETIC TREES

How to Read:

- Start from the “trunk” – this always represents a **common ancestor** that all organisms on the tree evolved from
- Each **node** represents a more recent common ancestor
- More branches an organism has, the further in relation it is from the common ancestor or another species





CELL DIVISION

MITOSIS AND MEIOSIS

OVERVIEW OF MITOSIS

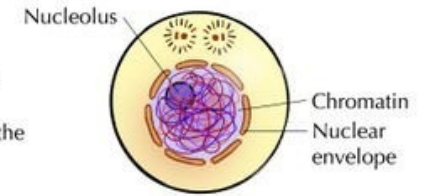
Key Concept	Answer
Why do cells undergo mitosis?	Growth, repair, and reproduction
What types of cells under go mitosis?	Diploid somatic or body
What is the resulting number of cells?	2
Are they genetically identical or unique?	identical
Do organisms use this type of cell division for asexual or sexual reproduction?	Asexual
How many individuals are necessary for asexual reproduction?	1
How many phases in mitosis?	4 see diagram

Stage

1

Interphase

The nucleolus and the nuclear envelope are distinct and the chromosomes are in the form of threadlike chromatin.



2

Prophase

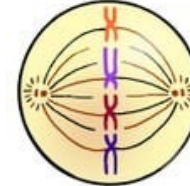
The chromosomes appear condensed, and the nuclear envelope is not apparent.



3

Metaphase

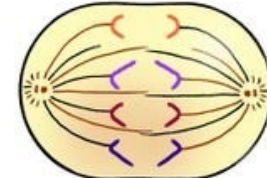
Thick, coiled chromosomes, each with two chromatids, are lined up on the metaphase plate.



4

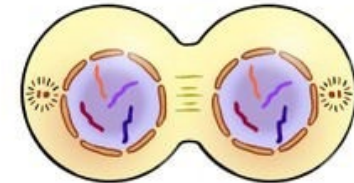
Anaphase

The chromatids of each chromosome have separated and are moving toward the poles.



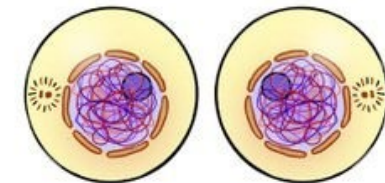
Telophase

The chromosomes are at the poles, and are becoming more diffuse. The nuclear envelope is reforming. The cytoplasm may be dividing.



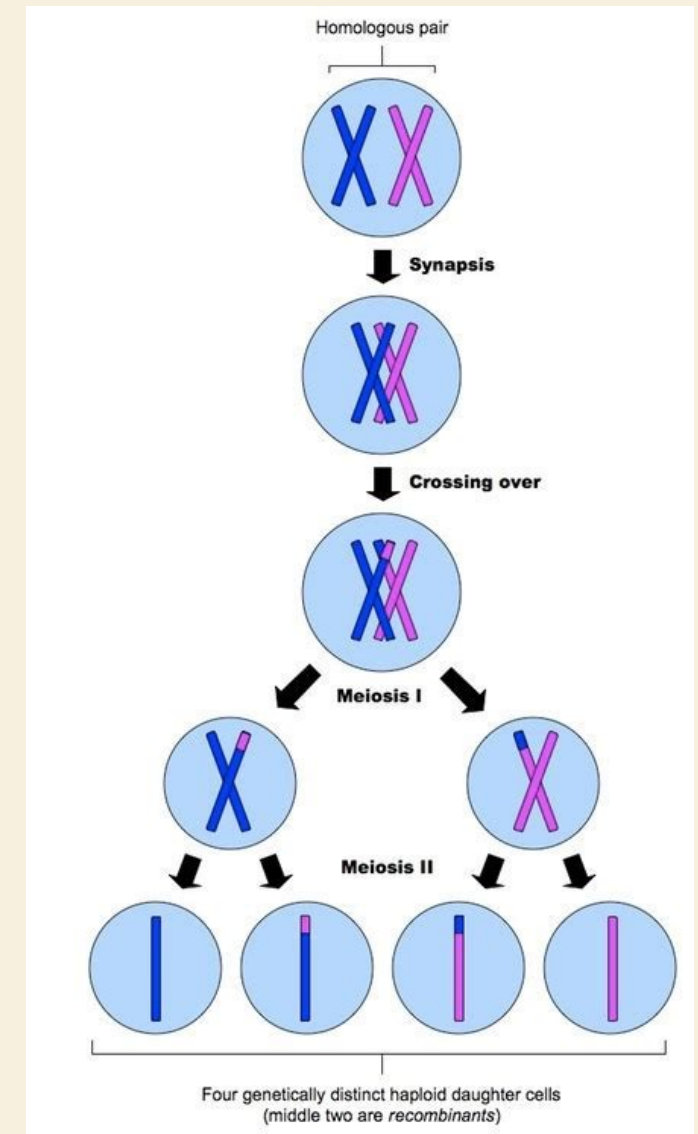
Cytokinesis (part of telophase)

Division into two daughter cells is completed.



OVERVIEW OF MEIOSIS

Key Concept	Answer
Why do cells undergo meiosis?	Produce haploid sex cells
What types of cells under go meiosis?	gametes
What is the resulting number of cells?	4
Are they genetically identical or unique?	unique
Do organisms use this type of cell division for asexual or sexual reproduction?	sexual
How many individuals are necessary for sexual reproduction?	2
How many phases in meiosis?	8 <i>see diagram</i>



MITOSIS

Duplicated chromosome with "sister" chromatids



chromosome replication

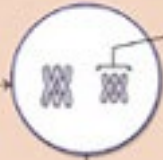


Parent Cell $2n = 4$
(before chromosome replication)

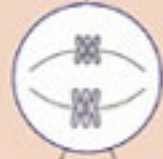
chromosome replication

MEIOSIS

tetrads are formed from homologous chromosomes and crossing over takes place



chromosome replication



Tetrads align at the metaphase plate and are separated by the microtubules into sister pairs.

MEIOSIS I



Homologous chromosomes separate during anaphase and sister chromatids remain together

Daughter Cells of Meiosis I

MEIOSIS II



Daughter Cells of Meiosis II

ANAPHASE & TELOPHASE

Chromosomes align at the metaphase plate and microtubules attach and equally separate DNA



