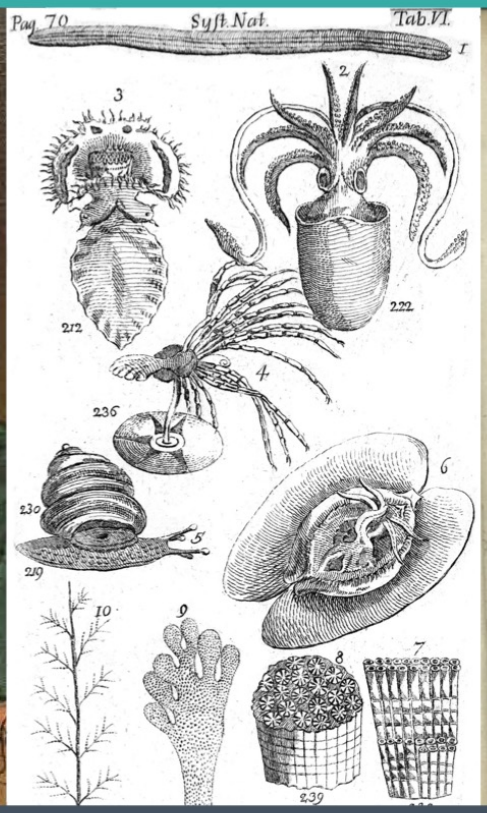
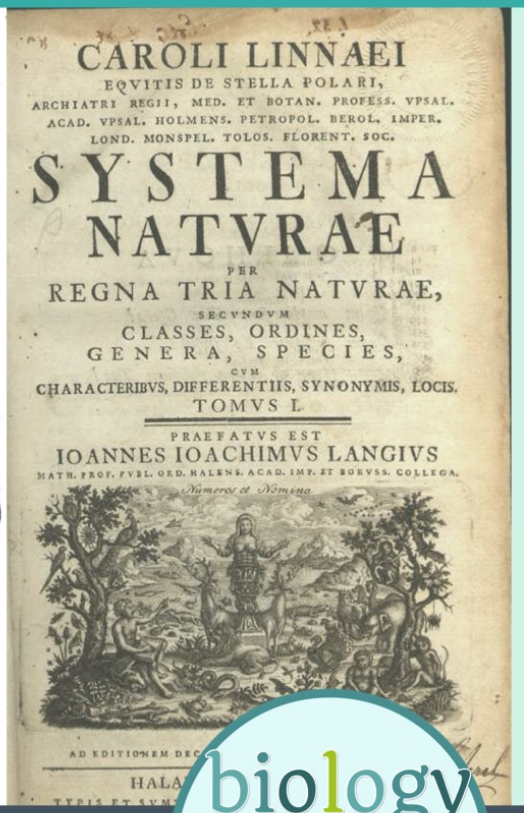
classification
Complete Bundle







POWERPOINT, TASK CARDS, LABS, PROJECTS, PLUS MORE

biology roots

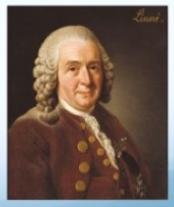
- Grades 7 and up
- Comes with its own unit planner to use as a guide
- Includes assessment- including quiz, test and "I have Who Has" review game.
- Everything you need to teach classification!

POWERPOINT PRESENTATION- 60 SLIDES- COMPLETELY EDITABLE

WHAT'S IN A NAME?

Scientists have a system for naming all the living organisms on earth.

- The system was created by a Swedish scientist named Carolus Linnaeus
- Developed over 200 years ago
- Linnaeus designed Binomial Nomenclature

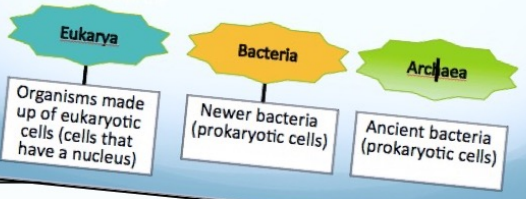


Bi= two Nomial= name

Domains

A domain is the most general type of classification (primarily based on cell type)- domains are currently the highest rank of classification.

As scientists learn more about organisms, classification systems change. Genetic sequencing has given researchers a whole new way of analyzing relationships between organisms.



EXAMPLES OF CLASSES



There are 6 classes in phylum chordata.

Class Reptilia- The Latin word Reptili means "creepy", or animals that crawl.

Class Amphibia- Amphi= double bia=life, these are animals that have life cycles in water AND on land.

Class Mammalia- The Latin word mammali means breast. These are animals that have mammary glands and produce milk.

Class Aves- "Avi" means to fly. These are flying animals.

(The remaining two classes are the bony and cartilaginous fishes).

How Biologists Classify

nists= scientists that classify organisms.

= group of particular organisms

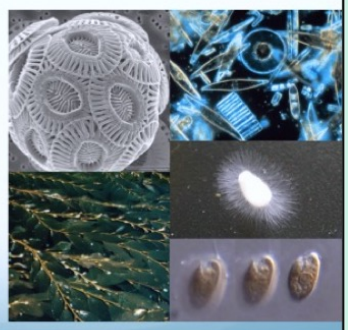
ny = the evolutionary past of an organism.

nists are constantly looking for clues to ne a species' phylogeny.

nomists are like detectives. They k for features to learn about and classify living organisms!



gdom Protista

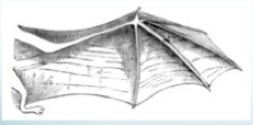


Protista are the most DIVERSE kingdom. For this reason, they have recently been organized into **SUPERGROUPS** to help narrow them down further.

CONVERGENT EVOLUTION

Convergent evolution: A process in which similar features evolve in two completely different organisms due to similar environments.

- Convergent evolution leads to analogous characters- characters that have similar functions, but are not related.



Bat wing

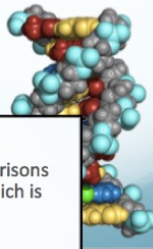


Bird wing

LINNAEUS vs. MODERN CLASSIFICATION

Linnaeus grouped organisms by their physical characteristics. However, there was one missing piece of the puzzle...

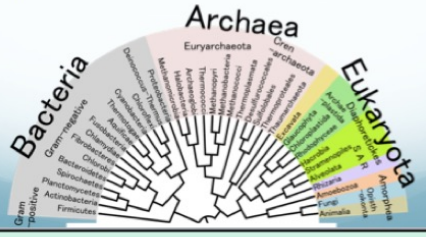
DNA codes for proteins, which contributes to our physical appearance.
Similar DNA = similar appearance
Because of this, Linnaeus' system works



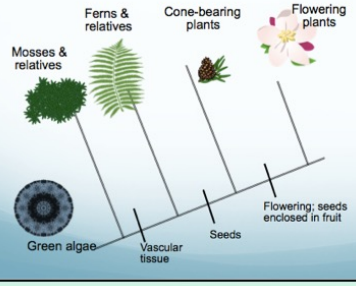
EVOLUTIONARY SYSTEMATICS

Evolutionary systematics: an alternative method of grouping organisms by using their phylogeny and evolutionary relationships.

- Produces phylogenetic tree or evolutionary trees, which **incorporate time** and also form clades.

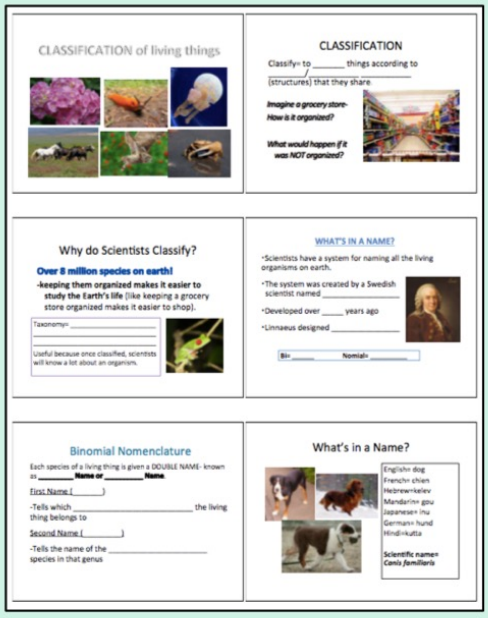


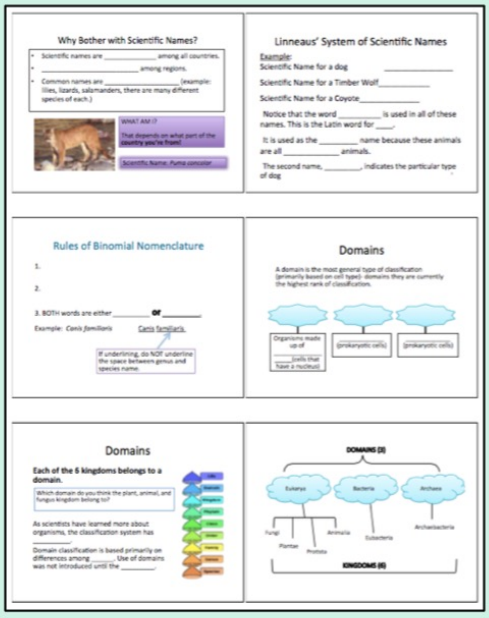
- **Out-group:** the distantly related organism seen on a cladogram. The outgroup serves as a base for comparisons with the other organisms seen on the cladogram, which is known as the in-group.

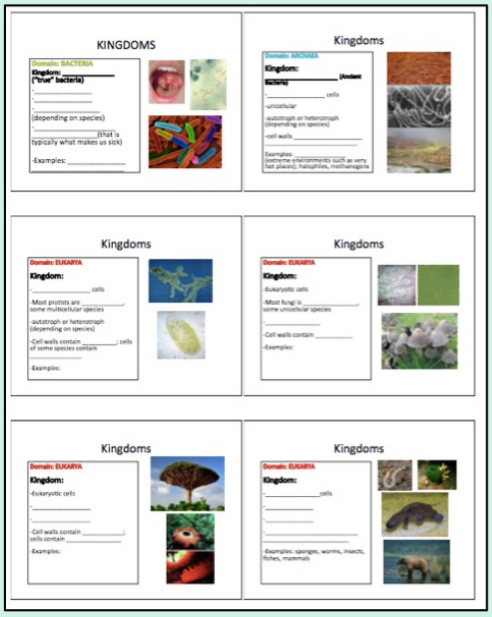


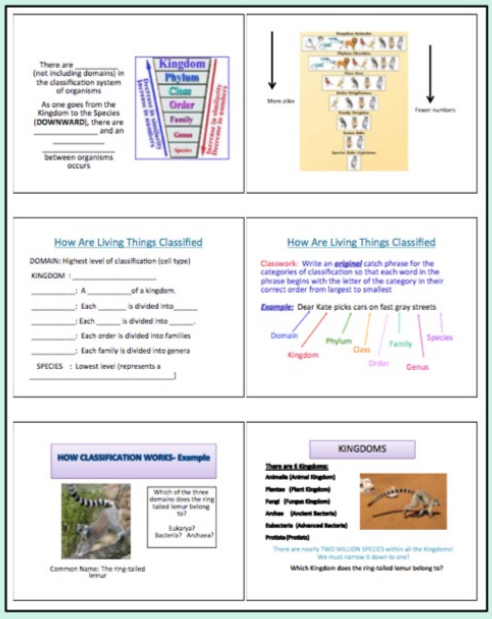
The out-group of this particular cladogram is the green algae, because it does not contain any derived characters.

