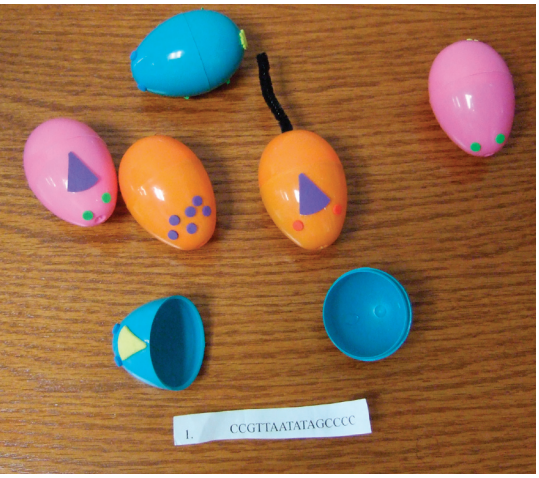
Thermal Biology in Yellowstone National Park

Lesson plan by Deb Williams, modified by TBI



VOCABULARY

Taxonomy, Phylogeny Tree
DNA, Tree of Life
3 Domains of Life: Archaea, Bacteria, and Eukaryote

Content:

SCIENCE STANDARDS

NATIONAL SCIENCE STANDARDS:

NS.5-8.3 Life Science

- Structure and function of living systems
- Diversity and adaptations of organisms

NS.5-8.7 History and the Nature of Science

- Science as a human endeavor
- Nature of science
- History of science

MONTANA SCIENCE STANDARDS:

Content standard 3. Life Science

- Create and use a basic classification scheme to identify plants and animals.

Content standard 6: Historical developments in science and technology

- Examples of scientific discoveries and the interrelationship between technological advances and scientific understanding.
- Identify major milestones in science that have impacted science, technology, and society.
- Describe and explain science as a human endeavor and an ongoing process.

LESSON GOALS:

Understand that the access to more information has allowed us to better understand the relationships of living organisms based on their shared genetic material. As a consequence, scientists are in the process of re-organizing how they classify organisms.

LEARNER OBJECTIVES:

1. Students will understand that organisms can be classified in many different ways and that classification is necessary to help us understand relationships between living things.

2. Students will understand that scientists classify living organisms into three different domains based on their genetics.

3. Students will understand that all living things share a common ancestor

BACKGROUND CONTENT:

Traditionally, the classification of organisms or **taxonomy** has relied on physical characteristics to understand the relationships

between living things. Carl Linnaeus in the 1700's classified organisms this way. His system used broad grouping characteristics that gradually become more descriptive until the organism reached a species name. The system that began with Linnaeus is Kingdom, Phylum, Class, Order, Family, Genus and Species. For example the wolf is classified in the Animalia Kingdom (all moving and respiring organisms), Chordata Phylum (animals with spinal cords), Mammalia Class (animals with hair and mammary glands), Carnivora Order (meat eaters), Canidae Family (dogs), Canis Genus (jackals, coyotes, and wolves), *lupus* Species (wolf). The binomial name is *Canis lupus* which translates to wolf dog. The naming of organisms with binomial nomenclature helps describe and identify related species. At the present time there are approximately 1.4 million named species, an overwhelming diversity of species that can be comprehended using taxonomy. The following 2 examples use a classification scheme to separate out 6 kinds of animals. Note that classification can occur in several ways.

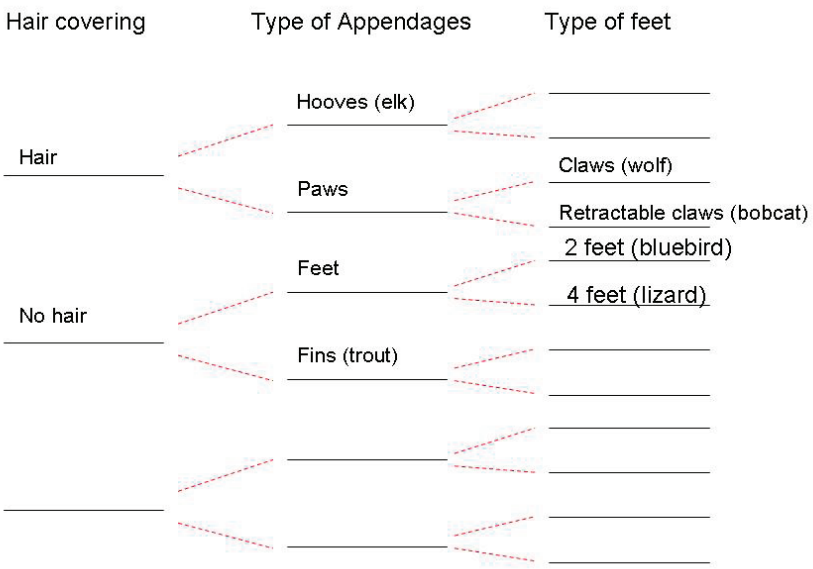


FIGURE 1. Classification of elk, bobcat, wolf, lizard, bluebird, and trout.