Sister chromatids separate during anaphase



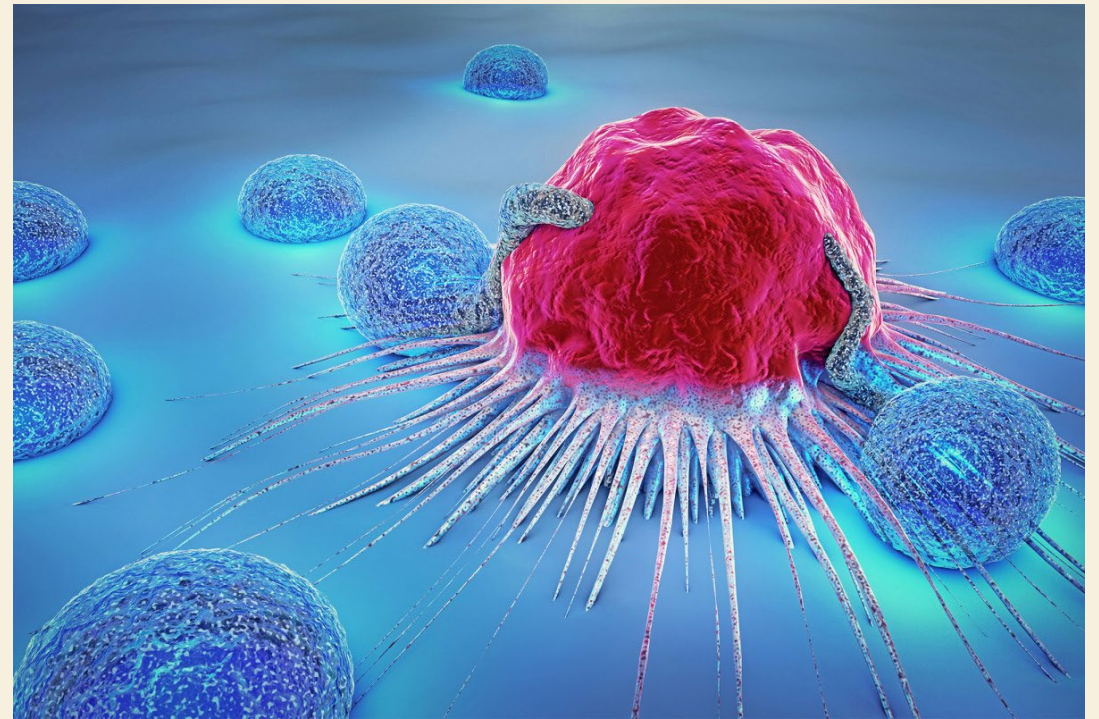
Daughter Cells of Mitosis
(after cell division)

* MITOSIS: Creates multicellular organisms from a zygote. It is the basis of all tissue growth and repair. Chromosome number is conserved.

* MEIOSIS: Produces sex cells by reducing their chromosome number by half. This is important because it creates genetic variability in the gametes.

CANCER

- Unregulated growth of a mutated cell.
- Cell has an error and isn't "checked" by the body, so it keeps dividing (mitosis)



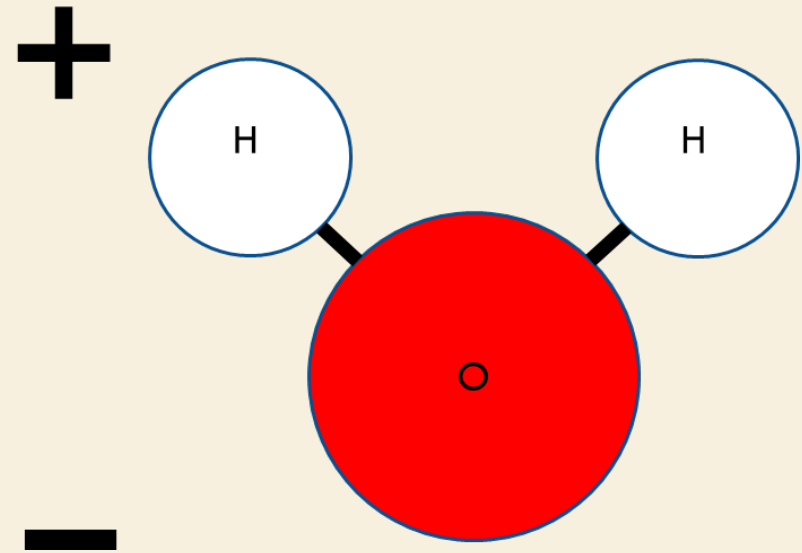
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PROPERTIES OF WATER

APART OF BIOMOLECULE UNIT

PROPERTIES OF WATER

- Water is a *polar* molecule (Mickey Mouse-shape) meaning it has a positive and negative end like a magnet
- This shape makes it “sticky” or good at *bonding* (attaching to other molecules)
- It’s polarity allows it to form *hydrogen bonds* which gives water special properties



PROPERTIES OF WATER

Property	Description	Example
Cohesion Adhesion	Water sticking to itself Water sticking to another polar molecule	<ul style="list-style-type: none">• Capillary action (plants or straws)• Water droplets forming on a glass
High specific heat	It requires a lot of energy to heat up water	<ul style="list-style-type: none">• Long time for a pot to boil• How some organisms regulate body temperature• Bodies of water (i.e. oceans and lakes) don't fluctuate in temperature quickly
Expands when freezes	When water cools and becomes ice or a solid, it's density is lower then when it was a liquid. It also expands or gets bigger	<ul style="list-style-type: none">• Ice floats• Soda can will burst if left to freeze in freezer
Universal Solvent	Water is able to dissolve or break down most other materials	<ul style="list-style-type: none">• Sugar goes away when you make Kool-Aide• Ocean is salty

Name _____ Period _____

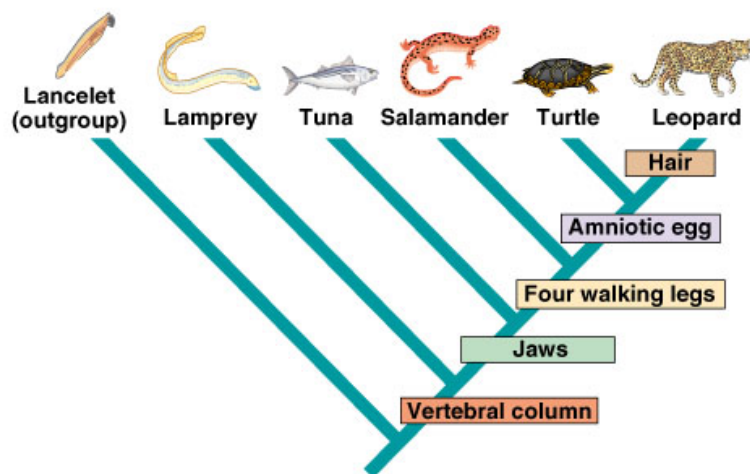
Teacher _____

Biology Unit Packet

Unit 9 Classification

CHARACTERS	TAXA					
	Lancelet (outgroup)	Lamprey	Tuna	Salamander	Turtle	Leopard
Hair	0	0	0	0	0	1
Amniotic (shelled) egg	0	0	0	0	1	1
Four walking legs	0	0	0	1	1	1
Jaws	0	0	1	1	1	1
Vertebral column (backbone)	0	1	1	1	1	1

(a) Character table

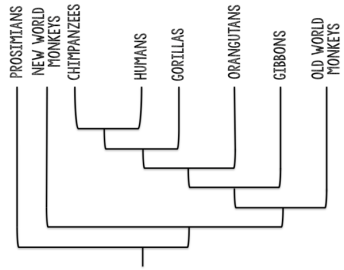
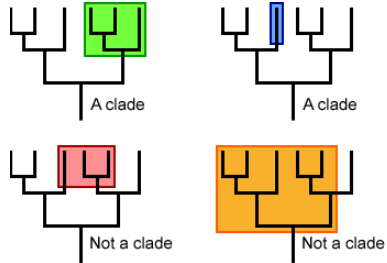