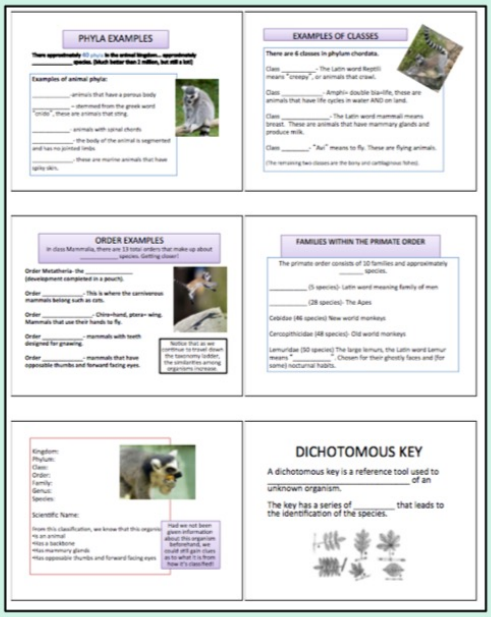
STUDENT SHEET FOR RECORDING NOTES INCLUDED

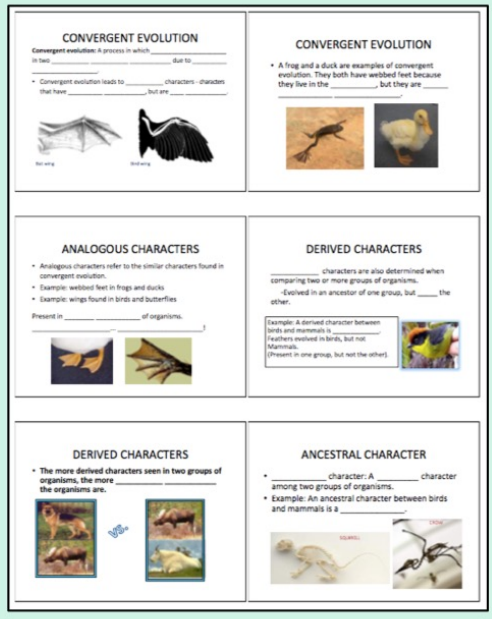


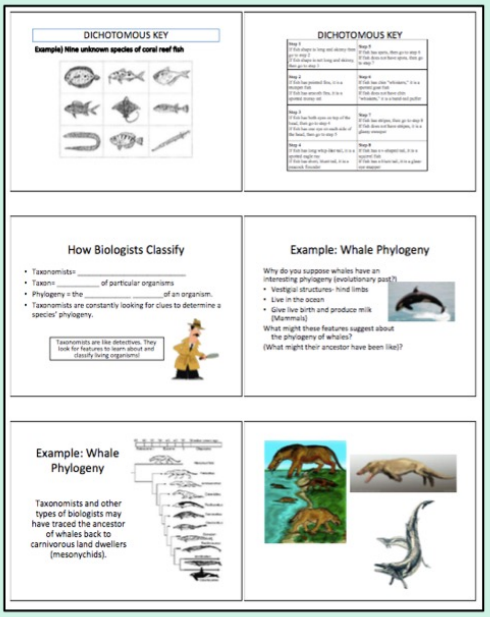


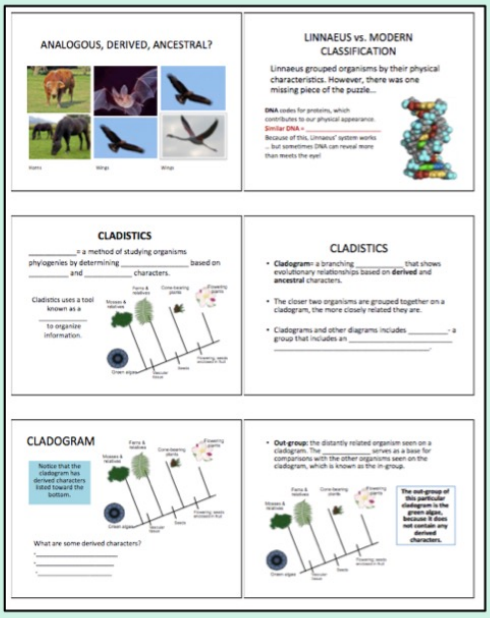


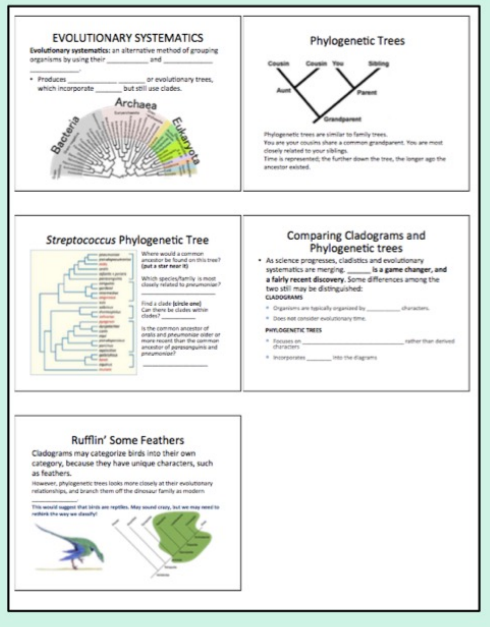




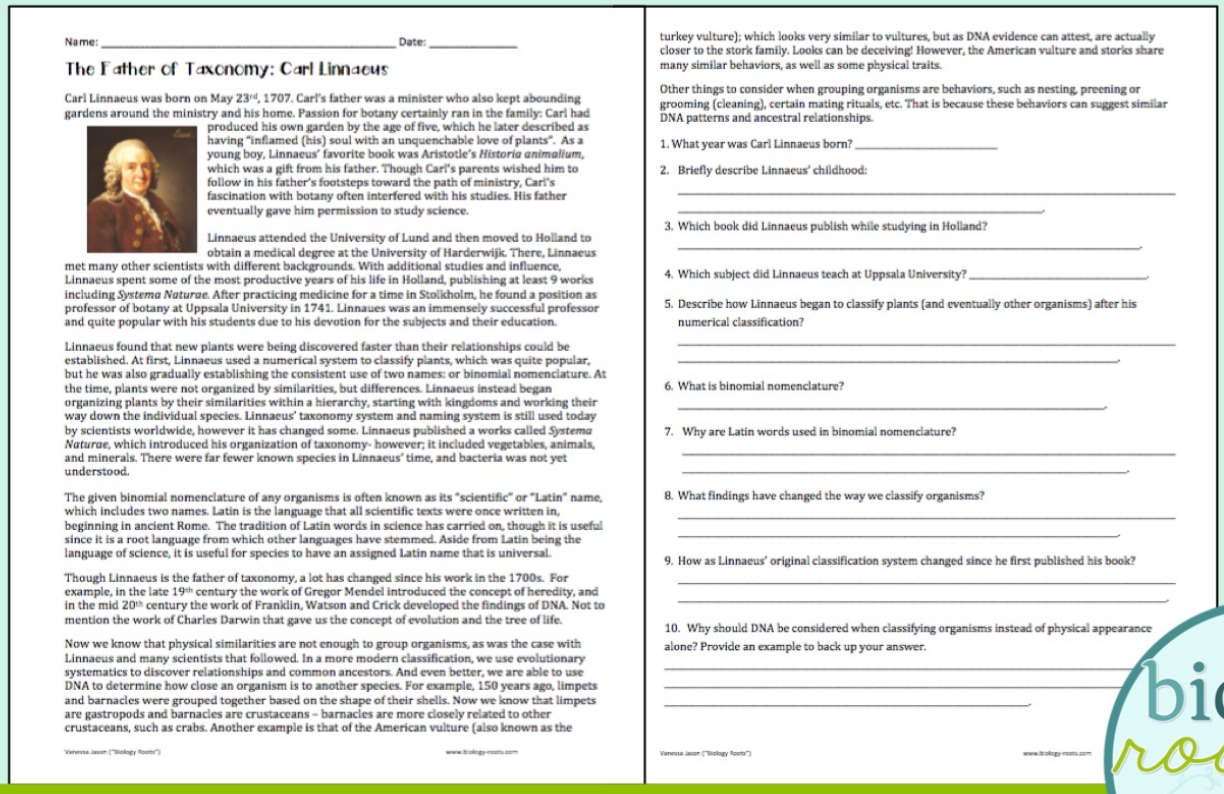








classification Close Reading



Name: _____ Date: _____

The Father of Taxonomy: Carl Linnaeus

Carl Linnaeus was born on May 23rd, 1707. Carl's father was a minister who also kept abounding gardens around the ministry and his home. Passion for botany certainly ran in the family: Carl had produced his own garden by the age of five, which he later described as having "inflamed (his) soul with an unquenchable love of plants". As a young boy, Linnaeus' favorite book was Aristotle's *Historia animalium*, which was a gift from his father. Though Carl's parents wished him to follow in his father's footsteps toward the path of ministry, Carl's fascination with botany often interfered with his studies. His father eventually gave him permission to study science.

Linnaeus attended the University of Lund and then moved to Holland to obtain a medical degree at the University of Harderwijk. There, Linnaeus met many other scientists with different backgrounds. With additional studies and influence, Linnaeus spent some of the most productive years of his life in Holland, publishing at least 9 works including *Systema Naturae*. After practicing medicine for a time in Stolkholm, he found a position as professor of botany at Uppsala University in 1741. Linnaues was an immensely successful professor and quite popular with his students due to his devotion for the subjects and their education.

Linnaeus found that new plants were being discovered faster than their relationships could be established. At first, Linnaeus used a numerical system to classify plants, which was quite popular, but he was also gradually establishing the consistent use of two names: or binomial nomenclature. At the time, plants were not organized by similarities, but differences. Linnaeus instead began organizing plants by their similarities within a hierarchy, starting with kingdoms and working their way down the individual species. Linnaeus' taxonomy system and naming system is still used today by scientists worldwide, however it has changed some. Linnaeus published a works called *Systema Naturae*, which introduced his organization of taxonomy- however; it included vegetables, animals, and minerals. There were far fewer known species in Linnaeus' time, and bacteria was not yet understood.

The given binomial nomenclature of any organisms is often known as its "scientific" or "Latin" name, which includes two names. Latin is the language that all scientific texts were once written in, beginning in ancient Rome. The tradition of Latin words in science has carried on, though it is useful since it is a root language from which other languages have stemmed. Aside from Latin being the language of science, it is useful for species to have an assigned Latin name that is universal.

Though Linnaeus is the father of taxonomy, a lot has changed since his work in the 1700s. For example, in the late 19th century the work of Gregor Mendel introduced the concept of heredity, and in the mid 20th century the work of Franklin, Watson and Crick developed the findings of DNA. Not to mention the work of Charles Darwin that gave us the concept of evolution and the tree of life.

