Unit: The Characteristics of Life

Lesson Plan 3: Determining Relationship

Objective(s):

Students will be able to:

- Define the following terms: 1) phylogeny, 2) cladistics, and 3) cladogram.
- List the five determinants of relationship.
- Identify the parts, and their meaning, of a tree of life.

Materials:

PowerPoint: "Classifying Life's Diversity"

Anticipatory Set:

On a sheet of paper, use your imagination to draw 10 new species of animals or plants. Be as creative as you can be. Look over your drawings. Create a list of similarities between each species. You as an artist, or intelligent designer, created 10 different species using your own imagination, yet there are similar traits that can be found among the species (give examples). These similar traits would be used by taxonomists to classify each organism.

Lesson:

I. PowerPoint presentation: Part 1 – "Determining Relationship"
II. Tree of Life worksheet

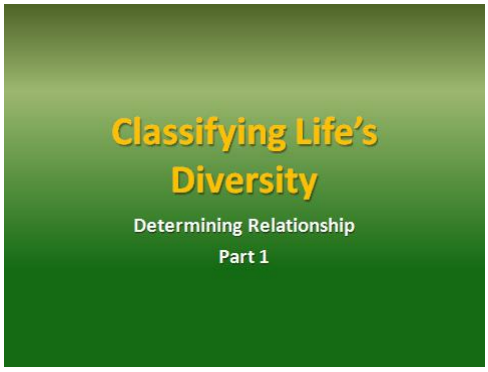
Lab / Project:

- Cladogram Lab
- Tree of Life Project

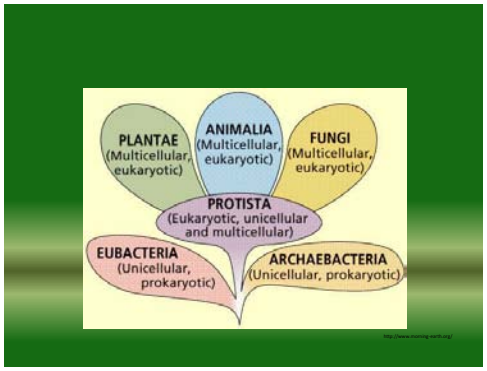
Evaluation:

- Tree of Life worksheet
- Quiz

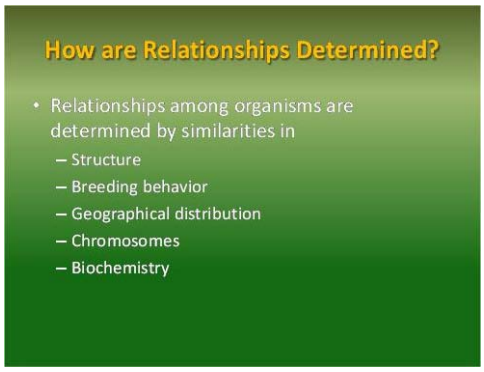
PowerPoint Notes:



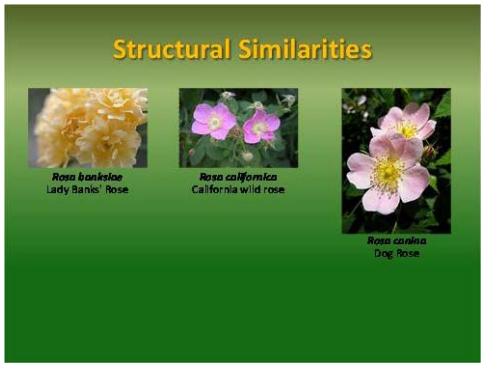
Slide Notes:
In classifying organisms, taxonomists must figure out the relationships among species. In this lesson we will learn how relationships are determined.



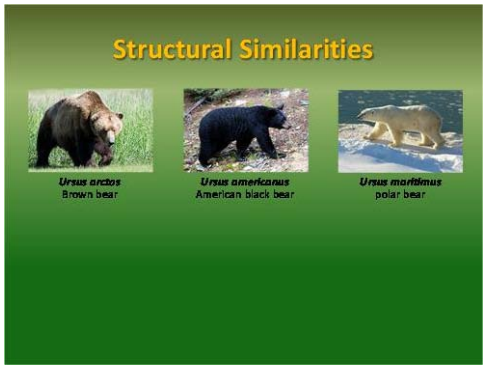
Slide Notes:
Remember that every organism falls into one of the six kingdoms.



Slide Notes:
Modern classification looks at the similarities, not differences, among organisms. *Relationship* refers to how similar different organisms are. The more qualities they have in common, the closer the relationship. Listed are the five major determining factors in identifying relationship among species.



Slide Notes:
What similar qualities do these species have? They all have the structure of plants, more specifically the structure of flowering plants. Have students list the similar structural qualities they can observe. These traits are why the three species fall into the *rose* genus.