(b) Cladogram

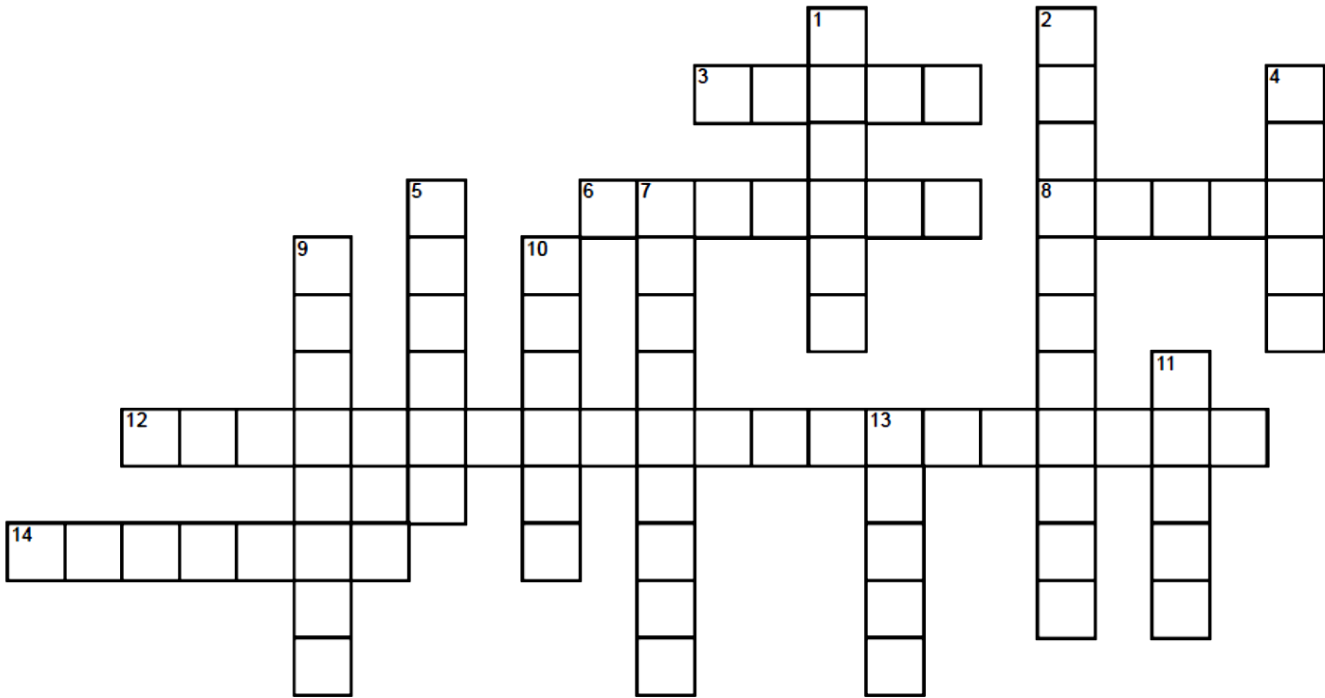
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Assignment Checklist

✓	Assignment	Points/Category	Due Date
	Vocabulary Activity		Friday, 24 April 2020
	Guided Lecture Notes		
	Activity 1		
	Activity 2		
	Open-Note Test		
	<i>Bonus Activity</i>		

Unit 9 Classification Vocabulary			
Word	Definition	Example(s)	
Taxonomy	A system of naming and classifying organisms based on shared characteristics and universal rules.	<i>Root Words</i> <i>taxis</i> “arrangement” <i>nomos</i> “law”	
Binomial nomenclature	A naming system developed by Carolus Linnaeus where each species is assigned a two-part scientific name.	<i>Homo sapien</i>	
Systematics	The science of naming and grouping organisms whose goal is to put living things into groups that have biological meaning.	---	
Taxon	(plural: taxa) a more general term for group or level of organization into which organisms are classified	African elephants form the genus <i>Loxodonta</i> , a widely accepted taxon.	
Phylogeny	The evolutionary history of lineage. Represented via phylogenetic or evolutionary trees.		
Clade	Evolutionary branch of a cladogram that includes a single ancestor and all its descendants		
Species	(Plural: species) A group of similar organisms that can breed and produce fertile offspring	<u>Humans</u> <i>Homo sapien</i>	<u>Camel</u> <i>Camelus bactrianus</i>
Genus	(Plural: genera) a group of similar species. Second of the species name usually refers to an important trait or habitat	<i>Homo</i>	<i>Camelus</i>
Family	In classification, a group of similar genera.	<i>Hominidae</i>	<i>Camelidae</i>
Order	In classification, a group of closely related families.	<i>Primate</i>	<i>Artiodactyla</i>
Class	In classification, a group of closely related orders.	<i>Mammalia</i>	<i>Mammalia</i>
Phylum	In classification, a group of closely related classes.	<i>Chordate</i>	<i>Chordate</i>
Kingdom	Largest and most inclusive group in Linnaean classification.	<i>Animalia</i>	<i>Animalia</i>
Domain	Larger, more inclusive taxonomic category than a kingdom.	<i>Eukaryota</i>	<i>Eukaryota</i>

Unit 9 Vocabulary Activity



ACROSS

- 3 Evolutionary branch of a cladogram that includes a single ancestor and all its descendants
- 6 Organisms that are able to make babies that make babies with one another.
- 8 Sharks are in the class Chondrichthyes, in general that would be the sharks' _____.
- 12 Means to have a name with "two" parts
- 14 Largest and most inclusive group in Linnaean classification.

DOWN

- 1 Always end in "dae"
- 2 The science of naming and grouping organisms whose goal is to put living things into groups that have biological meaning.
- 4 *Homo* is the ____ for humans.
- 5 Broadest classification based on your cell types.
- 7 The evolutionary history of lineage. Represented via phylogenetic or evolutionary trees.
- 9 A system of naming and classifying organisms based on shared characteristics and universal rules
- 10 Examples include porifera, cnideria, chordata, and mollusca.
- 11 In classification, a group of closely related families.
- 13 The classification level "Chondrichthyes" for sharks.

Unit 9 Classification | Guided Lecture Notes

Key Words & Questions

I. Introduction | *Species and their Organization*

Earth's Species

A group of similar organisms that can breed and produce fertile offspring

- Total number of **species** is estimated to be between 8 and 8.7 million
- Most are not studied or documented
- It may take over 1000 years to fully catalogue them all

Classification

Classification

- *is the arrangement of organisms into orderly groups based on their similarities.*
- Classification is also known as **taxonomy**
- Based on evolutionary relationships from genetic testing (DNA sequencing)
- **Benefits of Taxonomy**

Naming Species

Scientific name

Common name

Binomial
nomenclature

Rules for Naming Species

Example:

Quick Questions

1. Who is most closely related? Who is not?
2. How could a common name make organizing species confusing?

II. Taxa

Classifying Groups

Taxon

Domain

Kingdom

- The first model of kingdoms just separated plants and animals
- As technology developed, so did the number of kingdoms

List the current
kingdoms

Domain	Bacteria	Archaea	Eukarya			
Kingdom	Eubacteria	Archaeobacteria	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 (carbohydrate like lobster shells)	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	Most multicellular; some green algae unicellular	Multicellular
Mode of Nutrition	Autotroph or heterotroph	Autotroph or heterotroph	Autotroph or heterotroph	Heterotroph	Autotroph	Heterotroph
Examples	<i>Streptococcus</i> , <i>E. coli</i>	Methanogens, halophiles	Amoeba, paramecium, slime molds, giant kelp	Mushrooms, yeasts	Mosses, ferns, flowering plants, conifers	Sponges, coral, worms, insects, mammals, birds, fish

Remaining Taxa

- .
- .

Candiru Example

Quick Questions

- Why do the organisms from the bottom not appear at the top?
- How many levels of organization are there?
- Can you create your own mnemonic for remembering the taxa order?
- What is the main/first characteristic that divides the domains?
- What would be the next group or taxa an organism would be categorized in?
- Why would the taxa or number of groups change?
- How many kingdoms do we currently have?
- What current technology do scientists use to determine relationships between organisms?
- What could future discoveries mean for the organization and number of taxonomic groups?