Now we know that physical similarities are not enough to group organisms, as was the case with Linnaeus and many scientists that followed. In a more modern classification, we use evolutionary systematics to discover relationships and common ancestors. And even better, we are able to use DNA to determine how close an organism is to another species. For example, 150 years ago, limpets and barnacles were grouped together based on the shape of their shells. Now we know that limpets are gastropods and barnacles are crustaceans – barnacles are more closely related to other crustaceans, such as crabs. Another example is that of the American vulture (also known as the

Vanessa Jason ("Biology Roots") www.biology-roots.com

turkey vulture); which looks very similar to vultures, but as DNA evidence can attest, are actually closer to the stork family. Looks can be deceiving! However, the American vulture and storks share many similar behaviors, as well as some physical traits.

Other things to consider when grouping organisms are behaviors, such as nesting, preening or grooming (cleaning), certain mating rituals, etc. That is because these behaviors can suggest similar DNA patterns and ancestral relationships.

1. What year was Carl Linnaeus born? _____
2. Briefly describe Linnaeus' childhood:
   _____
   _____.
3. Which book did Linnaeus publish while studying in Holland?
   _____.
4. Which subject did Linnaeus teach at Uppsala University? _____.
5. Describe how Linnaeus began to classify plants (and eventually other organisms) after his numerical classification?
   _____
   _____.
6. What is binomial nomenclature?
   _____.
7. Why are Latin words used in binomial nomenclature?
   _____
   _____.
8. What findings have changed the way we classify organisms?
   _____
   _____.
9. How as Linnaeus' original classification system changed since he first published his book?
   _____
   _____.
10. Why should DNA be considered when classifying organisms instead of physical appearance alone? Provide an example to back up your answer.
    _____
    _____
    _____.

Vanessa Jason ("Biology Roots") www.biology-roots.com

CARL LINNAEUS BIOGRAPHY

- ★ Brief mention of Linnaeus' childhood and passion for botany
- ★ Linnaeus' studies
- ★ Linnaeus as a professor
- ★ Early days of classification
- ★ *Systema Naturae*
- ★ How the Linnaean system played a role today
- ★ How classification has evolved
- ★ 2 pages; 10 questions; answer key included

organizing information

Name:_____ Date: _____

Organizing Information: Classification

You have just been hired at the OIC zoo, which is a brand new zoo and growing! Before it gets any bigger, the zoo owner has asked you to classify the animals that are there into two large groups for easier navigating, feeding, and habitat design. This information will help the zoo owner design the blue prints for the zoo!

Here is a list of the current animals living at the zoo: bats, eagles, ostriches, turtles, giraffes, octopus, Grizzly bears, lions, alligators, elephants, and beluga whales.

Try to group the organisms into 2 large groups and 2 sub groups as evenly as possibly. Think of features that they share when grouping them, such as where they live, how they eat, or how they give birth, or any other features! It can be *any* similarity or difference that you think of.

GROUP 1: _____

GROUP 2: _____

Sub Group 1:

Sub Group 2:

Sub Group 3:

Sub Group 4:

1. Why is classifying organisms important, whether it's at a zoo or studying many organisms found in nature?

_____

_____.

© 2010 Vanessa Jason ("Biology Roots")

2. How did you choose to separate the organisms and why? _____

_____.

3. If you had to come up with another sub group to further classify the organisms how would you divide them? Choose one of the four sub groups and come up with an example:

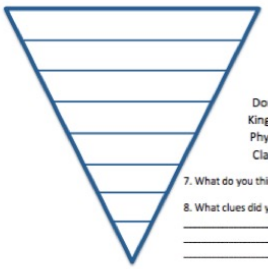
Sub Group #	How you could further classify/divide it:

4. When classifying a large group of organisms, the group starts off as a (circle one) [large | small] group of organisms with [less | more] variation, and is divided into (circle one) [large | small] groups each with [less | more] variation.

In biology, scientists use a taxonomy ladder to help classify organisms. The ladder begins with one large group called the Domain, with could contain millions of species, and ends with one small group that typically has ONE organism in it, called the species.

The order is as follows: **D**omain, **K**ingdom, **P**hylum, **C**lass, **O**rder, **F**amily, **G**enus, **S**pecies.
Create an acronym to help you remember the order of the levels, from domain to species.
An example would be "Dear King Philip Came Over For Good Spaghetti".

5. Come up with your own acronym: _____



6. Fill in the shape at left with the levels of the taxonomy ladder. Be sure that the biggest chunk represents the largest level and works it's way down to the smallest in the correct order.

GUESS THE ORGANISM:

Domain: Eukarya
Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Carnivora
Family: Felidae
Genus: *Panthera*
Species: *tigris*

7. What do you think the organism is? _____

8. What clues did you use to come up with your guess?

_____

_____

_____.

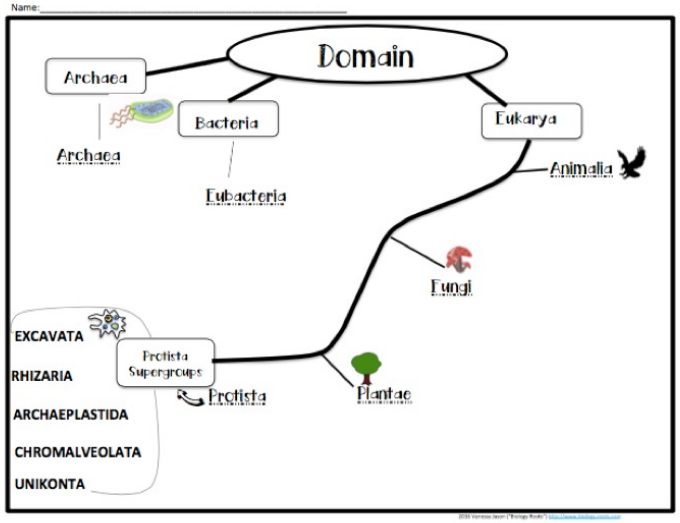
9. Name one other animal that shares the same class as *Panthera Tigris:* _____

10. The name *"Panthera tigris"* is known as the (circle one) [common name | scientific name].

© 2010 Vanessa Jason ("Biology Roots")

domain branch

Name:_____



2010 Vanessa Jason ("Biology Roots") http://www.biology-roots.com

	Nucleus	Uni-cellular	Multi-cellular	Autotrophic	Hetero-trophic	Chloroplast	Cell wall-chitin	Cell wall-cellulose	Cell Wall-peptidoglycan	Cell Wall-Other
Archaea										
Eubacteria										
Animalia										
Fungi										
Plantae										
Protista										

1. Do all autotrophs contain chloroplasts? _____

   a. What are chloroplasts used for? _____

   b. What is another way an organism could obtain their own energy (autotroph) without using the sun? _____

   _____.

   Are all cell walls the same? Explain. _____

   _____.

3. Judging by the chart, what is the most diverse group of organisms (archaea, eubacteria, animalia, fungi, plantae, or protista)? Why do you think so? _____

   _____.

4. If a new species was discovered that had a cell wall with chitin, but was an autotroph that contained chloroplast, how would you group it and why? _____

   _____.

2010 Vanessa Jason ("Biology Roots") http://www.biology-roots.com

binomial nomenclature& classification

Name: _____ Date: _____



Binomial Nomenclature and Classification

1. Why do biologists use a classification system to study the diversity of life?

_____

_____.

2. The science of classifying organisms and assigning them universally accepted names is known as _____.

3. Why do you think it might help to use scientific names instead of common names in biology?

_____

_____

_____.

4. Circle or highlight the sentence below that is *true* about early efforts at naming organisms.
   a. Names were usually in English.
   b. Names often described detailed physical characteristics of a species.
   c. Names often contained many words.
   d. It was difficult to standardize the names.

5. The two-word naming system developed by Linnaeus is called _____

_____.

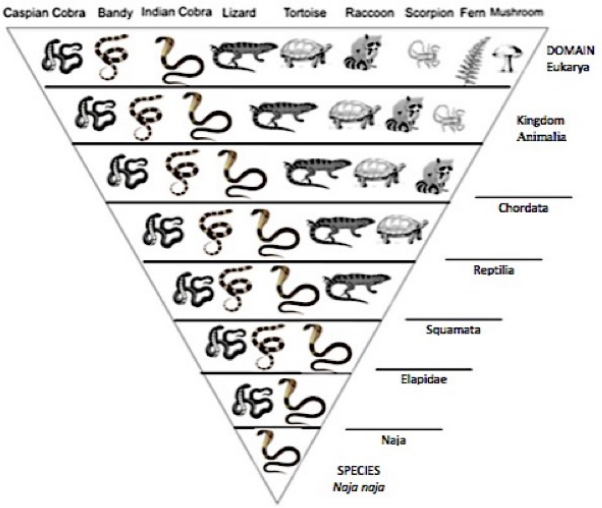
6. Circle or highlight the sentence below that is true about binomial nomenclature.
   a. The system is no longer in use today.
   b. Each species is assigned a two-part scientific name.
   c. The scientific name is always written in Italics.
   d. The second part of the scientific name is capitalized.

7. What is the genus of the grizzly bear, *Ursus arctos*? _____.

8. The grizzly bear, *Ursus arctos*, and the North American black bear, *Ursus americanus* share the same (circle one) genus | species.

9. The largest taxonomic group is the _____, which could be Archaea, Bacteria, or Eukarya.

10. On the following page, f ill in the name of each missing taxonomic category.



11. Describe what happens as you work your way down the taxonomy ladder:

_____

_____

13. What is the scientific name of the Indian Cobra? _____

Use the chart below to answer questions 14-20.

Common Name	Scientific Name
Domestic dogs	*Canis latrans*
Gray wolf	*Canis lupus*
Spotted hyena	*Crocuta crocuta*
Golden Jackal	*Canis aureus*
Red fox	*Vulpes vulpes*
African Wild Dog	*Lycaon pictus*


Gray wolf

14. Which animal is more closely related to domestic dogs, jackals or African wild dogs?

15. Which two animals is the wolf most closely related to?

16. If a new animal was discovered and examined by scientists, then given the scientific name *Vulpes lupus*, would it look more similar to a wolf or a fox? Why do you think so?

17. All of the animals listed in the chart belong to the same family: Canidae. Therefore, they must also all belong to the same (circle one) [order] | [genus].

18. _____True or False: red foxes and African wild dogs belong to the same phyla.

19. _____ True or False: dogs, wolves, and jackals share the same genus.

20. _____True or False: African wild dogs belong to the genus Lycaon.