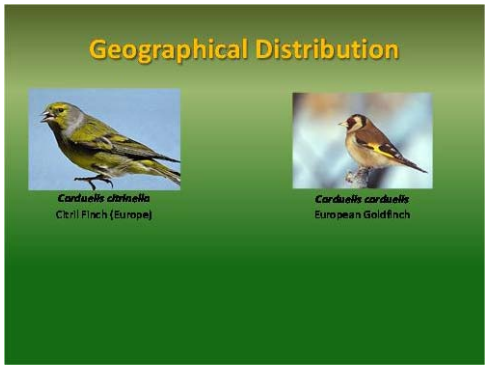


Slide Notes:
What similar qualities do these species have? Have students list the similar structural qualities they can observe. These three species fall into the *ursus*, or *bear*, genus.

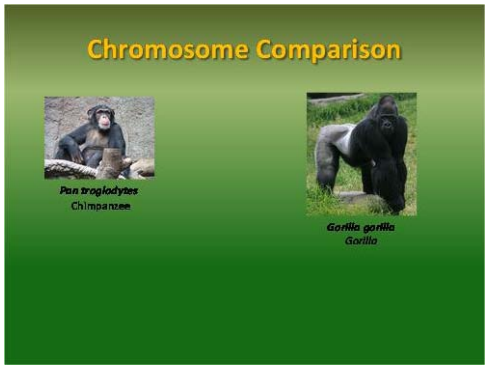
Slide Notes:
What similar qualities do these two species have? Have students give ideas of how birds reproduce.

Slide Notes:
What similar qualities do these two species have?

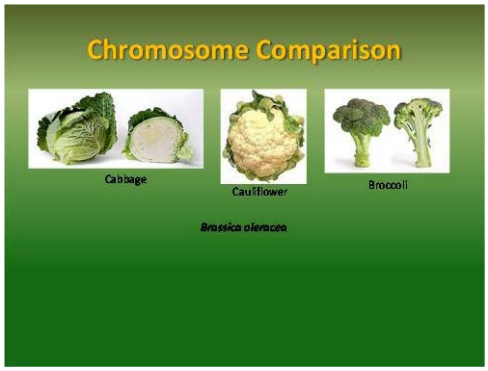
Slide Notes:
What similar qualities do these species have? Finches are found in many parts of the world. These two are considered very close in relation because they are both found in the Galapagos Islands of South America.



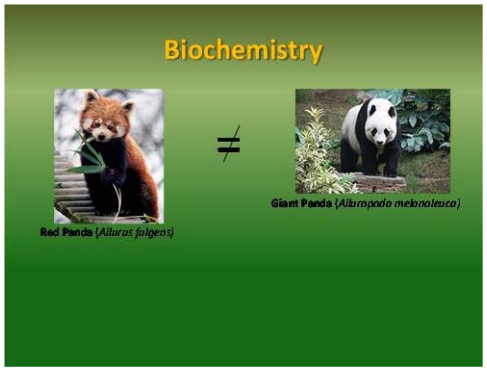
Slide Notes:
These finches and the finches on the last slide are in close relation compared to other types of birds, but not in comparison to each other. Ask students why. The finches on the other slide were found in the Galapagos, but these finches are found in Europe. Their location is one reason they are placed in different genus.



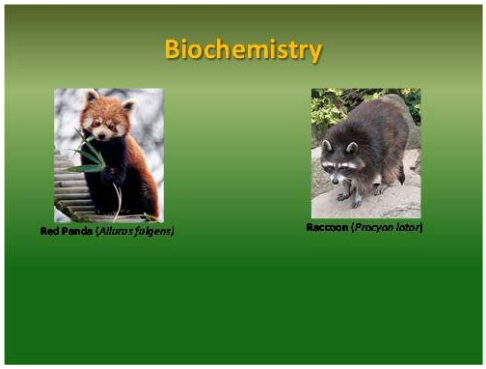
Slide Notes:
What is it that determines what traits are expressed by different organisms? Their DNA. These two species have a lot in common because of their chromosomes. Taxonomists look at the number of, shape of, and information held on chromosomes to determine relationship.



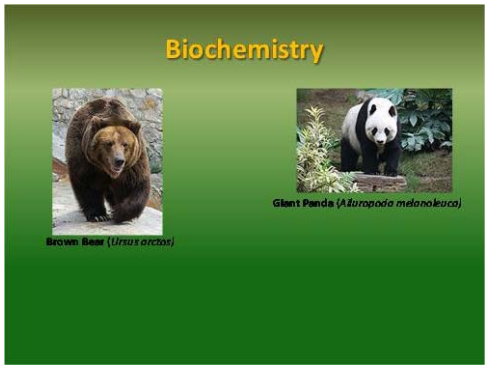
Slide Notes:
Look at these vegetables. One would automatically think they are different species because of how they look. However, taxonomists have found that though they look different, they have exactly the same chromosomes with all the exact same information. Thus, they have been classified as members of the same species.



