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DEPARTMENT OF EDUCATION
SCHOOLS DIVISION OF NEGROS ORIENTAL
REGION VII

Kagawasan Ave., Daro, Dumaguete City, Negros Oriental



SYSTEMATICS BASED ON EVOLUTIONARY RELATIONSHIPS (CLADISTICS AND PHYLOGENY)

for General Biology 2 Grade 11
Quarter 3 / Week 8



SELF-LEARNING KIT

FOREWORD

This self-learning kit will serve as a guide for learners in understanding the diversity and evolutionary relatedness between and among species. By going through with the methods utilized by scientists and biologists in illustrating evolutionary relationships among organisms, may these guide learners to better understand how life is interconnected with each other.

Just like a family tree, siblings are close together, indicating a close genetic relationship, but the siblings are far from their great aunt, indicating a more distant genetic relationship.

May this lesson help learners to classify organisms on their own depending on which species they are interested in classifying. In this way, students will be able to visualize evolutionary relatedness using observable physical features.

OBJECTIVES

At the end of the lesson, learners shall be able to:

K: describe the evolutionary relationships of organisms based on a cladogram;

S: identify the common traits present in organisms; and

A: recognize the importance of classifying organisms.

LEARNING COMPETENCY

Describe the species diversity and cladistics, including the types of evidence and procedures that can be used to establish evolutionary relationships. (**STEM_BIO11/12IIIhj-16**)

I. WHAT HAPPENED

PRE-ACTIVITY

Do you remember the last time you had a family reunion or a get together with some of your relatives?

Directions:

1. Collect at least two latest pictures taken from your family reunion or get together with your family and other relatives and describe each picture. You can do it in your notebook or in a bond paper.
2. Can you describe your family members? What makes you similar to them and what makes you unique?
3. List the characters or features that served as evidence that indeed you belong to the same family. Write down as many as you can (e.g., color of the eyes, skin, hair)

Rubrics:

Content ----- 10 points

Organization--- 10 points

Total 20 points

II. WHAT I NEED TO KNOW

DISCUSSION

Biodiversity refers to the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. Scientists have identified about 1.9 million species alive today. They are divided into the six kingdoms of life shown in Figure 1 below. Scientists are still discovering new species. Thus, they do not know for sure how many species really exist today. Most estimates range from 5 to 30 million species.

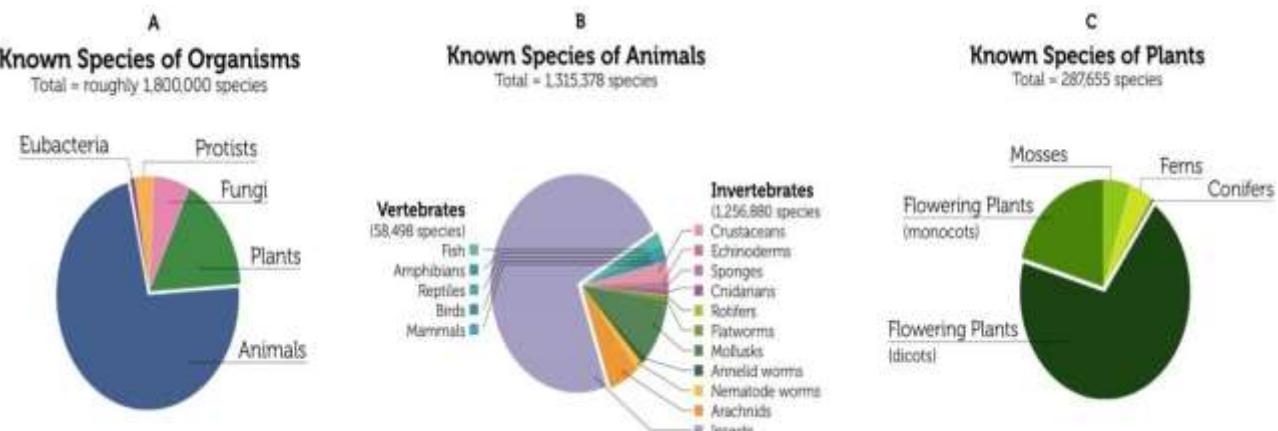


Figure 1. Known life on Earth. Source: <https://courses.lumenlearning.com/wm-biology1/chapter/reading-the-diversity-of-life/>