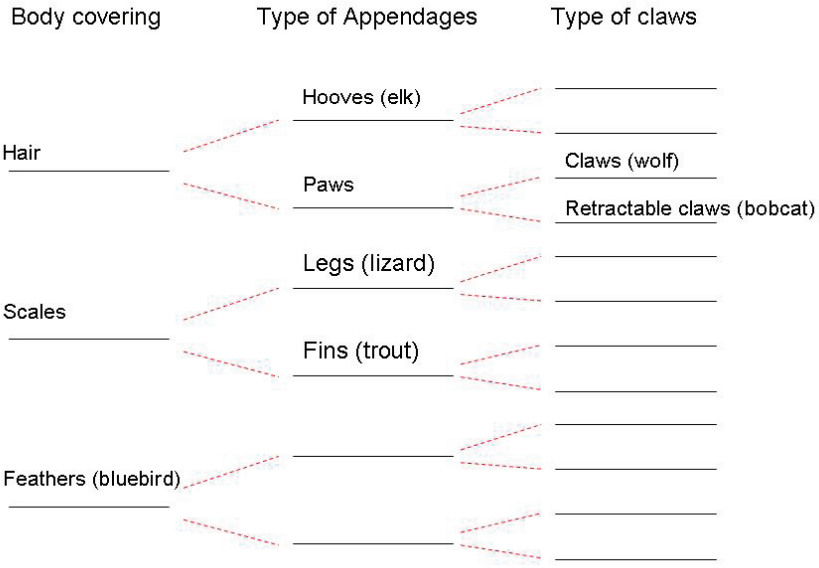


FIGURE 2. Classification of elk, bobcat, wolf, lizard, bluebird, and trout.

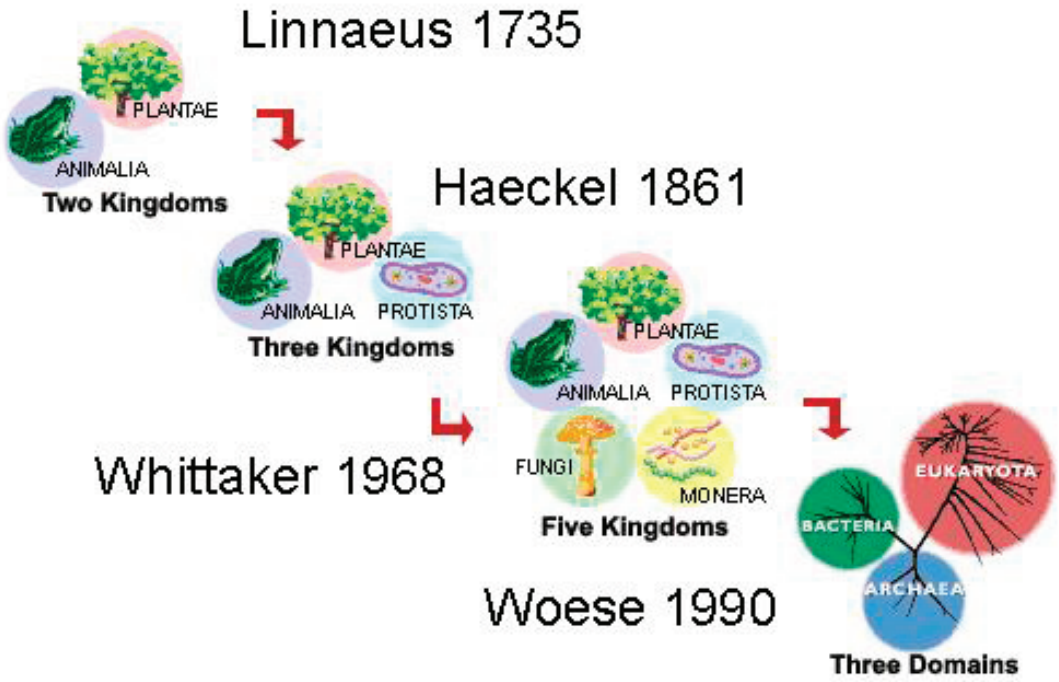


FIGURE 3. The history of classification schemes

Classification schemes have changed dramatically through time as technology advancements have been made (Figure 3). The most recent advancement occurred when a scientist by the name of Carl Woese used genetic evidence to define organism relationships and then suggested that there are **3 domains of life**, Bacteria, Archaea, and Eukaryote for all organisms, instead of the traditional five kingdoms. His work was published in the 1990's and today is well accepted by the scientific community.