GRADES 7+

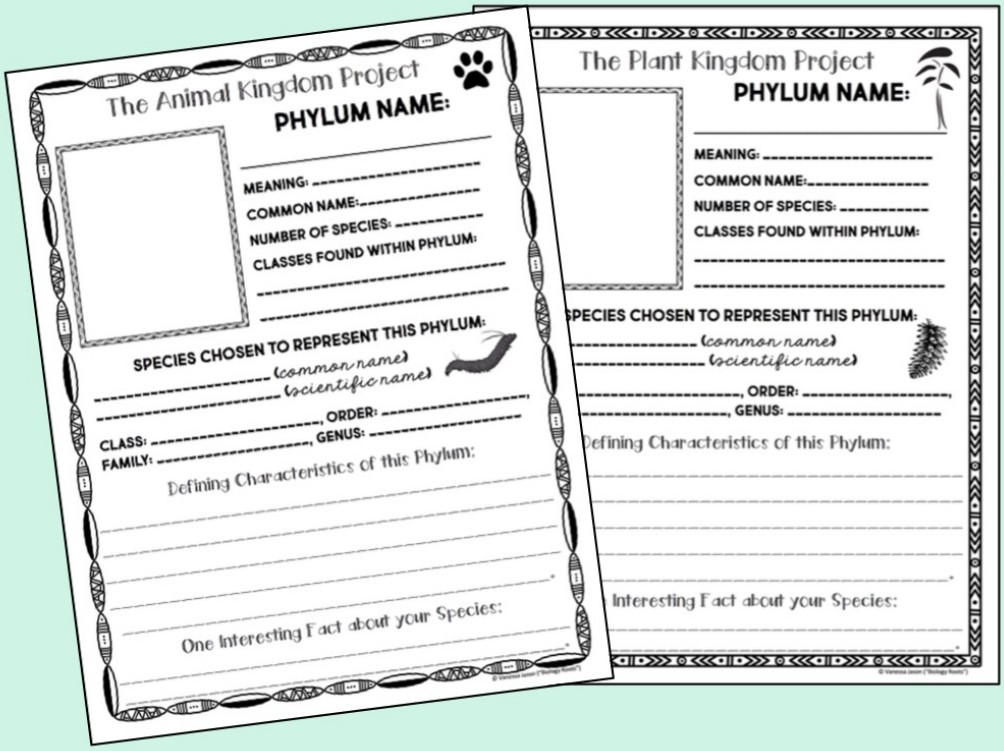
2.5 PAGES

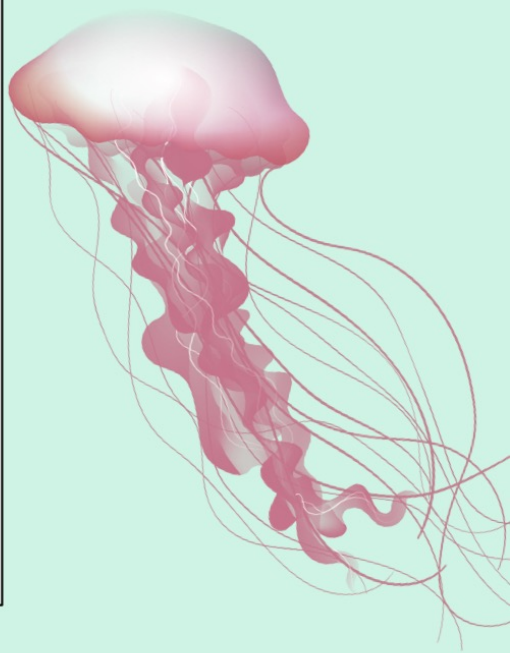
ANSWER KEY INCLUDED

REINFORCEMENT TOOL

20 questions/items

classification
Kingdom Project





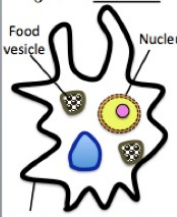
EXPLORES THE DIVERSITY OF KINGDOMS

Students research an assigned phyla and choose one species from to represent their phyla. Some light research is required (interesting facts, taxonomy, names, characteristics, etc.)

Display the posters around the room so students can see just how diverse each kingdom is!

CLASSIFICATION CARDS

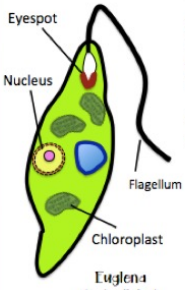
Kingdom: Protista



Protists are any eukaryote that is neither plant, nor animal, nor fungus. Protists are the oddballs! They are a very diverse group!

Some protists, such as euglena, contain chloroplasts, which means that they are **autotrophic** because they obtain their energy from the sun or chemicals.

Other protists, such as amoebas and paramecia are **heterotrophic** because they engulf tiny food particles via endocytosis.



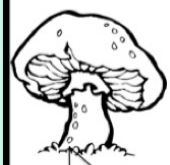
Most protists are **unicellular**, because most protists are single-celled organisms; except for some types of algae, which are multicellular.

Protista are **eukaryotic** because they contain a nucleus.

Because Protista is so diverse, it has been recently divided into **5 SUPERGROUPS**

1. **EXCAVATA**
2. **CHROMALVEOLATA**
3. **RHIZARIA**
4. **ARCHAEPLASTIDA**
5. **UNIKONTA**

Kingdom: Fungi

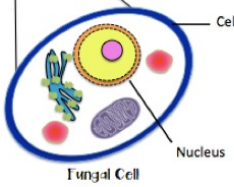


Fungi are **heterotrophic** because it relies on other living organisms for food.

Most fungi are **multicellular**, such as mushrooms which are made up of more than one cell.

Other fungi, such as yeast, are **unicellular** because they are single-celled organisms.

Fungal Cells are **eukaryotic** because they contain a nucleus.



Many fungal cells can release powerful enzymes to help break down dead matter. Other fungi act as parasites, feeding off of other organisms.

Examples of 3-5 organisms that can be found in the Fungi Kingdom: Mushrooms, yeast, mold.

Kingdom: _____

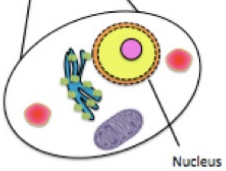


Animals are _____ because they relies on other living organisms for food.

All animals are _____, meaning they are all made up of more than one cell.

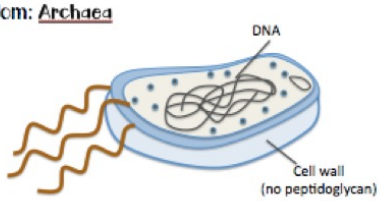
Animal Cells are _____ because they contain a nucleus.

The animal kingdom is very diverse. Some animals are carnivores, some are herbivores, and some are parasites, such as ticks, and others are detritivores, such as earthworms. Some animals lay eggs, while others are viviparous.



Examples of 3-5 organisms that can be found in the Animal Kingdom:

Kingdom: Archaea



Archaea are ancient single-celled organisms that are often called "Life's extremists" because they can survive in very **extreme** environments.

Most archaea are **autotrophic,** because they use energy from the sun or chemicals from the environment to create energy.

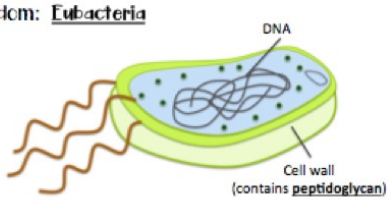
Some archaea, such as methanogens, are **heterotrophic** because they get their nutrition from the digestive tracts of animals, plant remains, or sewage.

All archaea are **unicellular**, meaning they are single-celled organisms.

Archaea are **prokaryotic** because they do not contain a nucleus.

Archaeans live insome of the most extreme environments on the planet. Some live in deep sea vents where the temperatures reach 100° C (212° F). Others live in hot springs, in extremely alkaline or acid waters, or in extremely saline (salty) conditions.

Kingdom: Eubacteria



Most eubacteria are **heterotrophic** because most rely on nutrition from other organisms.
Some eubacteria are **autotrophic**, because they use energy from the sun or chemicals from the environment to create energy.

All eubacteria are **unicellular**, meaning they are single-celled organisms.

Eubacteria are **prokaryotic** because they do not contain a nucleus.

*Though eubacteria and archaea look very similar, they are in fact quite different in their chemical makeup, metabolic processes, and mechanisms.

Some heterotrophic eubacteria infect our cells, and can make us sick. Think of 3-5 examples of types of bacteria that fit this category.

Examples of 3-5 organisms that can be found in the Eubacteria Kingdom: E. Coli, Streptococcus, Staphylococcus, Spirochetes, Helicobacter, etc.

Kingdom: Plantae

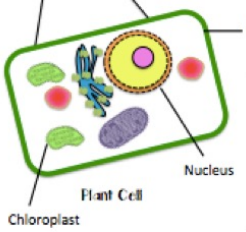


Plants are **autotrophic** because they can produce their own food using the sun.

All plants are **multicellular**, meaning they are all made up of more than one cell.

Plant Cells are **eukaryotic** because they contain a nucleus.

Plant cells are unique because they are eukaryotic cells that contain **chloroplasts**, which are organelles necessary to harvest energy from the sun.



Depending on the type of plant, the process of reproduction can differ. Some plants produce seeds within cones or fruit, while other plants use flowers. Some plants, such as mosses, use spores.

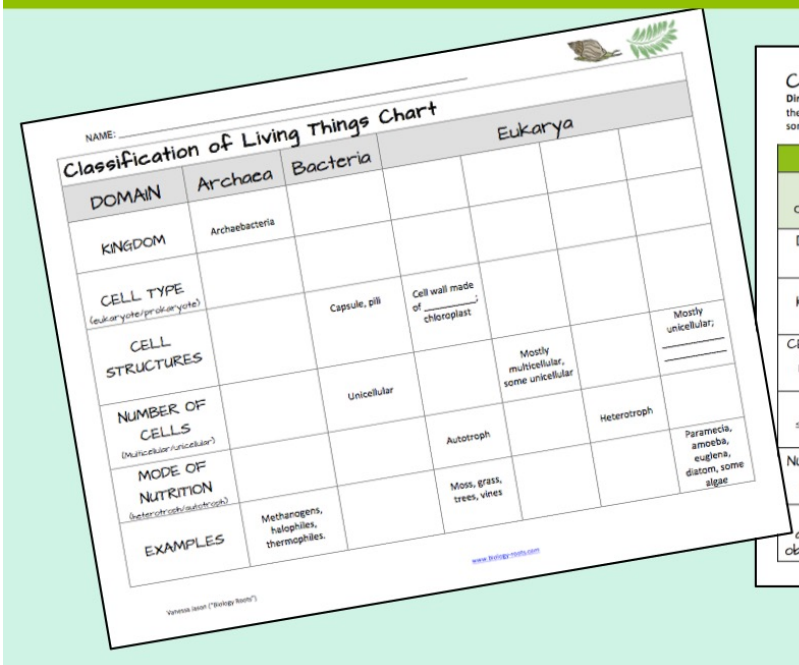
Examples of 3-5 organisms that can be found in the Plant Kingdom: Moss, ferns, flowering plants, fruit-bearing plants, conifers

STUDENTS FILL IN THE BLANKS AND READ FUN FACTS!
CAN BE USED FOR REVIEW, HOMEWORK, OR AS PART OF AN INTERACTIVE NOTEBOOK.