Biologists, however, are always alert to levels of organization and have identified three unique measures of life's variation:

- The most precise and specific measure of biodiversity is **genetic diversity or genetic variation** within a species. This measure of diversity looks at differences among individuals within a population, or at difference across different populations of the same species.

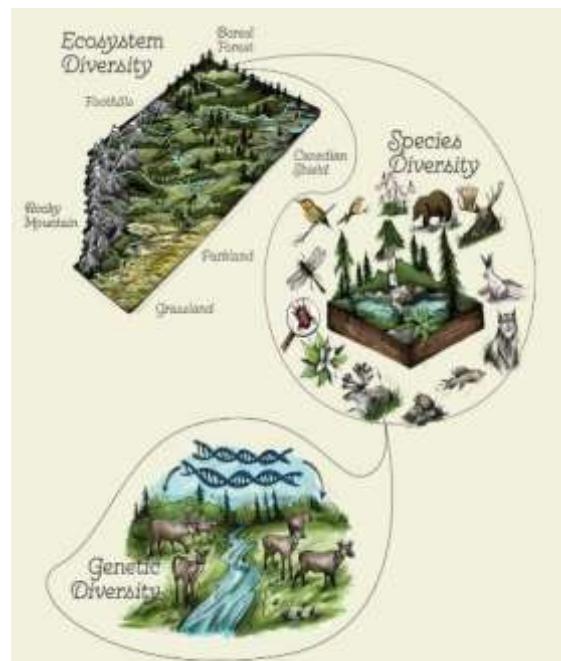


Figure 2. Ecosystem diversity.
Source: <https://courses.lumenlearning.com/wm-biology1/chapter/reading-the-diversity-of-life/>

- The level just broader is **species diversity**, which best fits the literal translation of biodiversity: the number of different species in a particular ecosystem or on Earth. This type of diversity simply looks at an area and reports what can be found there.
- At the broadest most encompassing level, we have **ecosystem diversity** (Figure 2). As Leopold clearly understood, the “cogs and wheels” include not only life but also the land, sea, and air that support life. In ecosystem diversity, biologists look at the many types of functional units formed by living communities interacting with their environments.

Although all three levels of diversity are important, the term biodiversity usually refers to **species diversity**.

Diversity may be measured at different scales. These are three indices used by ecologists:

- **Alpha diversity** refers to diversity within a particular area, community, or ecosystem, and is measured by counting the number of taxa within the ecosystem (usually species).
- **Beta diversity** is species diversity between ecosystems; this involves comparing the number of taxa that are unique to each of the ecosystems.
- **Gamma diversity** is a measurement of the overall diversity for different ecosystems within a region.

Amidst such diversity of these organisms is also an amount of similarity. This gives us the idea that somehow organisms are indeed related. Life is somehow interconnected to each other.

Over the last few centuries, systematists have developed different approaches to show relationships among organisms. The most commonly used is **cladistics**. The relationship is shown in a **cladogram**. It is based on a phylogeny which is the study of evolutionary relationships. Sometimes, a cladogram is called a phylogenetic tree (though technically there are minor differences between the two).

The basic assumption behind cladistics is that members of a group share a common recent ancestor and are thus more "closely related" to one another than they are to other groups of organisms.

Related groups of organisms are recognized because they share a set of derived characters. These derived characters were inherited from a recent ancestor.

Cladistics was developed in the 1950s by a scientist named Willi Hennig (Figure 3). Over the next several decades, it became very popular and is still widely used today.