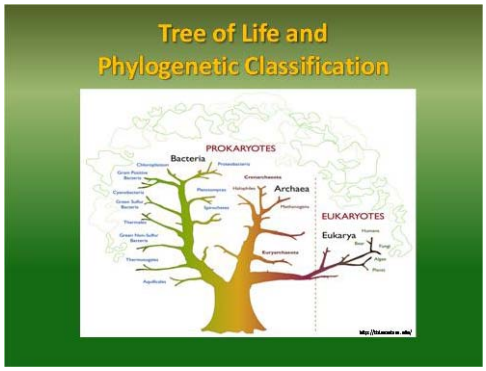
Slide Notes:
For a long time taxonomists believed these two creatures were closely related. This is why they share similar common names (panda). Taxonomists, however, have recently had to reclassify them when they began to study the biochemistry of the organisms.



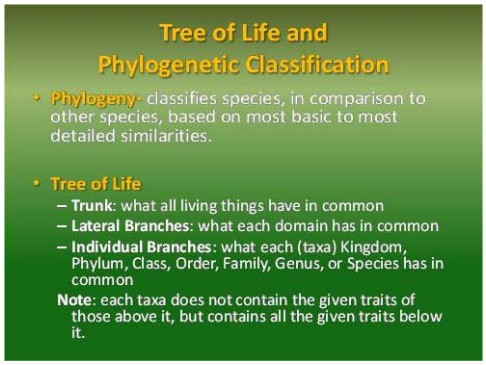
Slide Notes:
Biochemistry research has shown that the red panda has much more in common with a raccoon than it does with the giant panda.



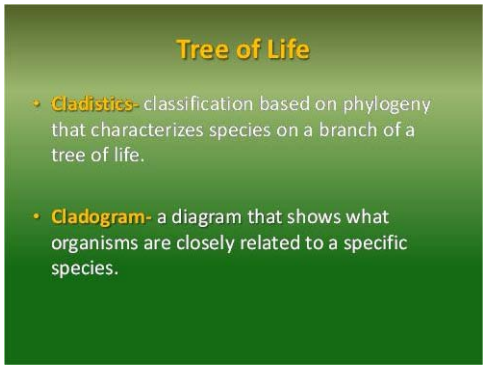
Slide Notes:
Biochemistry research has shown that a giant panda has much more in common with a bear than it does with the red panda.



Slide Notes:
Once the relationship between organisms has been determined, they can be organized on a chart referred to as a tree of life.



Slide Notes:
A tree of life uses phylogeny to show the shared characteristics among different species. The trunk represents what all living things have in common (made of cell(s), grow, adjust, adapt, need energy, and reproduce). Each lateral branch represents a different domain (Archaea, Bacteria, and Eukarya).

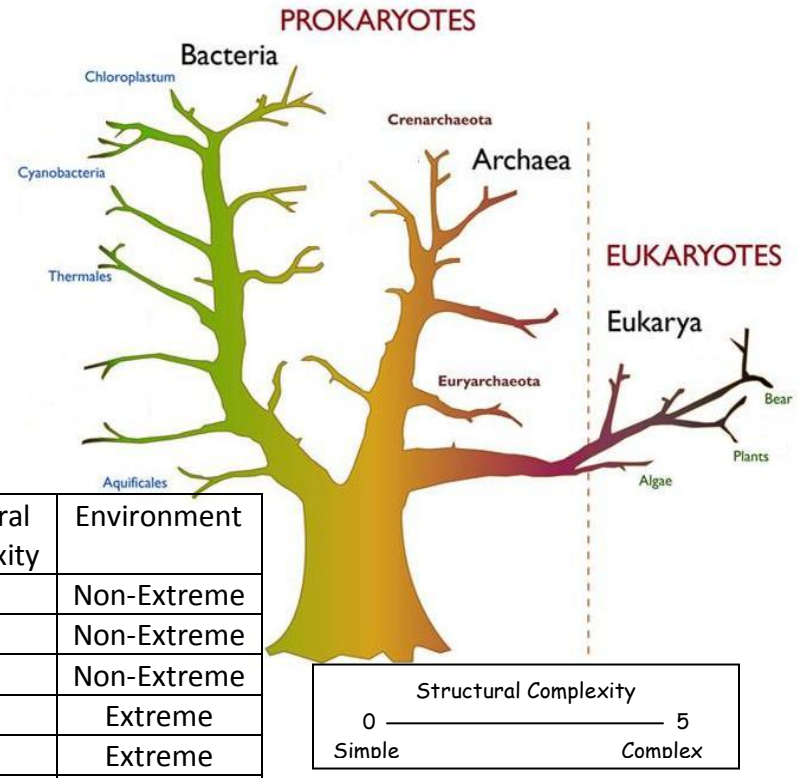


Slide Notes:
Cladistics looks at the similar traits among species. It is a more detailed picture of one branch of a tree of life.

Tree of Life
Date: _____

Name: _____
Class: _____

Study the following example.



Organism	Cell Type	Structural Complexity	Environment
Plants	E	2	Non-Extreme
Algae	E	3	Non-Extreme
Bear	E	4	Non-Extreme
Euryarchaeota	P	1	Extreme
Crenarchaeota	P	4	Extreme
Aquificales	P	1	Non-Extreme
Thermales	P	2	Non-Extreme
Cynobacteria	P	3	Non-Extreme
Chloroplastum	P	4	Non-Extreme

A tree of life is a drawing, much like a family tree, that shows how one organism relates to other organisms. A tree of life drawing generally gives less detail than a cladogram, but can be a collection of cladograms showing the relationships of the different species in each domain.