classification
Mini Lab Practical



PRE LAB CHART AND LAB TEMPLATE



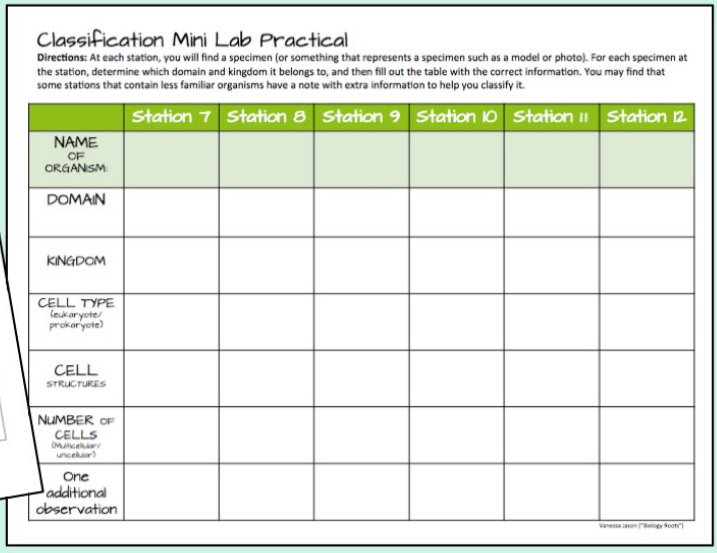
NAME:

Classification of Living Things Chart

DOMAIN	Archaea	Bacteria	Eukarya			
KINGDOM	Archaebacteria					
CELL TYPE (eukaryote/prokaryote)						
CELL STRUCTURES		Capsule, pili	Cell wall made of _____, chloroplast			Mostly unicellular; _____ _____
NUMBER OF CELLS (Multicellular/unicellular)		Unicellular		Mostly multicellular, some unicellular		
MODE OF NUTRITION (heterotroph/autotroph)			Autotroph		Heterotroph	
EXAMPLES	Methanogens, halophiles, thermophiles.		Moss, grass, trees, vines			Paramecia, amoeba, euglena, diatom, some algae

www.biology-roots.com

Vanessa Jason ("Biology Roots")



Classification Mini Lab Practical

Directions: At each station, you will find a specimen (or something that represents a specimen such as a model or photo). For each specimen at the station, determine which domain and kingdom it belongs to, and then fill out the table with the correct information. You may find that some stations that contain less familiar organisms have a note with extra information to help you classify it.

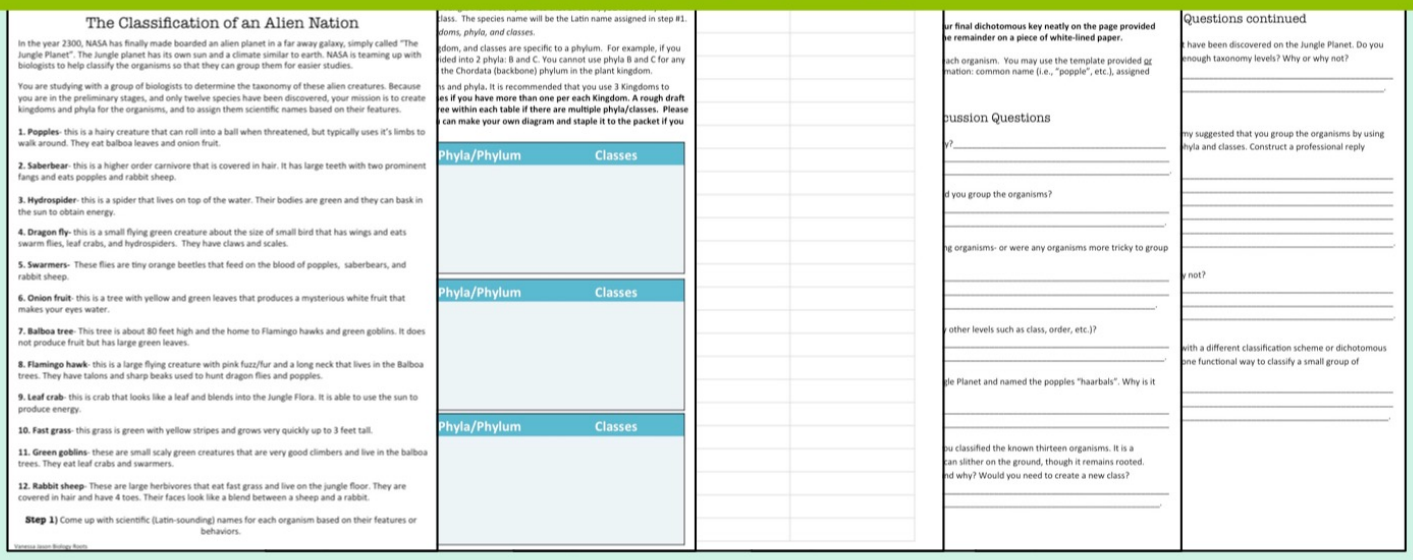
	Station 7	Station 8	Station 9	Station 10	Station 11	Station 12
NAME OF ORGANISM						
DOMAIN						
KINGDOM						
CELL TYPE (eukaryote/ prokaryote)						
CELL STRUCTURES						
NUMBER OF CELLS (Multicellular/ unicellular)						
One additional observation						

Vanessa Jason ("Biology Roots")

classification project



COMPREHENSIVE CLASSIFICATION PROJECT FOR GRADES 8-12.



The Classification of an Alien Nation

In the year 2300, NASA has finally made boarded an alien planet in a far away galaxy, simply called "The Jungle Planet". The Jungle planet has its own sun and a climate similar to earth. NASA is teaming up with biologists to help classify the organisms so that they can group them for easier studies.

You are studying with a group of biologists to determine the taxonomy of these alien creatures. Because you are in the preliminary stages, and only twelve species have been discovered, your mission is to create kingdoms and phyla for the organisms, and to assign them scientific names based on their features.

1. Popples- this is a hairy creature that can roll into a ball when threatened, but typically uses it's limbs to walk around. They eat balboa leaves and onion fruit.

2. Saberbear- this is a higher order carnivore that is covered in hair. It has large teeth with two prominent fangs and eats popples and rabbit sheep.

3. Hydrospider- this is a spider that lives on top of the water. Their bodies are green and they can bask in the sun to obtain energy.

4. Dragon fly- this is a small flying green creature about the size of small bird that has wings and eats swarm flies, leaf crabs, and hydrospiders. They have claws and scales.

5. Swarmers- These flies are tiny orange beetles that feed on the blood of popples, saberbears, and rabbit sheep.

6. Onion fruit- this is a tree with yellow and green leaves that produces a mysterious white fruit that makes your eyes water.

7. Balboa tree- This tree is about 80 feet high and the home to Flamingo hawks and green goblins. It does not produce fruit but has large green leaves.

8. Flamingo hawk- this is a large flying creature with pink fuzz/fur and a long neck that lives in the Balboa trees. They have talons and sharp beaks used to hunt dragon flies and popples.

9. Leaf crab- this is crab that looks like a leaf and blends into the Jungle Flora. It is able to use the sun to produce energy.

10. Fast grass- this grass is green with yellow stripes and grows very quickly up to 3 feet tall.

11. Green goblins- these are small scaly green creatures that are very good climbers and live in the balboa trees. They eat leaf crabs and swarmers.

12. Rabbit sheep- These are large herbivores that eat fast grass and live on the jungle floor. They are covered in hair and have 4 toes. Their faces look like a blend between a sheep and a rabbit.

Step 1) Come up with scientific (Latin-sounding) names for each organism based on their features or behaviors.

Phyla/Phylum | Classes

Phyla/Phylum | Classes

Phyla/Phylum | Classes

Questions continued

phylogenies

Web Quest

Name: _____ Date: _____

WEB QUEST: PHYLOGENETICS

Part I: The Family Tree https://tinyurl.com/family-tree-evo4

By studying inherited characteristics and historical evidence, we can reconstruct evolutionary _____ and represent them on a "family tree" called a _____.

Observe the family tree. Click on the portion "Eukaryota".

- Note the location of tunicates and cnidarians. Which one do you think is more closely related to vertebrates? Why?

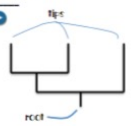
_____

_____.

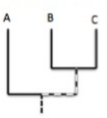
- **Click on "Vertebrates".** Name two types of groups that you think are closely related.

_____

Part II: Understanding Phylogenies ("Family Trees") next



- The root of the tree represents _____.
- The tips of the tree represent _____
- Trees can represent time. As you move from root to tip, you are moving _____ in time.
- A branching represents _____. Draw stars where this event occurs on the tree to the right.



- Phylogenies trace _____ of _____ _____ between lineages.

Using the tree on the website as a guide, outline the lineage of organism B in green and C in blue (or another color of your choice). Then, make a key similar to the one found on the website that includes the colors and the dashed line.

KEY

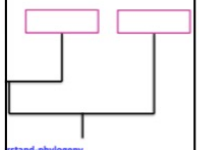
Part III: Reading Trees https://tinyurl.com/readingtrees

- An evolutionary tree represents _____ _____ among a set of organisms or groups called _____ (singular: _____).
  - -The tip of the tree represents groups of _____ taxa.
  - -The nodes of the tree represent the _____ _____.
  - --Descendants split from the same group are called _____ _____.
  - -Many phylogenies include an _____, which is a taxon _____ _____.

What's the difference between a phylogeny, an evolutionary tree, a phylogenetic tree, and a cladogram?

^Please read this portion! As science progresses, biologists are beginning to use these terms interchangeably, but there are still some distinctions among them. *The last page of this web quest contains a space for you to write some notes.*

Vanessa Jason www.biology-roots.com



estand-phylogeny

are not clades. The ones that are not clades
y do not share a common
_____.

- Clades are nested within one another, forming a _____ _____.

next **Trees, not ladders**

When reading a phylogeny, it is important to keep these 3 things in mind:

1. Evolution produces _____ _____.
2. Just because we tend to read phylogenies from left to right, _____ _____.
3. For any _____ event on a phylogeny, the choice of which lineage goes to the right and which goes to the left is _____. (Look at the examples given where the tree is mirrored. The two trees are (circle one) [equal | not equal].

next **Building the tree**

When reading a phylogeny, it is important to keep these 3 things in mind:

To build a phylogenetic tree, biologists must collect data about the _____ of each organism. Characters can be:

- _____ traits (morphology)
- _____ sequences
- _____ traits

Our goal is to find evidence that will help us _____ organisms into less _____ (smaller) clades. Specifically, we are interested in _____ _____ characters.
Shared derived characters can be used to group organisms into _____.
Examine the cladogram that includes sharks → ray finned fishes.
What is the derived character highlighted in green? _____.

Vanessa Jason www.biology-roots.com 2

However, the presence of four-limbs is not useful in determining _____ _____ in green above, since all _____ _____.

What would you need to examine in order to determine relationships within the green clade?

_____.

next next **Using the tree for classification**

Biologist use phylogenetic trees for many purposes, including:

- _____ about _____.
- Learning about the characteristics of _____ species and _____ _____.
- _____ organisms.

Most of us are accustomed to Linnaeus' system of classification, which was created long before scientists understood that organisms evolved; because this system is **not** based on _____, most biologists are switching to a classification system that reflects the organisms' _____ _____.

Examine the cladogram in its step-by-step description (notice it is the same cladogram, just highlighted differently depending on what the text is pointing out).
Using Linnaeus' system, why do reptiles not form a clade? (Hint: there is an organism included within the reptilian group that we do not classify as reptiles).

_____



What does this cladogram suggest about the evolutionary history of birds?