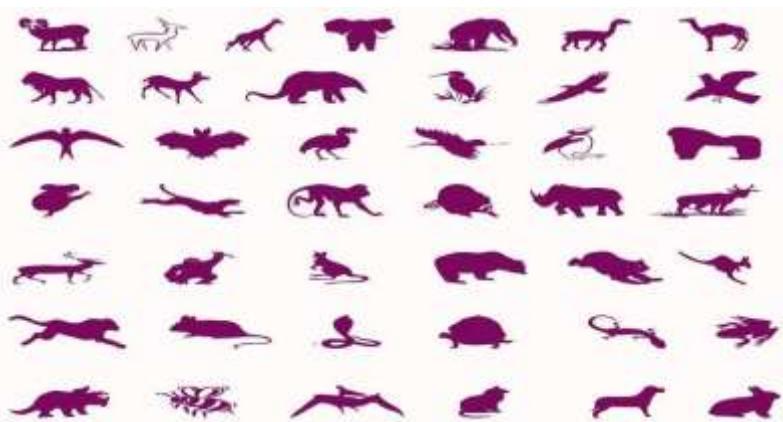


Figure 3. Phylogeny and cladistics. Image from Phylogenetic Classification-CK12.

Can two different species be related?

Of course, they can. For example, there are many different species of mammals, or of one type of mammal, such as mice. And they are all related. In other words, how close or how far apart did they separate from a common ancestor during evolution? Determining how different species are evolutionarily related can be a tremendous task.

One way of classifying organisms that shows phylogeny is by using the **clade**. A **clade** is a group of organisms that includes an ancestor and all its descendants. Clades are based on cladistics. This is a method of comparing traits in related species to determine ancestor-descendant relationships. Clades are represented by **cladograms**, like the one in Figure 4. This cladogram represents the mammal and reptile clades. The reptile clade includes birds. It shows that birds evolved from reptiles. Linnaeus classified mammals, reptiles, and birds in separate classes. This masks their evolutionary relationships.

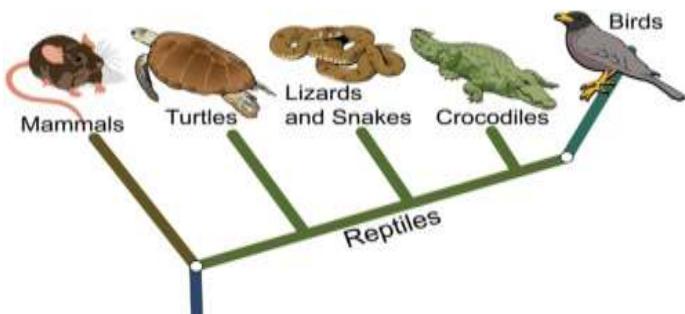


Figure 4. The cladogram classifies mammals, reptiles, and birds in clades based on their evolutionary relationships. Image from Phylogenetic Classification- CK12.

Phylogenetic Tree

In scientific terms, the evolutionary history and relationship of an organism or group of organisms is called **phylogeny**. Phylogeny describes the relationships of one organism to others—such as which organisms it is thought to have evolved from, which species it is most closely related to, and so forth. Phylogenetic relationships provide information on shared ancestry but not necessarily on how organisms are similar or different.

Scientists use a tool called a phylogenetic tree to show the evolutionary pathways and connections among organisms. A **phylogenetic tree** is a diagram used to reflect evolutionary relationships among organisms or groups of organisms. Scientists consider phylogenetic trees to be a hypothesis of the evolutionary past since one cannot go back to confirm the proposed relationships. In other words, a “tree of life” can be constructed to illustrate when different organisms evolved and to show the relationships among different organisms.

A phylogenetic tree can be read like a map of evolutionary history (Figure 5). Many phylogenetic trees have a single lineage at the base representing a common ancestor. Scientists call such trees rooted, which means there is a single ancestral lineage (typically drawn from the bottom or left) to which all organisms represented in the diagram relate. Notice in the rooted phylogenetic tree that the three domains—Bacteria, Archaea, and Eukarya—diverge from a single point and branch off. The small branch that plants and animals (including humans) occupy in this diagram shows how recent and minuscule these groups are compared with other organisms. Unrooted trees do not show a common ancestor but do show relationships.