In the example above, the three lateral (main) branches represent the three domains. The organisms on each branch are ordered based on their structural complexity. Those organisms that are the least complex are found closest to the truck of the tree. Looking at the Eukarya branch, Algae is the least complex. Seaweed is one of the most complex forms of algae, but it still lacks some of the organs found in many land plants. Thus seaweed is ranked below plants. Additionally, although trees are plants with complex organ system, they do lack a system that allows them to move from place to place. Thus plants are ranked below bears.

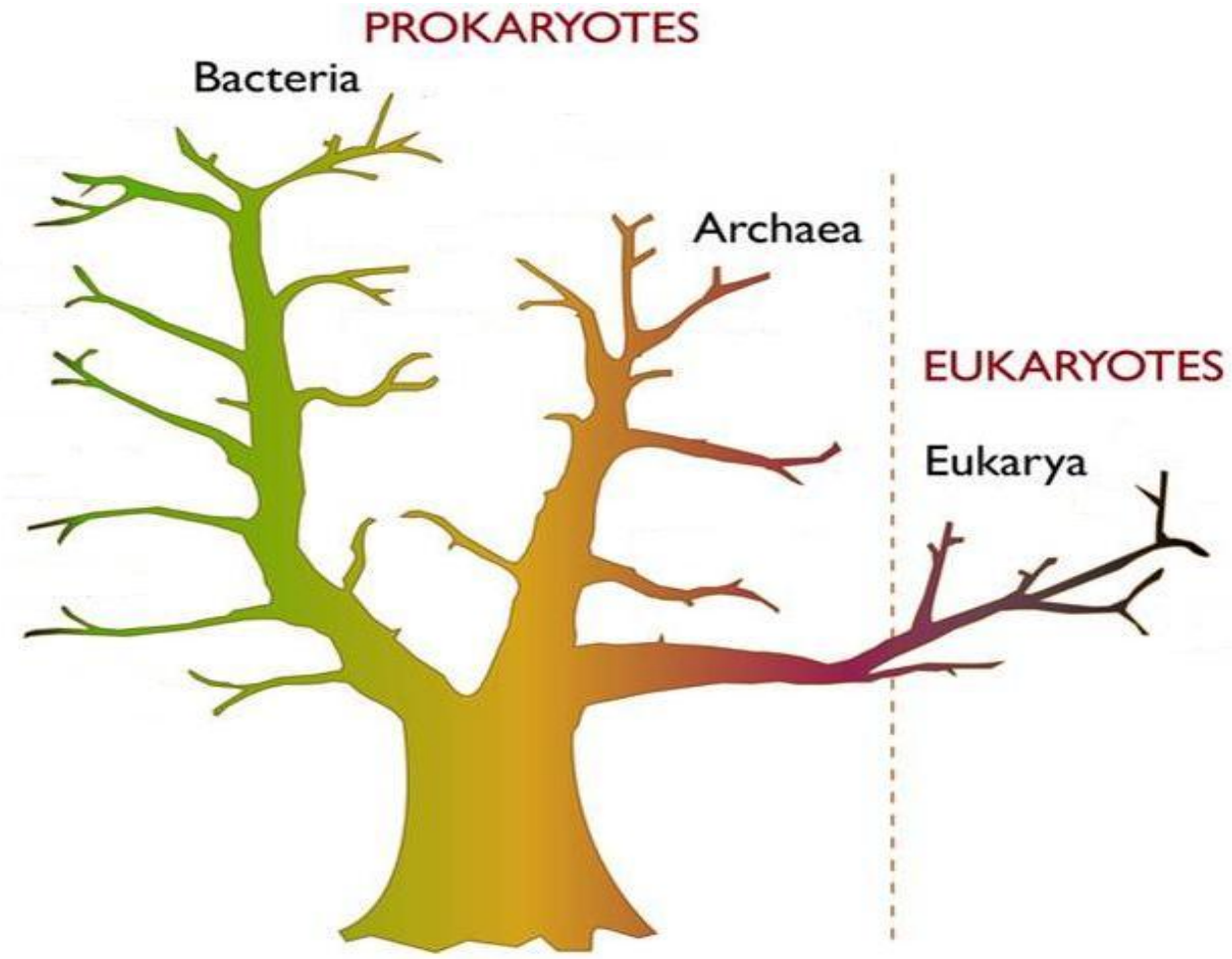
Lab: Tree of Life
Date: _____

Name: _____
Class: _____

Position each organism on the tree of life below.