III. Diagrams

Dichotomous Key

How to Read a Dichotomous Key

Cladogram

How to Read a Cladogram

Quick Questions

12. *Image ID* _____

13. *Image ID* _____

14. *Image ID* _____

15. Compare evolutionary trees, phylogenetic trees and cladograms.

16. What do cats have that dogs do not?

17. Do marsupials have all the same traits as reptiles and amphibians? What do they have that is different?

18. What clade are amphibians apart of?

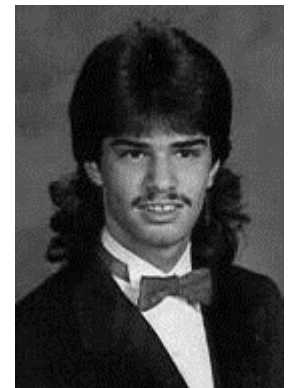
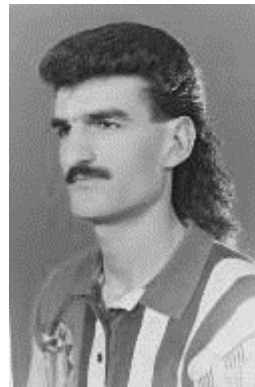
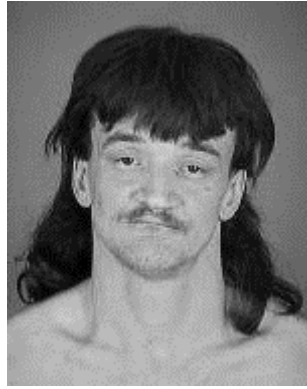
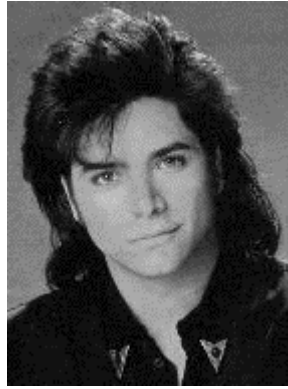
19. Why does diagram A not represent a clade while diagram B does?

20. Would lizards have the **same** derived traits as mammals?

Unit 9 Classification

Activity 1 | Mullet Dichotomous Key

Use the dichotomous key provided to identify the 9 sweet, sweet mullets below. This is practice for using a dichotomous key. Remember that this is solely based on physical characteristics and the descriptions within the key. Please write the name of the type of mullet on the line under the image.



Activity 1 | Mullet Dichotomous Key

Step	Characteristics	Result
1a	Short on top	Go to 2
1b	Swept back on top (<i>looks like a mullet, but isn't</i>)	<i>The Wuornos</i>
2a	Well defined mullet, definitely a mullet.	Go to 3
2b	Hard to see?	<i>The Unicorn</i> . Yes, this old lady had a glorious, glorious mullet
3a	Straight, whole thing is definitely straight	Go to 4
3b	Curly	Go to 5
4a	It has definitely been shampooed and styled	<i>Modern</i> . Why is it making a comeback?
4b	Don't touch it, you know they haven't	Go to 9
5a	The whole thing is curly	Go to 6
5b	Top is straight but back is curly	Go to 10
6a	Top looks like one solid piece	<i>90s Dad</i> . He's trying.
6b	It is not a helmet on top	Go to 7
7a	Definitely has product in it	<i>The Cube</i> . Everyone was doing it.
7b	Arguably doesn't have product or definitely not, look at that frizz.	Go to 8
8a	It's frizzy	<i>Lady Trucker</i>
8b	Under control	<i>80's Ladies Man</i>
9a	Image is from the back	<i>Euro Futbol Star</i>
9b	Image is from the front, definitely a mugshot	<i>The Breaking Bad</i>
10a	Mullet is all one shade of brunette	<i>The Dude</i> ...I'm totally graduating with this hair.
10b	Has some bleaching/blond in it	Go to 11
11a	Person also has earrings	<i>THE TIGER KING!</i>
11b	Person is wearing a necklace	<i>The Billy Ray</i> . It just hurts my achy breaky heart...

Unit 9 Classification

Activity 2 | Make a Cladogram

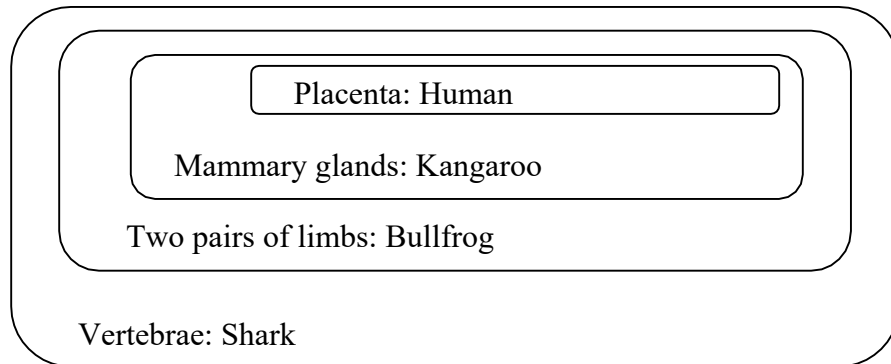
Cladograms are diagrams which depict the relationships between different groups of taxa called “clades”. By depicting these relationships, cladograms reconstruct the evolutionary history (phylogeny) of the taxa. Cladograms can also be called “phylogenies” or “trees”. Cladograms are constructed by grouping organisms together based on their shared derived characteristics.

Example

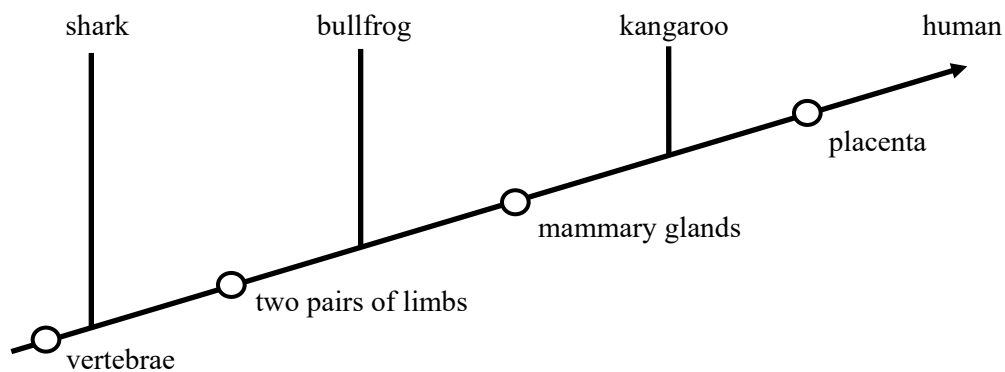
1. Given these characters and taxa:

Characteristics	Shark	Bullfrog	Kangaroo	Human
Vertebrae	X	X	X	X
Two pairs of limbs		X	X	X
Mammary glands			X	X
Placenta				X

2. Draw a Venn diagram. Start with the character that is shared by all the taxa on the outside. Inside each box, write the taxa that have only that set of characters.