Technological tools have allowed scientists to readily and relatively inexpensively classify organisms by their genetic information. This advancement has greatly changed the way biologists view relationships between organisms and the **evolution** of organisms. Evolution is the process of change in heritable traits of organisms from one generation to the next. Scientists determine evolutionary history by analyzing genetic material, or **DNA**, in the cell.

DNA is the code for life and is found in every cell of every living organism. Scientists now can see genetically that certain organisms are similar because they share common genes and therefore ancestors. The following is an example of a phylogeny tree which shows the genetic relationship of organisms through evolutionary time (Figure 4). In the figure notice the common ancestor at point 'A' at 150 million years ago for mammalian and reptilian species. At point 'A' cold blooded land species diverged from warm blooded land species. There is a common ancestor at 500 million years ago for all species with boney vertebrae at point 'B'. At this point 'B', land species separated from aquatic species.

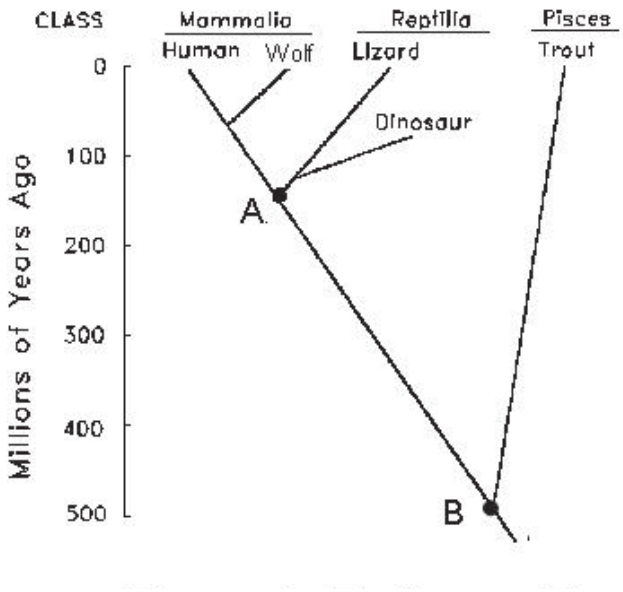


FIGURE 4. Phylogeny Tree

MATERIALS:

Plastic Easter eggs (6 per group, 3 different colors). Attach stickers to plastic eggs to represent tails, horns, eyes, and legs on each egg. Inside the egg include a genetic code sequence on a strip of paper. See suggested egg configurations in teaching materials.

ANTICIPATORY SET:

Teacher will have a tree of life skeleton on the board using a different color marker for each of the 3 domains. Each section will be individually labeled with Bacteria, Archaea, Eukaryote and the branches in each section will meet at a central connection point. A question will be written on the board asking "Where do you belong on this Tree of Life?"

PROCEDURE:

1. Obtain a set of 6 plastic Easter eggs from the resource table.

2. Carefully examine the eggs without opening them. Classify the eggs into at least two different groups (similar to Figures 1 and 2).

3. Record the characteristics you used to classify the eggs on the blank classification scheme provided.

4. Trade your classification scheme with another working group; use their scheme to classify your eggs. Did you classify the eggs the same way? Are there multiple ways to classify organisms by physical features? How do we find the correct one?

5. Discuss with the class the methods used to classify eggs.

6. Open your eggs and examine the genetic code inside. Record the code given for each of your eggs and their physical characteristic on the table provided.

7. Analyze the genetic code 3 letters at a time. Remember, these three letters represent the codon for the RNA, which is translated into an amino acid which they in turn hook together to make proteins. Determine which eggs are related genetically.

8. Describe how your eggs are related based on the genetic information. Explain any relationships in the last column of the table.

9. Create a phylogeny tree or "**Tree of Life**" for your eggs using the information you have learned (similar to Figure 4).

10. Compare the data you collected in the first part of the lab to the data from the second part of the lab. Is your physical classification scheme similar to the genetic classification scheme? If not, how are they different?