Organism	Cell Type	Structural Complexity	Environment
Zooplankton	E	2	Non-Extreme
Thermotogales	P	2	Non-Extreme
Cat	E	4	Non-Extreme
Methanogens	P	3	Extreme
People	E	5	Non-Extreme
Oak tree	E	3	Non-Extreme
Crenarchaeota	P	5	Extreme
Spirochetes	P	3	Non-Extreme
Proteobacteria	P	5	Non-Extreme

Structural Complexity
0 _____ 5
Simple Complex



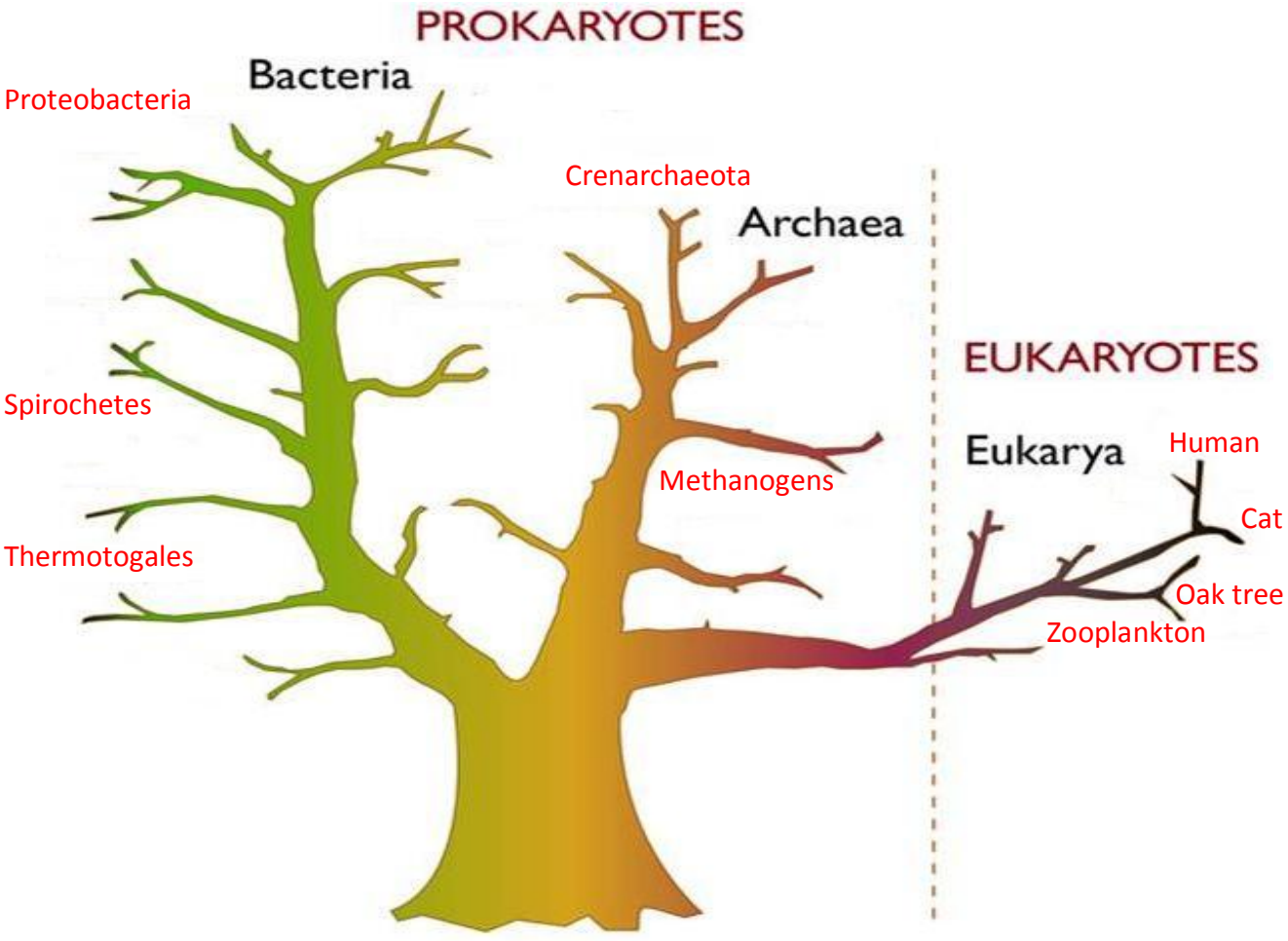
Lab: Tree of Life
Date: _____

Name: Key
Class: _____

Position each organism on the tree of life below.