3. Convert the Venn diagram into a cladogram like so:



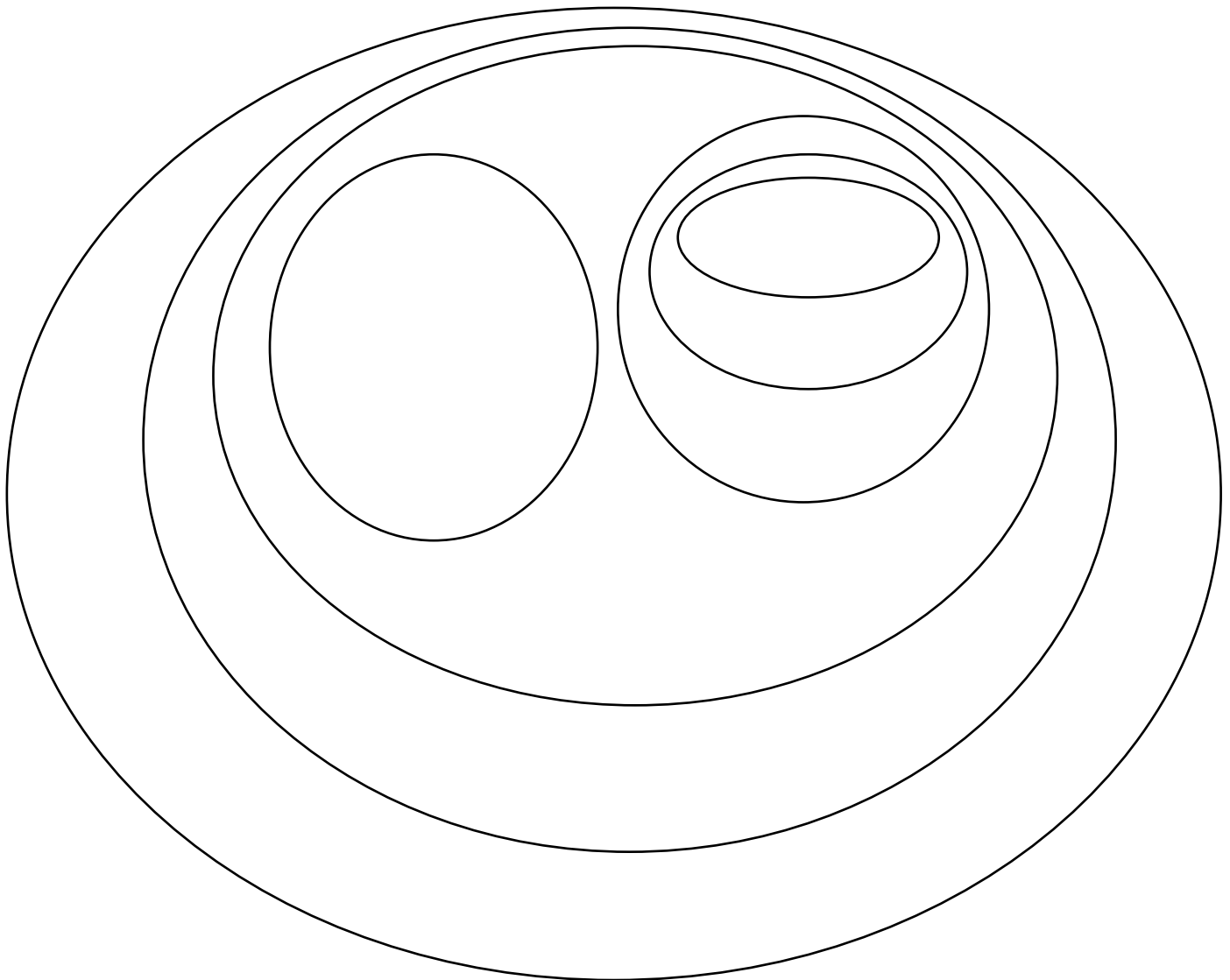
Activity 2 | Cladogram Worksheet

Convert the following data table into a venn diagram and then into a cladogram:

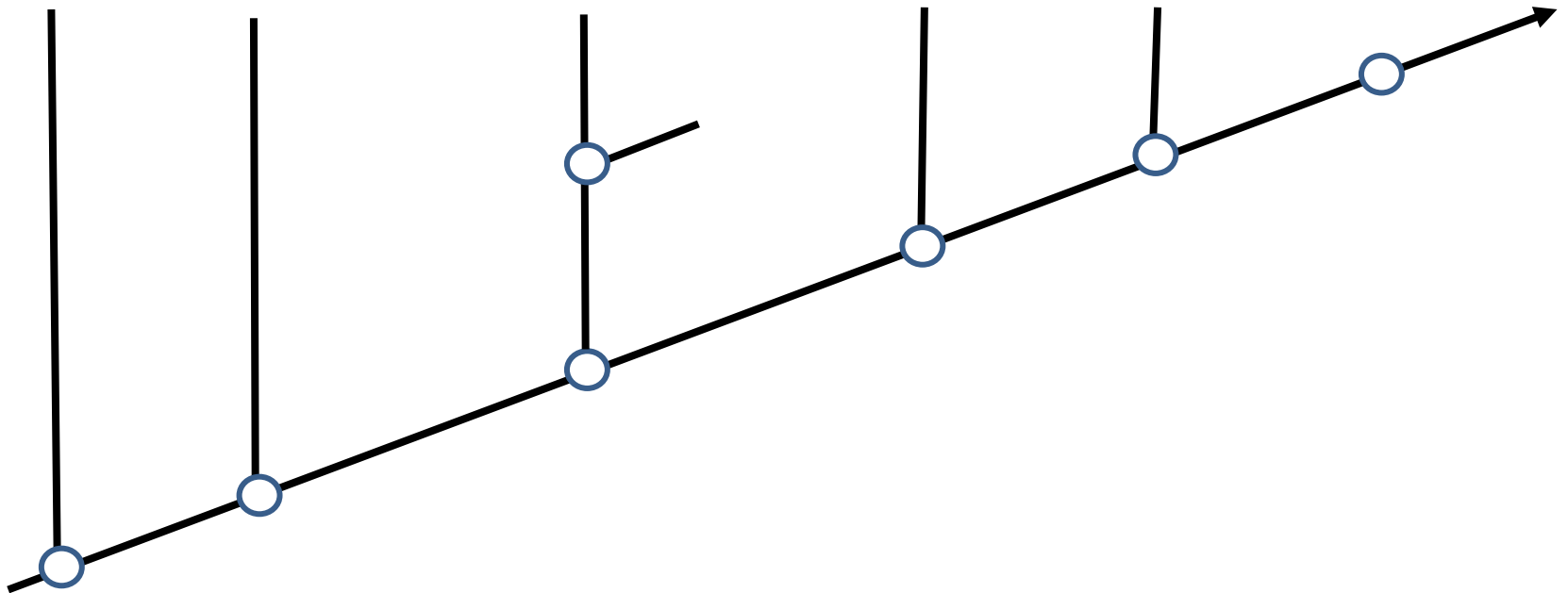
Characters	Jellyfish	Flatworm	Earthworm	Snail	Fruitfly	Sea Star	Human
Symmetry	X	X	X	X	X	X	X
Bilateral symmetry		X	X	X	X	X	X
Mesoderm			X	X	X	X	X
Head develops first			X	X	X		
Anus develops first						X	X
Segmented body			X		X		
exoskeleton					X		

Venn Diagram

The circles have been provided, make sure you are paying close attention to who has an "X" and who does not.