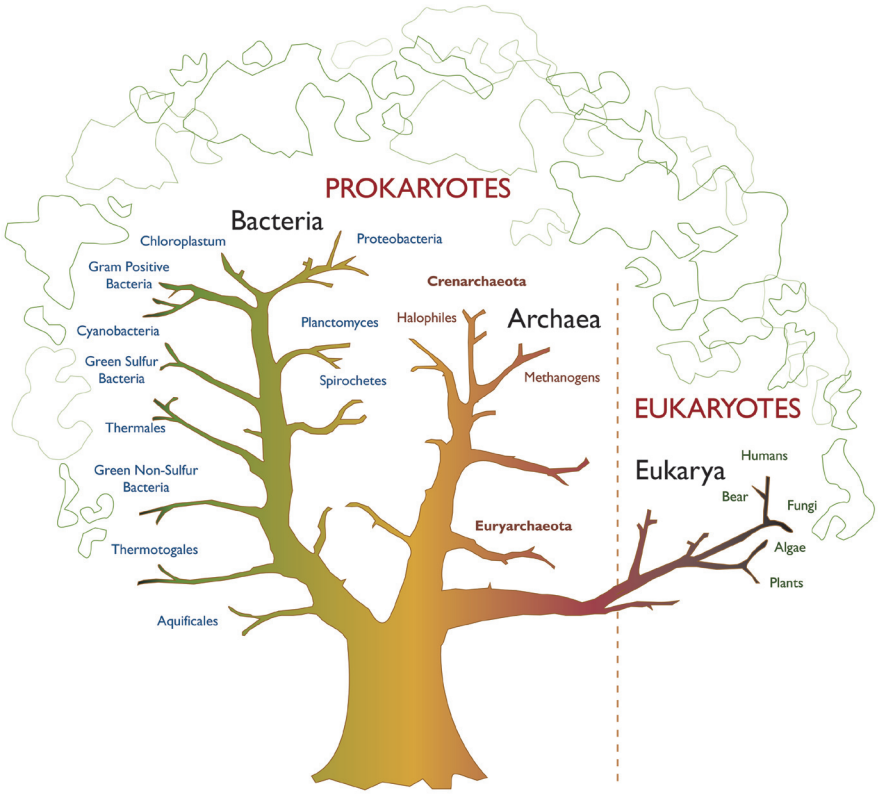
11. Describe a possible evolutionary event or events that occurred at the junctions of any lines on your phylogeny tree.

Genetic Code	Number of Egg	Color of Egg	Number of eyes	Horns	Tail	Number of legs	Relatedness of the Eggs
CCGTTAATATAGCCCC	1	Blue	2	Y	Short	4	Same as egg 2 (male and female, or adult and juvenile)
CCGTTAATATAGCCCC	2	Blue	2	N	Short	4	Same as egg 1 (male and female, or adult and juvenile)
CTGTTAATATAGCCCA	3	Orange	2	Y	Long	4	Closely related to eggs 1 and 2
AAGTAAATGGAGCTCA	4	Orange	6	N	None	0	Very little relationship to 5 and 6
CCGTAAATATAGCTGG	5	Pink	2	N	Short	0	Closely related to egg 6, and more distantly related to 1 and 2, and also 3
CCGTAATTATAGCTGG	6	Pink	2	Y	None	0	Closely related to egg 5

SUMMING IT UP:

The **Tree of Life** depicts the relationships of all life on earth. There are 3 domains of life, Bacteria, Archaea, and Eukaryotes that are represented by the 3 large branches. Bacteria and Archaea, as well as the base of the Eukaryote branch are all single celled organisms. Using the Tree of Life provided answer the following questions:

1. Where are humans on the tree of life?
2. What is the name of the Domain that humans belong?
3. Fungi and bears share a common ancestor. How can this be?
4. What is the purpose of classifying organisms?



CLOSURE:

In a whole class discussion, make the comparison between the two classification schemes. Discuss why scientists have shifted classification from physical characteristics to genetic characteristics.

RESOURCES:

http://nsm1.nsm.iup.edu/rgendron/labs.shtml

http://evolution.berkeley.edu/evosite/evo101/IIntro.shtml

http://www.tbi.montana.edu/outreach/hotscience/materials/

See next page!!! Genetic codes for cutting >

1. CCGTTAATATAGCCCC
2. CCGTTAATATAGCCCC
3. CTGTTAATATAGCCCA
4. AAGTAAATGGAGCTCA
5. CCGTAAATATAGCTGG
6. CCGTAATTATAGCTGG

1. CCGTTAATATAGCCCC
2. CCGTTAATATAGCCCC
3. CTGTTAATATAGCCCA
4. AAGTAAATGGAGCTCA
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