_____

Part IV: Using trees for Classification
https://tinyurl.com/usingtrees

Using the phylogeny of birds as an example, how does the Linnaean classification of birds compare to phylogenetic classification? _____

_____

_____

_____

Click on the link that says "Linnaean system of classification" and read the description.

What are the two main advantages of using phylogenetics over Linnaeus' system?

- First, phylogenetic classification tells you something important about the organism:

_____

- Second, _____

Though the cat family (called "Felidae") and the orchid family (called "Orchidaceae") are both at the family level in Linnaean classification, how many cat species belong to the cat family? _____ How many orchid species belong to the orchid family? _____

- Are all families of the Linnaean system created equal? Why or why not?

_____

_____.

Vanessa Jason www.biology-roots.com 3

d in the web quest (in no

What information can be found on phylogenetic trees?

What might a phylogenetic tree be used for?

What types of information are used to build phylogenetic trees?

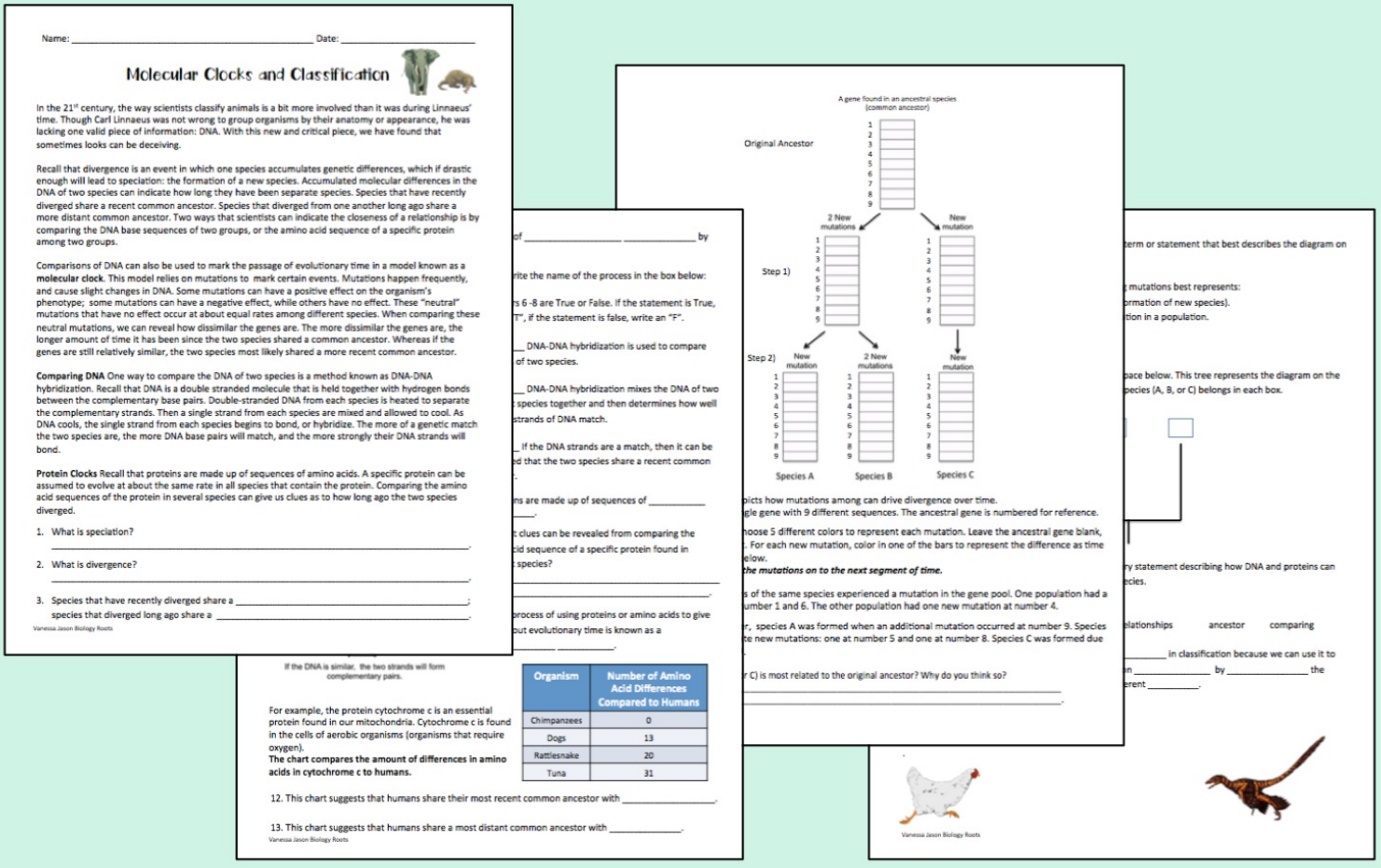
Why might the Linnaean system need to be modified?

Vanessa Jason www.biology-roots.com 4

GRADES 9 & UP EXPLORES PHYLOGENETIC TREES

biology roots

MODERN CLASSIFICATION: Molecular Clocks


Name: _____ Date: _____

Molecular Clocks and Classification

In the 21st century, the way scientists classify animals is a bit more involved than it was during Linnaeus' time. Though Carl Linnaeus was not wrong to group organisms by their anatomy or appearance, he was lacking one valid piece of information: DNA. With this new and critical piece, we have found that sometimes looks can be deceiving.

Recall that divergence is an event in which one species accumulates genetic differences, which if drastic enough will lead to speciation: the formation of a new species. Accumulated molecular differences in the DNA of two species can indicate how long they have been separate species. Species that have recently diverged share a recent common ancestor. Species that diverged from one another long ago share a more distant common ancestor. Two ways that scientists can indicate the closeness of a relationship is by comparing the DNA base sequences of two groups, or the amino acid sequence of a specific protein among two groups.

Comparisons of DNA can also be used to mark the passage of evolutionary time in a model known as a **molecular clock**. This model relies on mutations to mark certain events. Mutations happen frequently, and cause slight changes in DNA. Some mutations can have a positive effect on the organism's phenotype; some mutations can have a negative effect, while others have no effect. These "neutral" mutations that have no effect occur at about equal rates among different species. When comparing these neutral mutations, we can reveal how dissimilar the genes are. The more dissimilar the genes are, the longer amount of time it has been since the two species shared a common ancestor. Whereas if the genes are still relatively similar, the two species most likely shared a more recent common ancestor.

Comparing DNA One way to compare the DNA of two species is a method known as DNA-DNA hybridization. Recall that DNA is a double stranded molecule that is held together with hydrogen bonds between the complementary base pairs. Double-stranded DNA from each species is heated to separate the complementary strands. Then a single strand from each species are mixed and allowed to cool. As DNA cools, the single strand from each species begins to bond, or hybridize. The more of a genetic match the two species are, the more DNA base pairs will match, and the more strongly their DNA strands will bond.

Protein Clocks Recall that proteins are made up of sequences of amino acids. A specific protein can be assumed to evolve at about the same rate in all species that contain the protein. Comparing the amino acid sequences of the protein in several species can give us clues as to how long ago the two species diverged.

1. What is speciation?
   _____.
2. What is divergence?
   _____.
3. Species that have recently diverged share a _____;
   species that diverged long ago share a _____.

Vanessa Jason Biology Roots

A gene found in an ancestral species (common ancestor)

Original Ancestor

2 New mutations

New mutation

Step 1)

Step 2)

New mutation

2 New mutations

New mutation

Species A

Species B

Species C

Organism	Number of Amino Acid Differences Compared to Humans
Chimpanzees	0
Dogs	13
Rattlesnake	20
Tuna	31

The chart compares the amount of differences in amino acids in cytochrome c to humans.

12. This chart suggests that humans share their most recent common ancestor with _____.

13. This chart suggests that humans share a most distant common ancestor with _____.

Vanessa Jason Biology Roots

GRADES 8 + DIFFERENTIATED VERSION INCLUDED

EXPLORES 2 COMMON METHODS OF MOLECULAR CLOCKS: DNA-DNA HYBRIDIZATION AND PROTEIN CLOCKS.

APPLIES THESE METHODS TO SPECIATION AND CLASSIFICATION.

DINOSAUR
Cladogram Practice

Name: _____ Date: _____

DINOSAUR CLADOGRAM ANALYSIS

1. What is a cladogram?

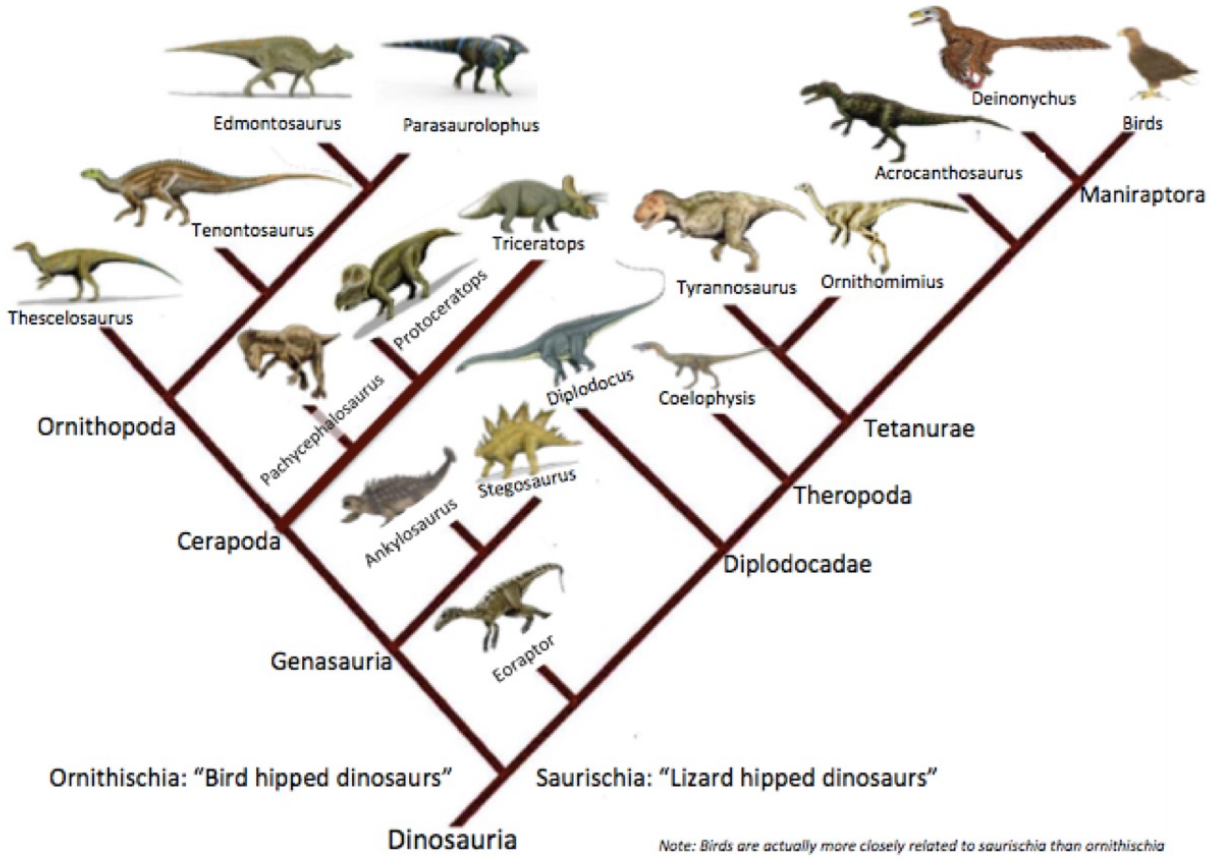
_____

_____.

Study the dinosaur cladogram. Given this cladogram, which of the two groups is more closely related (circle one)