Organism	Cell Type	Structural Complexity	Environment
Zooplankton	E	2	Non-Extreme
Thermotogales	P	2	Non-Extreme
Cat	E	4	Non-Extreme
Methanogens	P	3	Extreme
Human	E	5	Non-Extreme
Oak tree	E	3	Non-Extreme
Crenarchaeota	P	5	Extreme
Spirochetes	P	3	Non-Extreme
Proteobacteria	P	5	Non-Extreme

Structural Complexity
0 ——— 5
Simple Complex



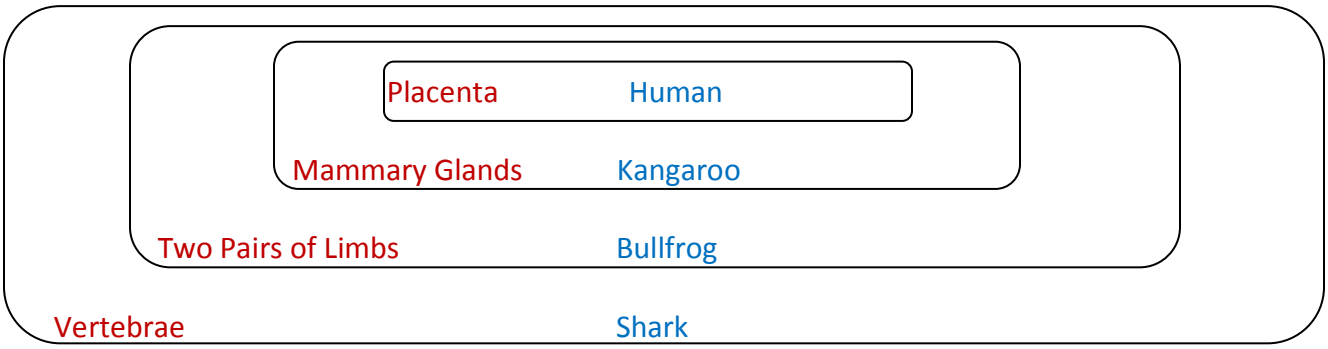
Lab: Cladogram **Name: _____**
Date: _____ **Class: _____**

Cladograms are diagrams that show the relationship between different groups of taxa, or clades. A cladogram show what similar traits and qualities different organisms have in common. Cladograms are constructed by grouping organisms together based on these similar qualities.

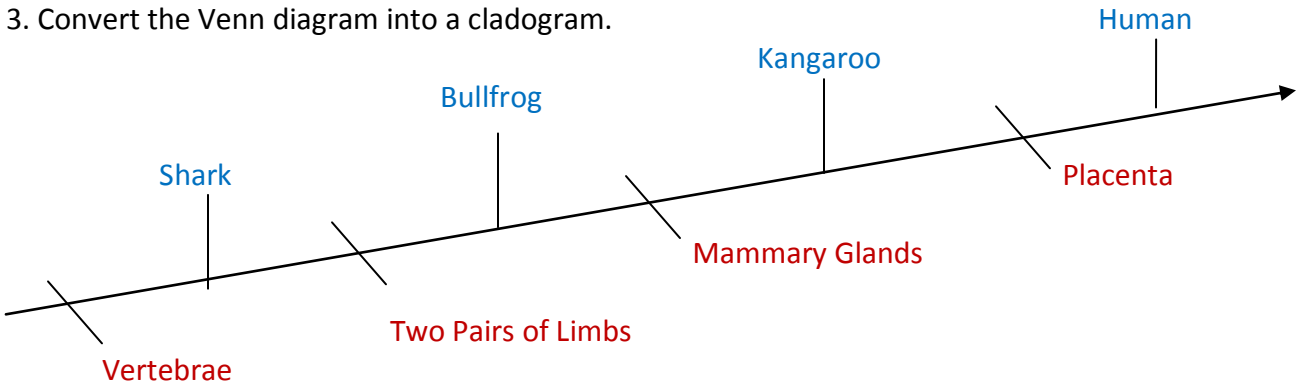
Example:
1. Observe the characteristics and taxa in the table.

	Taxa			
Characteristic	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 using the information in the table above. For this example, draw four circles; one inside the other. Each circle will contain the same characteristics as the circles surrounding it, but not the characteristics of circles within it.



3. Convert the Venn diagram into a cladogram.



Lab: Cladogram **Name: _____**

Date: _____ **Class: _____**

Directions: Use the information in the table below to create a Venn diagram and a cladogram.