Cladogram



ZIPGRADE.COM

Name

Period

1

A

B

C

D

17

A

B

C

D

33

A

B

C

D

2

A

B

C

D

18

A

B

C

D

34

A

B

C

D

3

A

B

C

D

19

A

B

C

D

35

A

B

C

D

4

A

B

C

D

20

A

B

C

D

36

A

B

C

D

5

A

B

C

D

21

A

B

C

D

37

A

B

C

D

6

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D

22

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38

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30

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B

C

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31

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B

C

D

16

A

B

C

D

32

A

B

C

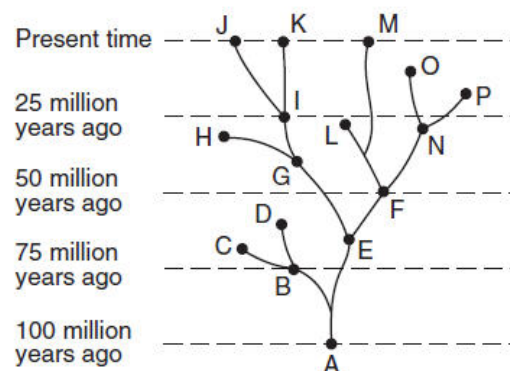
D

Unit 9 Test Classification (8926)

Unit 9 Test | Classification and Taxonomy

Please complete the open-notes test on Microsoft TEAMS- it is under the "Assignments" tab or print out the bubble sheet and complete with pencil then scan/photograph and submit with the rest of your packet.

- Organisms classified as fungi have unique characteristics. Which of the following characteristics is found only in organisms classified in the kingdom fungi?
 - single cells without a nucleus
 - multicellular with chloroplasts
 - multicellular filaments that absorb nutrients
 - colonies of single, photosynthetic cells that reproduce asexually
- The diagram below represents possible evolutionary pathways of certain organisms.



Which species is most closely related to species L?

- species E
 - species F
 - species G
 - species I
- Which kingdoms have photosynthetic organisms?
 - fungi and plants
 - protists and plants
 - fungi and protists
 - plants and animals
 - Some characteristics of a recently discovered organism are listed in the following table.

Based on the given characteristics, this organism would be classified in which kingdom?

- eubacteria
- fungi
- plantae
- protista

Organism Characteristics
Eukaryotic
Multicellular
Produces spores
Can reproduce sexually and asexually
Lacks chlorophyll
Non-motile

5. In 1990, Carl Woese introduced the three domain system for classifying living things, after the advancement of DNA analysis allowed for a comparison of species genetic code. Which of the following is the best explanation for why domains were added to the previous system of classification?
 - A. The old system of classification was wrong and needed to be corrected.
 - B. New species are evolving too quickly to keep up with the old system of classification
 - C. Domains have always been included, they were just made official recently.
 - D. Some organisms, which were previously characterized together, were determined to be genetically very different.

6. The levels of classification in order from LARGEST to smallest are:
 - A. genus, species, order, class, family, kingdom and phylum
 - B. kingdom, phylum, genus, species, order, family and class
 - C. kingdom, phylum, class, order, family, genus and species
 - D. phylum, class, family, species, kingdom, genus and order

7. Most often, the scientific name of an organism is in what language?
 - A. English
 - B. Latin
 - C. French
 - D. Spanish

8. Every organism is called by a two-word name representing it's?
 - A. genus and species
 - B. class and order
 - C. kingdom and phylum
 - D. family and genus

9. What is the correct way to show the scientific name of a lion?
 - A. *panthera leo*
 - B. *Panthera Leo*
 - C. *Panthera leo*
 - D. *panthera Leo*

10. In trying to classify a newly discovered organism, the following characteristics were noted: multicellular, specialized tissues and organs, chlorophyll-containing structures and cell walls. Into which kingdom should this organism be placed?
 - A. Fungi
 - B. Protista
 - C. Eubacteria
 - D. Plantae

11. The word taxonomy means to _____.
 - A. group
 - B. count
 - C. write
 - D. find things

12. A dichotomous key classifies things according to _____.
 - A. Latin origin
 - B. Breeding habits
 - C. Appearance
 - D. Habitat

13. Two animals belong to the same species if they _____.
 - A. look very similar
 - B. have similar food requirements
 - C. can produce fertile young
 - D. can live in a similar environment.

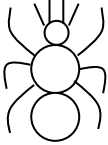
14. The first scientist to classify living things into two main groups was _____.
 - A. Hooke
 - B. Aristotle
 - C. Brown
 - D. Linnaeus

15. **Chart #1** is an example of a...

- A. Cladogram
- B. Dichotomous Key
- C. Family Tree
- D. Homology

Identify each of the following species by using the chart to the right, bubble the letter(s) in parenthesis beside the name.

16. Image A



17. Image B

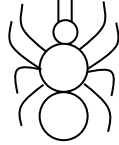


Chart #1

- | | | |
|----|----------------|----------------------------|
| 1. | a. Animal | go to # 2 |
| | b. Plant | <i>Botanis angelo</i> (AB) |
| 2. | a. Has legs | go to # 3 |
| | b. No legs | <i>Cutanius zambi</i> (AC) |
| 3. | a. 6 legs | go to # 4 |
| | b. 8 legs | <i>Cata torri</i> (AD) |
| 4. | a. No wings | go to # 5 |
| | b. 2 wings | <i>Fanis albany</i> (A) |
| 5. | a. Has Feelers | go to # 6 |
| | b. No Feelers | <i>Zachi usa</i> (B) |
| 6. | a. 2 Feelers | <i>Cornus pestus</i> (C) |
| | b. 4 Feelers | <i>Jacki jilli</i> (D) |

18. Which of the following is NOT one of the three domains?

- A. Bacteria
- B. Archaea
- C. Eukarya
- D. Monera

Using the six-kingdom classification system, identify the kingdom for each of the following organisms as:

- | | |
|---------------------|---------------|
| (A) Eubacteria | (D) Fungi |
| (B) Archaeobacteria | (AB) Plantae |
| (C) Protista | (AC) Animalia |



19. Tarpon
Megalops atlanticus



20. Chanterelle mushrooms
Cantharellus cibarius



21. Prickly Pear Cactus
Opuntia littoralis



22. Amoeba

23. A common ancestor and all its descendants make up a

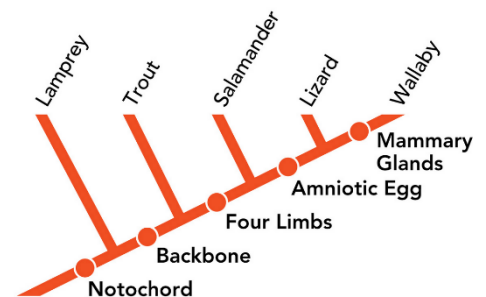
- A. Clade
- B. Domain
- C. Kingdom
- D. Order

24. The members of which domain are most apt to live in harsh habitats, such as volcanoes and hydrothermal vents?

- A. Archaea
- B. Bacteria
- C. Eukarya
- D. Monera

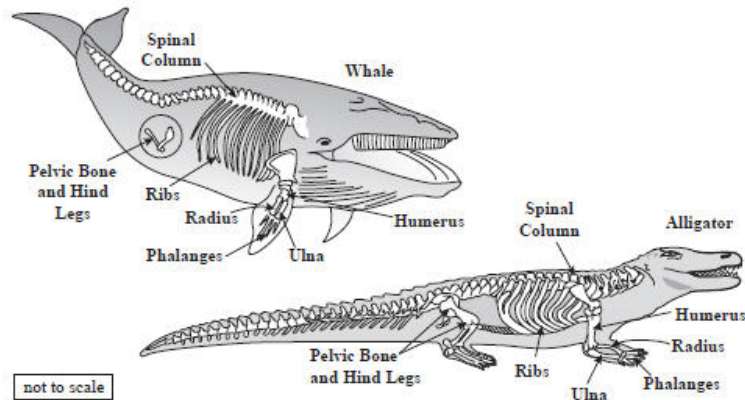
25. Of the characteristics listed in the cladogram, which do lizards and salamanders have in common?