2. [Tyrannosaurus | Ornithomimus] [Tyrannosaurus | Coelophysis]
3. [Pachycephalosaurus | Thescelosaurus] [Pachycephalosaurus | Triceratorps]
4. [Birds | Eoraptor]] [Birds | Deinonychus]
5. [Triceratops | Stegosarus] [Triceratops | Diplodocs]

6. The first trait used to divide the dinosaurs into two separate groups are the structure of their hips. What are the two groups and what do the group names mean?



cladograms & evolutionary trees

Name: _____ Date: _____

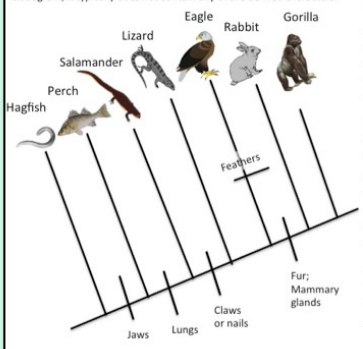
An INTRODUCTION to CLADOGRAMS and TREES

Biologists use **cladograms** to study the relationships among certain groups of organisms. Cladograms show how closely two or more groups are related based on ancestral (shared) and derived characters. Branching points on the diagram are made every time a derived character is identified.

Derived character: an uncommon trait or characteristic that separates two groups; not shared.

Cladograms offer a visual that we can use to make comparisons between organisms. We can compare organisms by how close or far apart they are on the cladogram. Organisms that are grouped more closely on a cladogram share more similarities than those farther apart. This suggests that the more closely grouped organisms share a more recent common ancestor than those found farther apart.

Typically there is an organism found in the cladogram that serves as an out-group. The out-group is a distantly related organism that serves as a base line for comparisons with all the other organisms in the cladogram; it typically does not contain any of the derived characters.



1. What is a derived character?

2. Make a list of all the possible derived characters included on this cladogram:

3. What are some derived characters among lizards and eagles? _____

4. What are some shared characters among rabbits and perch? _____

5. If mouse were added to this cladog

5. Examine the table below. For each derived character present, place a check mark.

Organism	Derived Character		
	Backbone	Legs	Hair/Fur
Earthworm			
Cod fish			
Frog			
Gorilla			

6. Using the table above as a guide, build a cladogram in the space below based on these organisms and characters.

7. How many of these characters does the earthworm have? _____

8. Which organism serves as the out-group for this particular cladogram? _____

9. How many characters are shared among the frog and the gorilla? _____

10. Which two organisms do you think are most closely related given the organisms in this cladogram? Elaborate.

11. Which two organisms are most distantly related? _____.
Why do you think so? _____

Vanessa Jason (Biology Roots)

e space below, create your own table similar to the one above that contains 5
s with 5 derived characters. Build a cladogram to reflect your information. A rough
ncouraged! You may use the same out group as the example cladogram or the
m on the previous page (hag fish or earth worm).

anism	Derived Character				

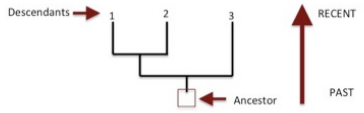
MY CLADOGRAM:

Vanessa Jason (Biology Roots)

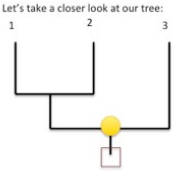
Evolutionary or phylogenetic trees depicts how ancestors are relate
much the organisms have changed. Though cladograms can be used
scientists tend to distinguish between the two.

Diagrams that are often referred to as phylogenetic trees depict phylogenies over time. The y-axis (top to bottom) on this cladogram represents time. The more recent changes occur at the top. Notice the fork-like pattern of this diagram. The tips of each fork lead to an organism or a group of organisms. The root of each fork leads to a common ancestor. The more closely grouped the organisms are, the more closely related they are. This is because they share a most recent common ancestor. The forking between two organisms shows where they diverged into separate species from their common ancestor.

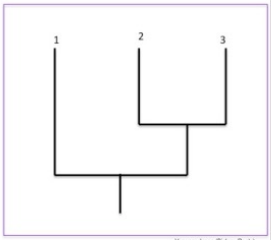
The diagram below represents a phylogenetic tree. The numbers 1-3 represent organisms. The common ancestor among all three of those organisms is labeled.



Let's take a closer look at our tree:



The circle on the diagram represents a speciation event occurred. This means that as time went on, the common ancestor diverged into two different species, most likely due to adapting to changes in environmental conditions.



13. Examine the tree at right.

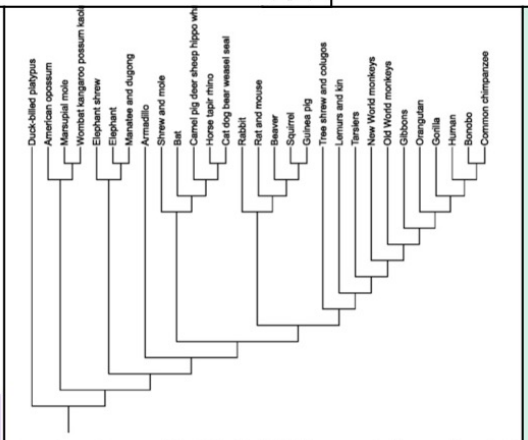
★Place a star at the common ancestor numbers 1-3 share.

Δ Place a triangle at the *most* recent common ancestor numbers 2 and 3 share.

14. How many speciation events occurred in the events of this tree diagram? _____

15. Which of the symbols represents the *oldest* organism on the tree (star or triangle)?
_____

Vanessa Jason (Biology Roots)



True or False. In the space provided, write "true" or "false". If the statement is false, cross off a word and re-write a new word to make it true.

_____ 16. In this tree, the closest descendant of the most common ancestor is the duck-billed platypus.

_____ 17. Shrews and moles are closely related to elephant shrews.

_____ 18. Squirrels are most closely related to rabbits.

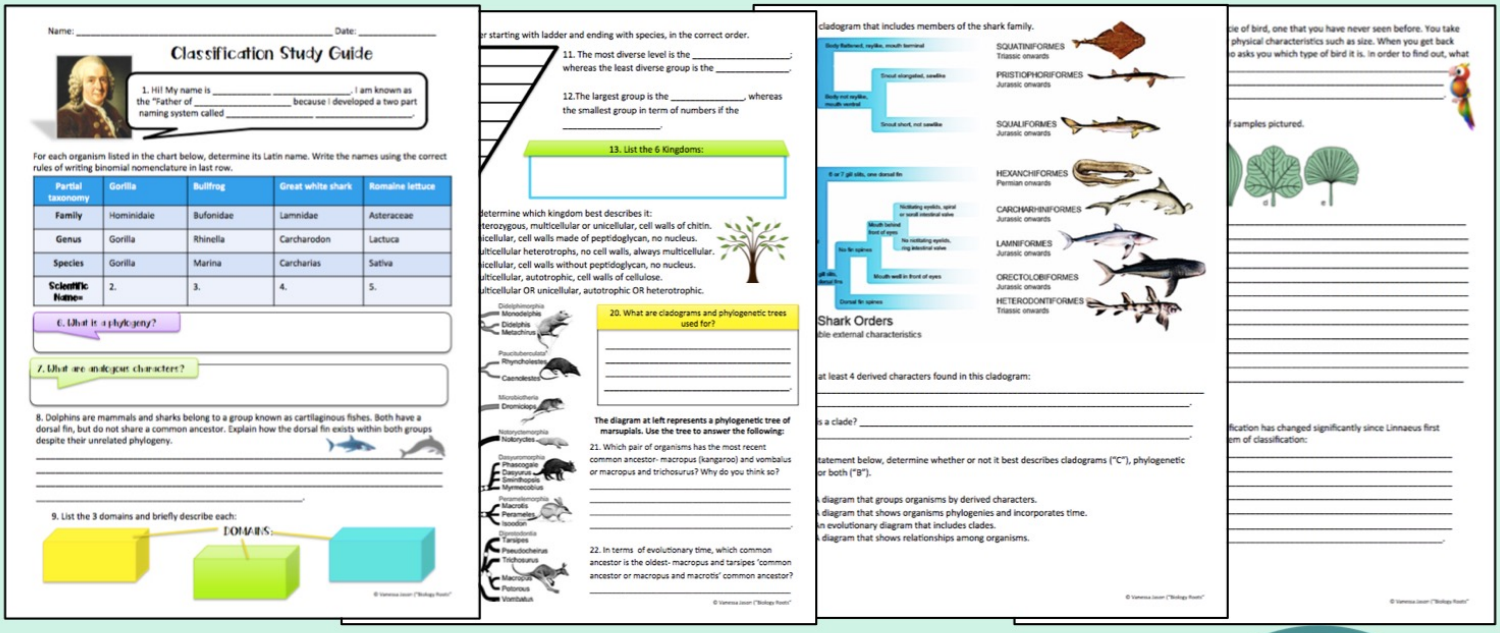
_____ 19. Humans share a common ancestor with bonobos and chimpanzees.

_____ 20. This tree suggests that all of these organisms share a common ancestor from long ago.

Vanessa Jason (Biology Roots)

5 PAGES; ANSWER KEY INCLUDED.
GREAT INTRODUCTORY TOOL!
HANDY SUB PLAN!

classification Study Guide



TAXONOMY, PHYLOGENY, DICHOTOMOUS KEYS- EDITABLE

- ★ 4 pages
- ★ Editable version included
- ★ Answer key included
- ★ Recommended for grades 9 and up

CLASSIFICATION:
Beyond Linnaeus

2 versions: one regular and one extended

Makes a great emergency plan!

Name: _____ Date: _____

Classification: Beyond Linnaeus

Carolus Linnaeus was one of the first scientists to begin organizing living things into groups based on similar characters. Linnaeus' system classifies organisms into kingdoms, followed by phyla, and the ladder continues all the way down to species. The organisms are generally grouped by similar characters. For example, in class Mammalia, you wouldn't find animals that lay eggs, such as snakes. 150 years ago around Linnaeus' time, organisms were grouped solely on similarities in appearance. However, some organisms, such as platypuses, would be difficult to group. Even dolphins may have been difficult to group in Linnaeus' system because they are mammals, but dolphins do not look very similar to other mammals.

Recall that Linnaeus was born in 1707, over one hundred years before Darwin. Darwin's theory of evolution changed the entire way that biologists have thought about classification. With Darwin's findings, scientists began to understand that organisms share certain traits because they share an evolutionary history. An organism's evolutionary history is called its *phylogeny*. Recall that Darwin was one of the first scientists to suggest that organisms share common ancestors. The more alike the organism, the more common the ancestor. The new way of making evolutionary trees depicts these relationships.