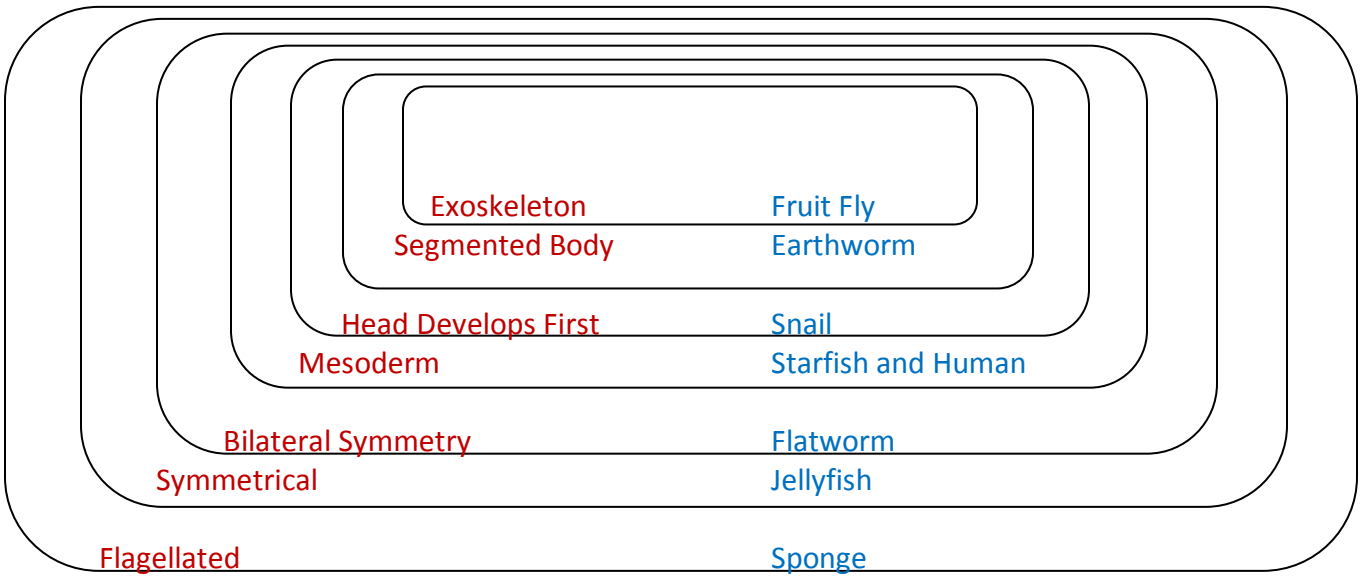
	Taxa							
Characteristics	Sponge	Jellyfish	Flatworm	Earthworm	Snail	Fruit fly	Starfish	Human
Flagellated	X	X	X	X	X	X	X	X
Symmetrical		X	X	X	X	X	X	X
Bilateral Symmetry			X	X	X	X	X	X
Mesoderm				X	X	X	X	X
Head Develops First				X	X	X		
Anus Develops First							X	X
Segmented Body				X		X		
Calcified Shell					X			
Exoskeleton						X		
Water-vascular System							X	
Vertebrae								X

Lab: Cladogram **Name: Key**
Date: _____ **Class: _____**

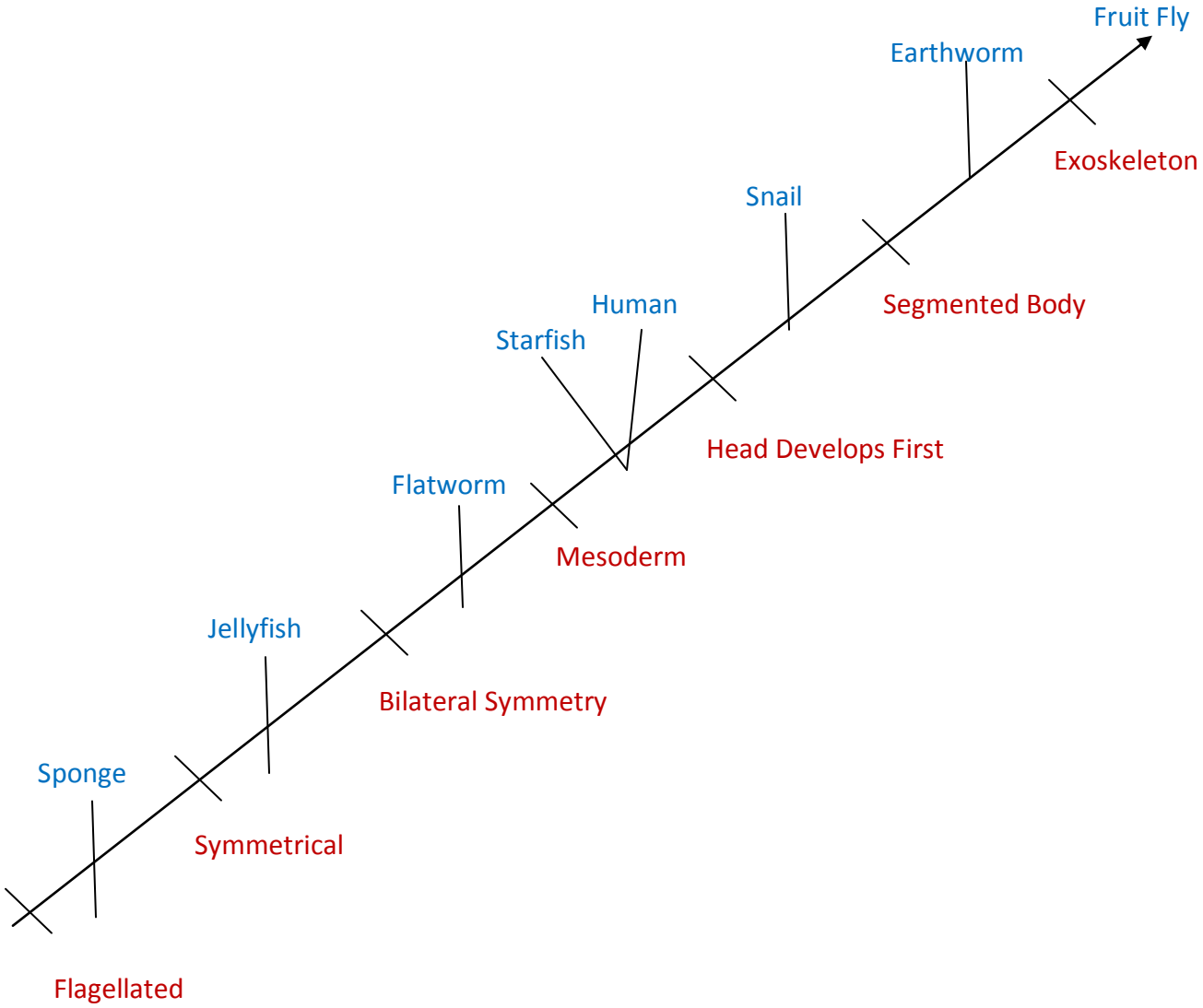
Directions: Use the information in the table below to create a Venn diagram and a cladogram.