- A. Mammary glands
- B. Amniotic egg
- C. Four limbs
- D. None of the above

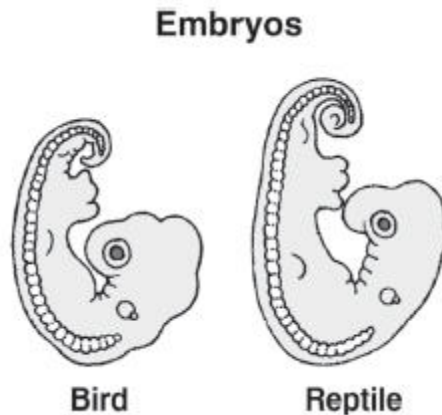


Review Section

26. The scientific theory of evolution is supported by different types of evidence. The diagrams below show the skeletons of two different animal species. How does comparing the skeletons of these animals provide support for the scientific theory of evolution?

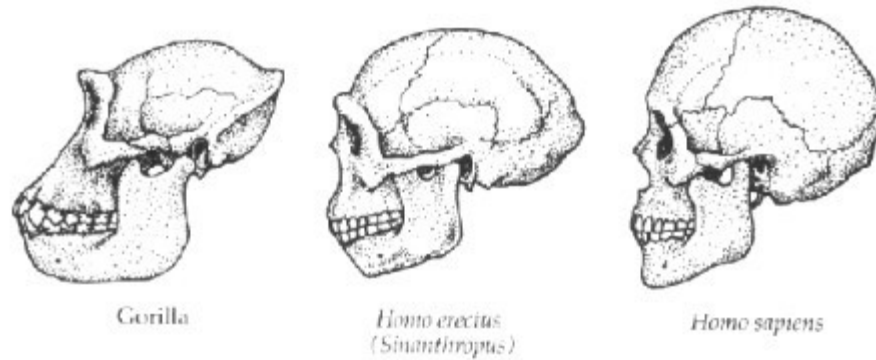


- A. It provides information about the organisms' habitats.
B. It shows possible common ancestry between organisms.
C. It provides information to determine the organisms' ages.
D. It shows possible chromosomal similarities between organisms.
27. According to fossil records, the horses that lived 50 million years ago were much smaller, weaker and slower than modern horses. Which process is most likely responsible for the changes that have led to the increased size, strength, and speed in horses?
- A. Commensalism
B. migration
C. inbreeding
D. evolution by natural selection
28. The diagram illustrates an embryonic stage of two organisms.



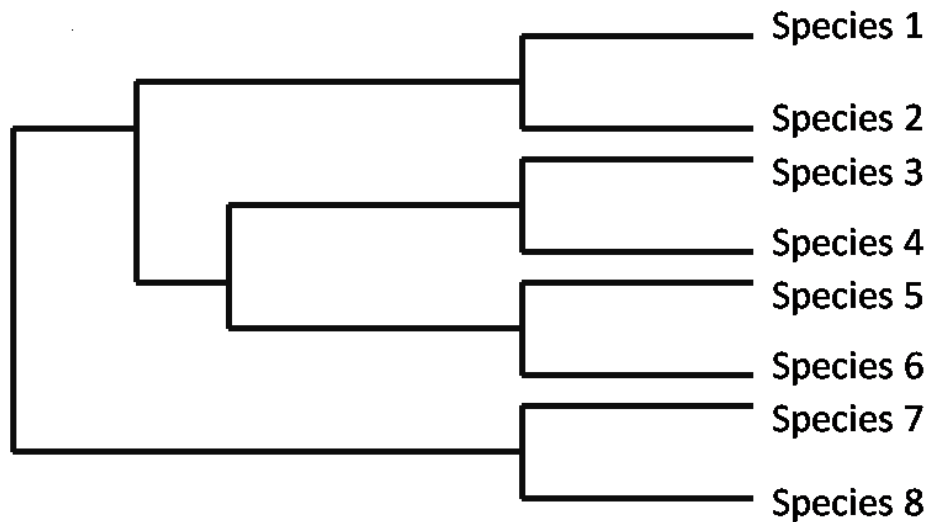
- Which of the following can be determined by observing the embryos shown in the diagram?
- A. The organisms share a common ancestry.
B. The organisms belong to the same genus.
C. The organisms are native to the same geographic areas.
D. The organisms will grow into anatomically similar adults.

29. Scientists have found evidence that about 2.4 million years ago a gene regulating jaw muscles mutated and may have led to the more graceful human jaw we see today. The diagram below shows the skulls of 3 hominid species.



Which statement below most closely explains the link between jaw size and hominid evolution?

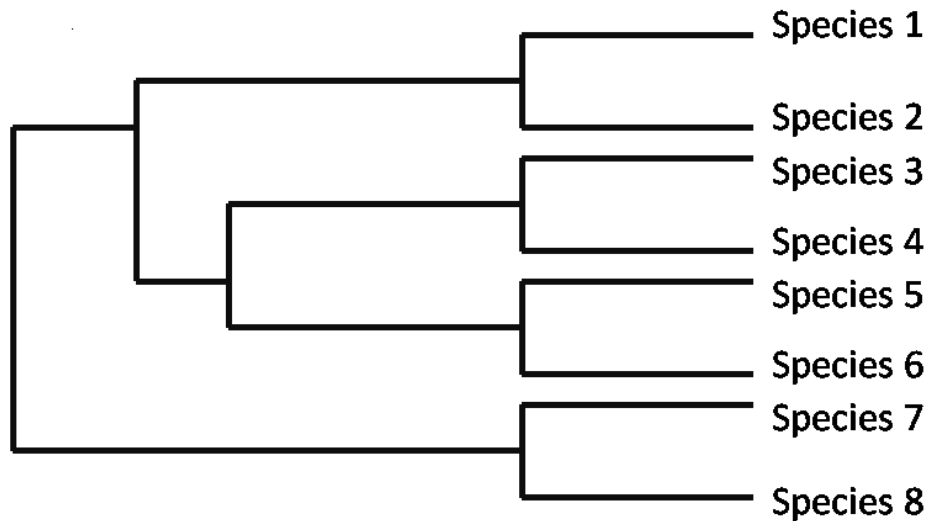
- A. The jaws of hominids evolved to be smaller and less protruding over time.
 - B. The jaws of hominids evolved to be larger and more protruding over time.
 - C. There appears to be no change in the jaws of hominids over time.
 - D. The jaws of hominids changed over time due to a change in brain size.
30. Scientists are studying the evolutionary history of a group of plants in the United States, and they developed an evolutionary tree, as shown below.



Which statement can be inferred from the evolutionary tree?

- A. Species 1 is least closely related to Species 8.
- B. Species 2 is most closely related to Species 3.
- C. Species 3 is most closely related to Species 7.
- D. Species 5 is least closely related to Species 6.

31. Scientists are studying the evolutionary history of a group of plants in the United States, and they developed an evolutionary tree, as shown below.



What information about the organisms' best helps the scientists to determine the evolutionary relationships among them?