Below are three organisms: crab, barnacle, and limpet.
Look closely at the pictures. Given their general appearance, try to come up with a *simple* diagram to group these three organisms based on characteristics.

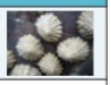
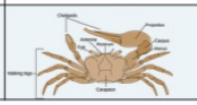
Organism	Diagram	Photo
Limpets (shown fixed to a rock)		
Barnacles (shown fixed to a whale)		
Crab		

Diagram #1

In Linnaeus' time there was less collaboration and information pertaining to plants and animals. As time has passed, we have discovered more about all sorts of things that we once may have thought insignificant (the lifecycle of barnacles, for example). With this uncovered information, we are now changing the way we classify organisms.

Limpets, barnacles and crabs all have similar juvenile forms: tiny free-swimming larva. The chart contains pictures of the organisms in their adult form (which is what most people see). In the case of barnacles and limpets, adults are sedentary (fixed; not moving). But, these juvenile forms can give us more clues about an organism's phylogeny. For example, when barnacles are juvenile, they have quite a different appearance. Barnacles have segmented bodies and an exoskeleton that molts. Crabs also have segmented bodies and an exoskeleton that molts. These characteristics are not found in limpets. This similarities would suggest a relationship among crabs and barnacles, and thus a common ancestor.

Barnacle Life Stages

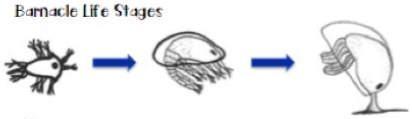


Diagram #2

1. What is a phylogeny? _____

2. Linnaeus' classifications system originally grouped organisms based on _____.

3. How did Darwin's findings change the way we are grouping organisms? _____
_____
_____.

4. _____ True or False: the common ancestor of limpets, barnacles, and crabs probably had a life cycle that contained tiny free swimming larva.
Why? _____

5. Compare your first and second diagrams depicting the relationship among limpets, barnacles and crabs. What characteristics did you use to create the diagrams? Fill in the table below:

RELATIONSHIP AMONG LIMPETS, BARNACLES, AND CRABS		
Diagram	Diagram #1	Diagram #2
Characteristics used to construct the diagram	6.	7.

8. When classifying animals, can you always rely on appearance alone? Explain.
_____
_____
_____
_____.

9. Which diagram best depicts the evolutionary relationships between the 3 organisms and why do you think so? _____
_____.

10. 10. Though Linnaeus did not know about natural selection, phylogeny, or DNA, his classification system from nearly 250 years ago is for the most part still used today. Why do you think it has been largely successful and still used today despite new advancements in science?
_____
_____
_____
_____.

5. Compare your first and second diagrams depicting the relationship among limpets, barnacles and crabs. What characteristics did you use to create the diagrams? Fill in the table below:

RELATIONSHIP AMONG LIMPETS, BARNACLES, AND CRABS		
Diagram	Diagram #1	Diagram #2
Characteristics used to construct the diagram	6.	7.

Ch-ch-ch-ch-changes
Turn and face the genes

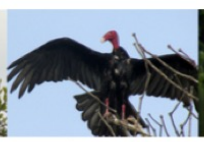
Barnacles are not the only species that have had a change in their classification. The genes of many organisms show important similarities at the molecular level. These similarities can be used to help determine the classification of an organism. Unlike the scientists of Linnaeus' time, scientists can sequence or read the information coded within DNA, and in doing so can compare the DNA of different organisms to determine the history of genes over time.

Even very different organisms can have common traits. For example, humans and yeasts show many similarities (considering you would think there would be absolutely no similarities!). Humans have a gene that codes for the protein myosin. Myosin is a protein found in our muscles that helps our muscles move, or contract. Yeasts also have the same gene that codes for myosin, and though yeasts do not have muscles, the myosin found in yeasts interacts with other proteins inside their cells to help the internal cell parts move!

DNA comparisons have also shed light on classification. For example, African vultures and American vultures were traditionally classified together as "vultures" in the falcon family. But one researcher noticed something peculiar: when American vultures get over-heated, they urinate or defecate on their legs to cool themselves off! There was only one other bird that shared that same behavior: storks. Could American vultures actually be more closely related to storks? Should American vultures remain with other vultures in the falcon family? Or do they belong in the stork family?



African vulture
(T. tracheliotos)



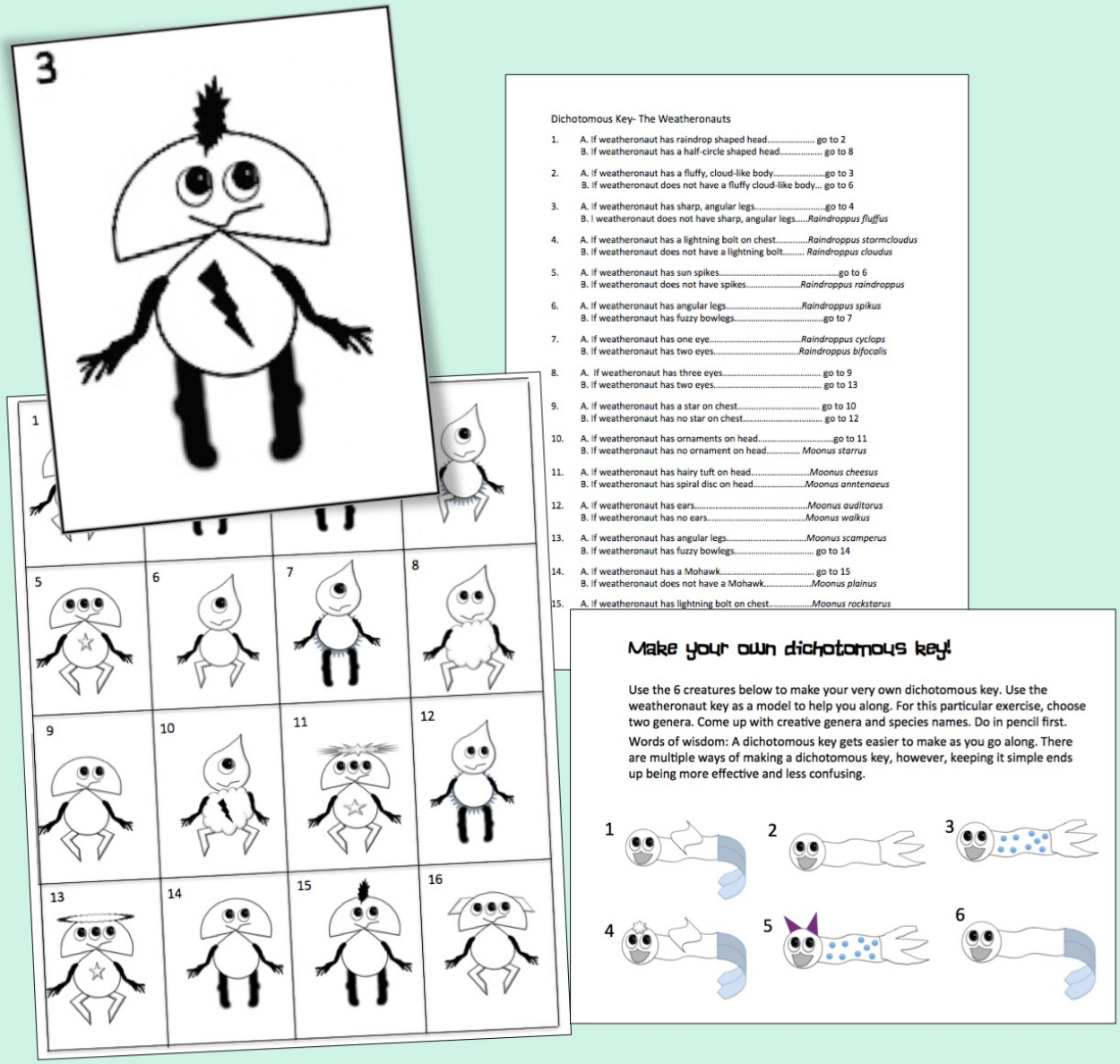
Afmerican vulture
(Cathartes aura)



Stork
Family Ciconiidae

dichotomous keys

"The Weather-o-nauts"



TWO PART CLASSIFICATION PRACTICE

USING AND MAKING DICHOTOMOUS KEYS

classification

task cards

Station 1- Binomial Nomenclature

WHAT is binomial nomenclature?

WHO invented binomial nomenclature?



Station 2- Binomial Nomenclature

A friend of yours from Alaska refers to the brown bears that roam near her house, and you wonder if these are the same bears that live near you, which you call Grizzly bears. You also have another friend that lives in a different region of Alaska, who calls brown bears Kodiak bears- but his friend, who is a native Alaskan, calls Kodiak bears tuquka-aq!

All 3 of you live in different areas, and all refer to the brown bears as different names. Could they be the same species? Using this as an example, explain why binomial nomenclature and classifying organisms comes in handy.



tion 4- What's in a n

Taxonomy Level	Classification
Domain	Eukarya
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Perissodactyla

tation 5- Scientific Names

g table includes a partial classification of 5 organisms. Using the information determine the scientific name for each.

orilla	Earthworm	Sunflower	Shitake mushroom	E. Coli
ominidae	Lumbricidae	Asteraceae	Omphalataceae	Enterobacteriaceae
orilla	Lumbricus	Helianthus	Lentinula	Escherichia
orilla	Terrestris	Annuus	Edodes	Coli

e to write the names following the correct rules of binomial nomenclature .

Station 7- Convergent Evolution

Compare the two tables, which list the classification of an opossum vs. the classification of a spider monkey.

Taxonomy Level	Opossum
Domain	Eukarya
Kingdom	Animalia
Phylum	Annelida
	mmalia
	himorphia
	elphidae
	delphus
	giniana

Taxonomy Level	Spider Monkey
Domain	Eukarya
Kingdom	Animalia
Phylum	Annelida
Class	Mammalia
Order	Primate
Family	Atelidae
Genus	Ateles
Species	Belzebuth

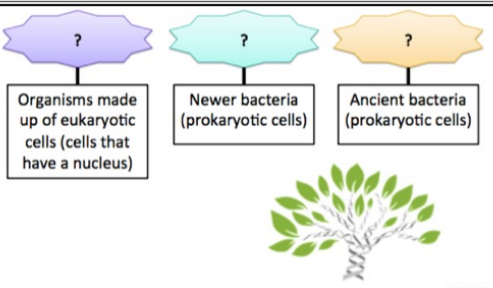
tion 7 continued-

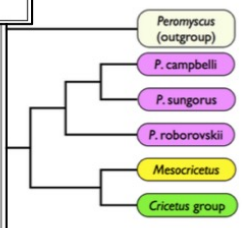
les, which list the classification of an opossum vs. classification of a spider monkey.

s of the Primate Order is opposable thumbs, yet posable thumbs, and are not Primates. They are ly. When comparing opposable thumbs among er monkeys, how might you describe this trait?









Phodopus is a genus found within the hamster family. The diagram at right organizes the species found in the Phodopus genus.

A clade is a group that reflects a common ancestor.



23 STATIONS PLUS STUDENT RECORDING SHEET. EDITABLE.

biology roots