	Taxa							
Characteristics	Sponge	Jellyfish	Flatworm	Earthworm	Snail	Fruit fly	Starfish	Human
Flagellated	X	X	X	X	X	X	X	X
Symmetrical		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		
Calcified Shell					X			
Exoskeleton						X		
Water-vascular System							X	
Vertebrae								X

Create a Venn diagram:



Create a cladogram:



Adapted from bu.edu/gk12/eric

Creating a Tree of Life

Introduction:

A tree of life is used in taxonomy to show the relationship among species, and it includes the three domains. The trunk of the tree represents what all living things have in common (made of cells, obtain and use energy, grow, adjust, adapt, and reproduce). The main branches, or lateral branches, represent each of the three domains (Archaea, Bacteria, and Eukarya). The excess branches, or individual branches, are used to show what the different taxa have in common.

There are various ways a tree of life can be represented. It may be a simple picture that omits the individual branches, or it may be a complex diagram that includes multiple cladograms in the place of the individual branches. The complexity of a tree of life is dependent on what details the taxonomist wishes to show.

Materials:

Poster
Nature Magazines
Art Supplies
- Color pencils, markers, paint, etc.
- Scissors
- Glue or tape

Procedures:

1. Look at several tree of life examples on the internet to get an idea of how you would like to make yours.
2. Select 3 Archaebacteria, 5 Bacteria, and 16 Eukarya (3 Protists, 3 Fungi, 5 Plants, and 5 Animals) to include in your tree of life. Research the similarities among each species.
3. Create a cladogram for each kingdom using your chosen species.
4. On a poster board, combine your cladograms into one tree of life. Be as creative as you can be. Include pictures on your tree. You may use pictures from magazines or you may draw your species. Refer to the rubric for additional requirements.

Rubric for Tree of Life Project

Use the following rubric as a guide in constructing your tree of life.

Criteria	Quality			Percent Grade
Knowledge & Understanding	Overall project displays a full understanding of cladograms and tree of life diagrams.	Overall project displays an incomplete understanding of cladograms and tree of life diagrams.	Overall project displays a lack of understanding of cladograms and tree of life diagrams.	25
Thinking & Inquiry	Evident that time was spent on research. Project shows full understanding of the relationships among diagramed species.	Some evidence of research. Project shows some understanding, though not all accurate, of the relationships among diagramed species.	Little evidence of time spent on research. Project does not show understanding of the relationships among diagramed species.	25
Application	Tree of life diagram accurately shows the relationships among all diagramed species.	Most branches of the tree of life show the accurate relationships among diagramed species.	Most branches of the tree of life show an inaccurate relationship among diagramed species.	25
Creativity	Tree of life diagram uniquely and neatly displays the information. A picture is included for each species.	Tree of life diagram is not uniquely designed, but neatly displays the information. A picture is included for most species.	Tree of life diagram is neither uniquely nor neatly displayed. Few or no pictures are included.	25
Notes				

Quiz: Determining Relationship **Name: _____**
Date: _____ **Class: _____**

Match:

_____ 1. Phylogeny a) characterizes species in a given taxon

_____ 2. Cladistics b) diagram that shows what organisms are closely related to a specific species

_____ 3. Cladogram c) classifies species based on basic to most detailed similarities

List the five determinants of relationship:

4. S_____

5. B_____ B_____

6. G_____ D_____

7. C_____

8. B_____

Identify the parts of a tree of life and describe their meaning:

9. T_____ -

10. L_____ B_____ -

11. I_____ B_____ -

Quiz: Determining Relationship **Name: Key**
Date: _____ **Class: _____**

Match:

c	1. Phylogeny	a) characterizes species in a given taxon
a	2. Cladistics	b) diagram that shows what organisms are closely related to a specific species
b	3. Cladogram	c) classifies species based on basic to most detailed similarities

List the five determinants of relationship:

4. Structure

5. Breeding Behavior

6. Geographical Distribution

7. Chromosomes

8. Biochemistry

Identify the parts of a tree of life and describe their meaning:

9. Trunk - represents what all living things have in common

10. Lateral Branches - represents what each domain has in common

11. Individual Branch - represents what each taxa has in common