- A. DNA sequences
 - B. Anatomical features
 - C. Habitat types
 - D. Reproductive Strategies
32. Mitosis and meiosis are processes involved in cellular reproduction. Which of the following describes an event that results from mitosis but NOT meiosis?
- A. two stages of cell division
 - B. replication of cellular genetic material
 - C. daughter cells that are identical to the parent cell
 - D. four daughter cells that are produced from each parent cell
33. How are sexual reproduction and asexual reproduction different from each other?
- A. sexual reproduction requires two parents and asexual reproduction requires only one parent
 - B. asexual reproduction requires two parents and sexual reproduction requires only one parent
 - C. mutation rates are lower in sexual reproduction than in asexual reproduction
 - D. asexual reproduction occurs only in multicellular organisms
34. Which type of reproduction leads to increased genetic variation on a population?
- A. Parthenogenesis
 - B. Sexual reproduction
 - C. Asexual reproduction
 - D. Vegetative reproduction
35. Which of the following phrases best describes cancer?
- A. absence of cyclins in the DNA
 - B. multiple gene mutations on a chromosome of DNA
 - C. uncontrolled cell growth caused by mutations in genes that control the cell cycle
 - D. presence of genetic defects caused by hereditary disorders

36. Which of the following phases of mitosis is represented by the diagram below?



- A. Prophase B. Metaphase C. Anaphase D. Telophase

37. A scientist wants to change the DNA of a sexually reproducing organism and have the new DNA present in every cell of the organism. In order to do this after fertilization, she would change the DNA in which of the following?

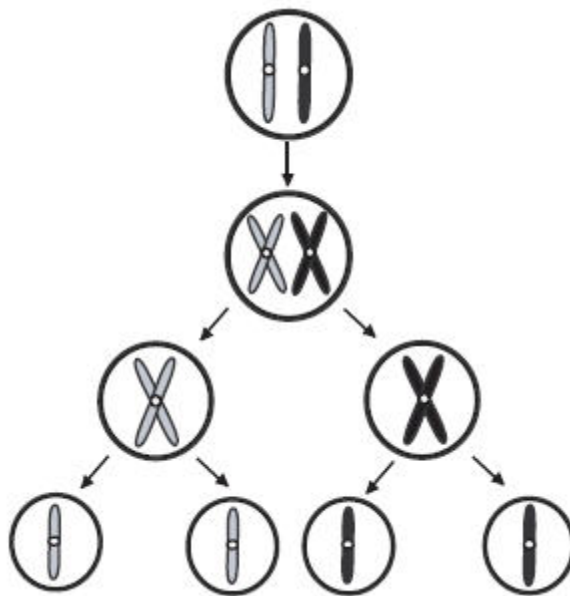
- A. Zygote C. Placenta
B. testes of the father D. ovaries of the mother

38. Which row in the chart below indicates the correct process for each event indicated?

Row	Formation of Egg	Formation of Sperm	Growth of Embryo
(1)	mitosis	mitosis	meiosis
(2)	mitosis	meiosis	mitosis
(3)	meiosis	mitosis	meiosis
(4)	meiosis	meiosis	mitosis

- A. row 1 B. row 2 C. row 3 D. row 4

39. The diagram below shows a cellular process that occurs in organisms.

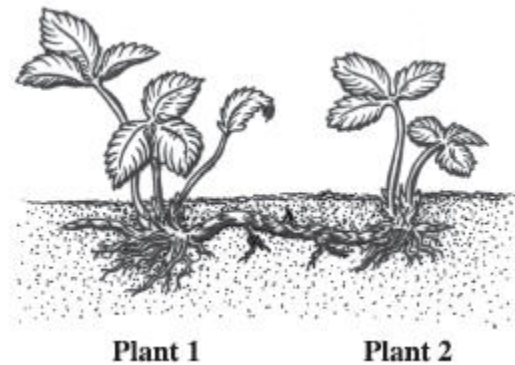


What is the name of this process?

- A. Meiosis B. Mitosis C. Endocytosis D. Phagocytosis

40. Which of the following best describes meiosis?
- A. It is carried out in all tissues that require cell replacement.
 - B. It occurs only in cells in the reproductive structures of organisms.
 - C. It happens in all tissues except the brain and spinal cord.
 - D. It is the first stage of mitosis.

41. The diagram below shows two strawberry plants.

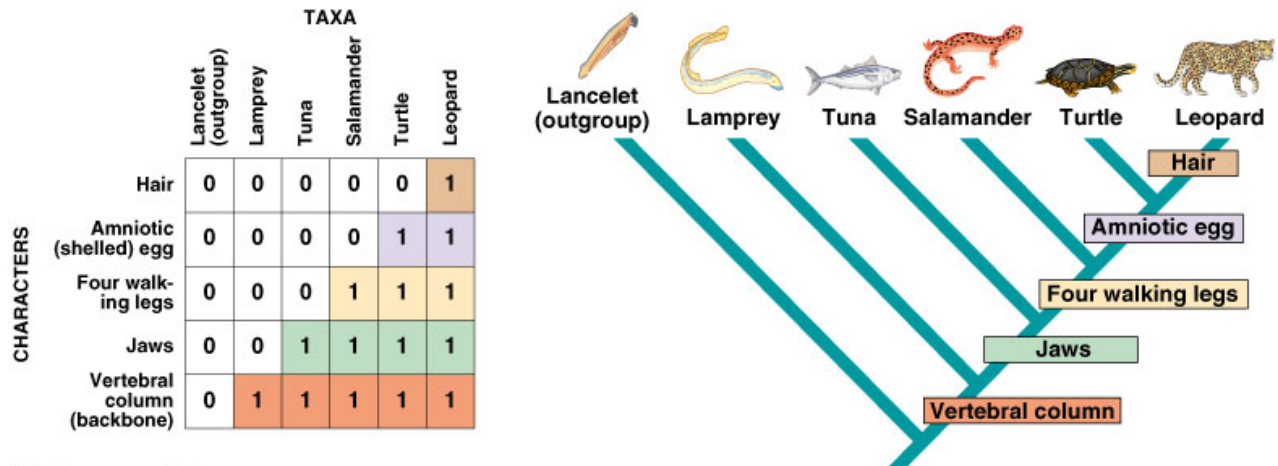


Plant 2 is produced asexually from Plant 1. If the leaf cells of Plant 1 have 56 chromosomes, how many chromosomes will be found in the leaf cells of Plant 2?

- A. 14
 - B. 28
 - C. 56
 - D. 112
42. Water is essential for life. Its special properties make water the single most important molecule in plant life. Which of the following properties of water enables it to move from the roots to the leaves of plants?
- A. Water expands as it freezes.
 - B. Water is an excellent solvent.
 - C. Water exhibits cohesive behavior.
 - D. Water is able to moderate temperature.
43. Large bodies of water, such as lakes and oceans, do not quickly fluctuate in temperature. What is the reason for this phenomenon?
- A. Water is an acid.
 - B. Water is a versatile solvent.
 - C. Water has a high heat capacity.
 - D. Water acts as a buffer.
44. Why does ice stay at the top of oceans instead of sinking to the bottom?
- A. Ice is colder than liquid water.
 - B. Ice is less dense than liquid water.
 - C. Ice is more dense than liquid water.
 - D. Ice is warmer than liquid water.
45. Water is often called the "universal solvent" because many substances can be dissolved in water. What property of water allows it to be such a versatile solvent?
- A. purity
 - B. polarity and cohesion
 - C. high heat capacity
 - D. expansion upon freezing

Unit 9 Classification | Bonus Activity

Points will be distributed as your biology teacher sees fit.



Answer the following questions based on the diagrams provided above:

1. What type of diagram is depicted above?
2. Does this type of diagram say that the leopard is a *better* species than a lancelet?
3. What trait does the lamprey have that the lancelet does not?
4. What traits do leopards and turtles share that tuna do not?
5. Jaws are not a trait for which organism(s)?
6. Hair is a unique trait for what organism(s)?