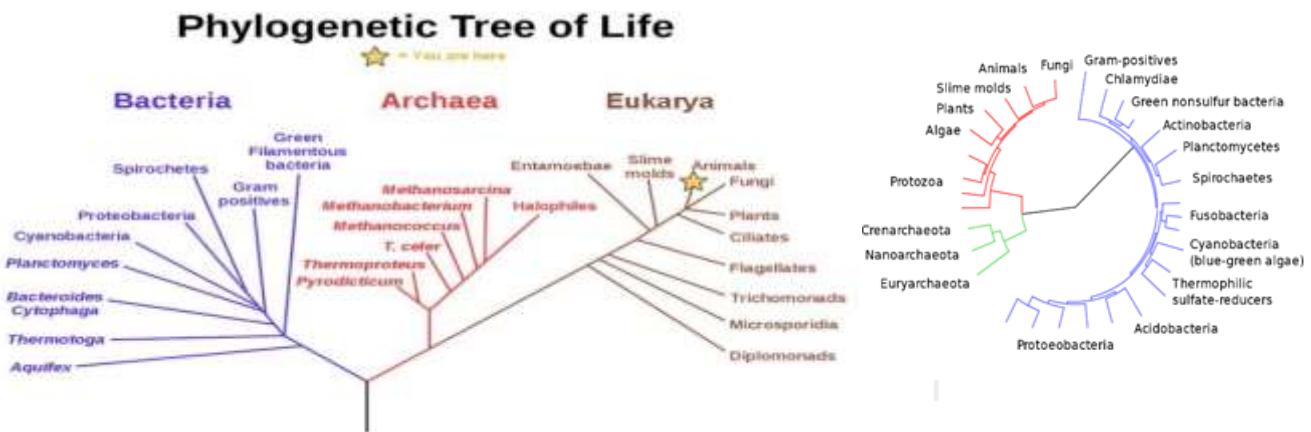


Figure 5. Phylogenetic tree of life. This phylogenetic tree was constructed by microbiologist Carl Woese using genetic relationships. The tree shows the separation of living organisms into three domains: Bacteria, Archaea, and Eukarya. Bacteria and Archaea are organisms without a nucleus or other organelles surrounded by a membrane and, therefore, are prokaryotes (Credit: modification of work by Eric Gaba). Source: <https://images.app.goo.gl/k2TRbQ62oyT6o6Bf7>.

It is like a family tree. **Family trees** show how people are related to each other. Similarly, scientists use phylogenetic trees like cladograms to study the relationships among organisms. Sometimes, family trees are used to show relationships between individuals. Those who are closely related are located closer together than those who are only distantly related. For instance, in a family tree, we can see that the siblings are close together, indicating a close genetic relationship, but the siblings are far from their great aunt, indicating a more distant genetic relationship. Family trees can also be used to see ancestral connections. That is, we can see that all the people in the last generation have the same great-great-grandparents in common. The same holds true for related species. The more distant the relationship between two related species, the farther back in time they shared a common ancestor.

Performance Task

Directions: Fill out the following character matrix. Mark “X” if an organism has the trait. Write your answers in your notebook.

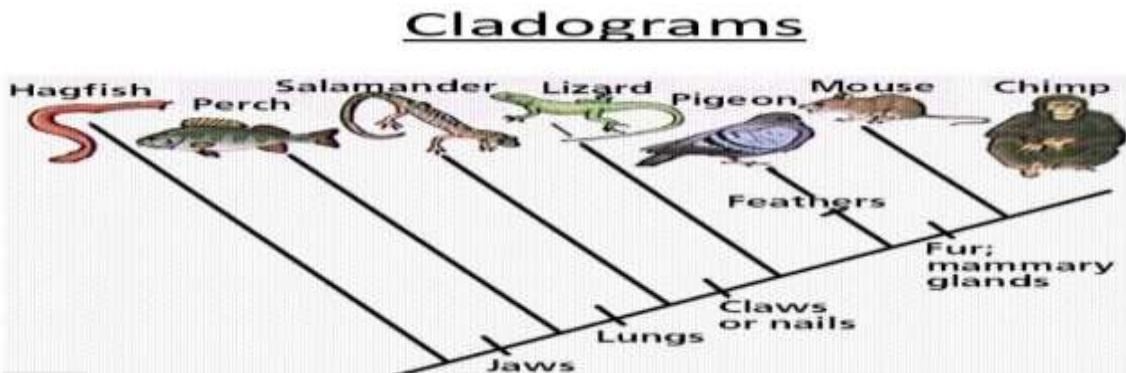
Organism	Cells	Legs	Antenna	Wings	Two sets of wings
Worm					
Spider					
Ant					
Housefly					
Dragonfly					

Guide Questions:

- a. Which two species are more closely related: worms and spiders or worms and ants? How do you know?
- b. What species are dragonflies most closely related to? How do you know?

III. WHAT I HAVE LEARNED

- I. **Cladogram Analysis.** Observe carefully and use the following cladogram to answer the guide questions. Write your answers in your notebook.



Source: https://www.google.com/search?q=cladograms&source=lnms&tbo=isch&sa=x&ved=2ahukewjnsf_8-duahwba4gkhef0cjkq_auoaxoe4qaw#imgrc=fct4wvmnuxzncm

Guide Questions:

1. What trait separates the salamander from the lizard in the cladogram?
2. What separates the lizard from the pigeon?
3. Which organism is closely related to the mouse?
4. Which organism's DNA will differ the most from the chimp? Why?

II. Short Essay. Cite the importance of classifying organisms. (5 points)

Rubrics:

Content ----- 3 points

Organization --- 2 points

Total 5 points

REFERENCES

<https://courses.lumenlearning.com/wmbiology1/chapter/readig-the-diversity-of-life/> Phylogenetic Classification CK12

<https://images.app.goo.gl/k2TRbQ62oyT6o6Bf7>

<https://courses.lumenlearning.com/wmnmbiology1/chapter/reading-phylogenetic-trees-2/>

https://www.google.com/search?q=cladograms&source=lms&tbo=isch&sa=X&ved=2ahUKEwjSnf_8--DuAhWBA4gKHeF0CjkQ_AUoAXoECA4QAw#imgrc=FCt4wVmNUxZncM

Lumenlearning.com

nigerianscholars.com/.../phylogeny-and-cladistics

Teaching Guide for Senior High School, pages 140-146



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SYNOPSIS

Earth has a remarkable diversity of life. As new organisms are still discovered every day, biologists continue to seek answers on how we can understand them. Phylogeny describes the relationships of one organism to others—such as which organisms it is thought to have evolved from, which species it is most closely related to, and so forth. Phylogenetic relationships provide information on shared ancestry but not necessarily on how organisms are similar or different.

A cladogram is a diagram that depicts evolutionary relationships among groups of organisms. Cladistics is a form of analysis that looks at the features of organisms that are considered “innovations” or newer features that serve the same purpose.

Cladogram Analysis						
Organism	Cell	Legs	Antenna	Wings	2 sets of wings	Wings
Dragonfly	X	X	X	X	X	X
Honeyfly	X	X	X	X	X	X
Ant	X	X	X	X	X	X
Spider	X	X	X	X	X	X
Worm	X	X	X	X	X	X

Pre-Activity: - A answers may vary

Performance Task

Guide Questions:

1. Clouds or nails
2. Feathers
3. Chimps
4. Hognose, answers may vary

A. Spider and ant because they are still related to the next trait which is the presence of legs
B. Housefly because both have wings

II. Short Essay (5 points)

A answers may vary

ANSWER KEY

ABOUT THE AUTHOR



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