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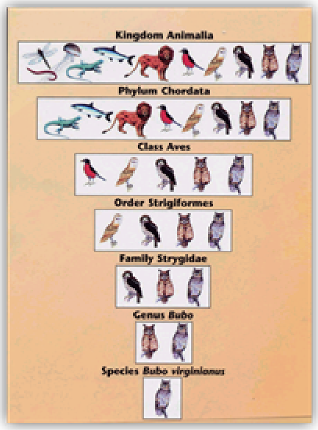
TAXONOMY

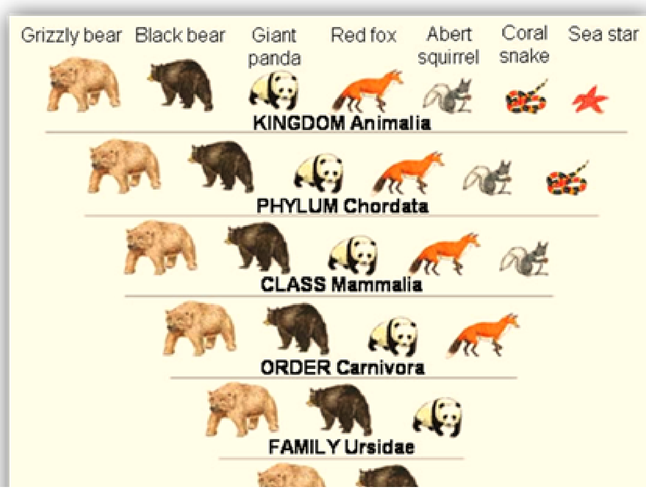


Taxonomy is the science of naming and classifying organisms. More than 2000 years ago the Greek philosopher Aristotle began classifying organisms. He classified all living things as either a plant or an animal. He classified plants according to differences in stem structure, and animals according to where they lived most of their life, as in living mainly on land, in water, or in air. For the time, that was good enough because many living organisms had not yet been discovered.

In the 17th century, with the invention of the microscope and more knowledgeable observations, many new organisms were being discovered. These new organisms were not fitting into Aristotle's classification system. Part of the problem was that his system was classifying plants based on structure and animals based on function or location. The two different ways of classifying was creating confusion. They were also finding organisms that did not exactly fit into the plant classification or animal classification, the organisms may have been a little of both.

Another problem with the early way of classifying organisms was the use of common names. Common names sometimes vary from one area or culture to the next. For example, a puma, cougar, and mountain lion are all the same cat, it just depends on what part of the country you are in as to which common name they use. Common names sometimes are named after some other organism of which the organism is not. For example, a jellyfish is not a "fish", horseshoe crab is not a "crab", and ringworm is not a "worm". When there was an attempt to create a scientific name for an organism, the scientific name, called a polynomial, turned out to be a name consisting of a very long description in Latin.

Scientists need a consistent and easier way of classifying and naming organisms. In the 1750s a Swedish biologist, Carl Linnaeus, developed a consistent classification system and a two-word Latin naming system as the scientific name for an organism. He created a system of grouping organisms according to structural differences and only structural differences. His classification system classified organisms in sequential levels, starting with the broadest and largest categories down into more and more specific categories until eventually you reach the most specific category for naming the organism. The two-word naming system Linnaeus used to identify every living thing



is known as **binomial nomenclature**. Linnaeus was not the first to attempt to develop a two-word naming system for every living thing. Gaspard Bauhin, a Swiss scientists, was the first at attempting to name organisms with a two word naming system, however, Linnaeus popularized the two word naming system along with having a classification system.

Linnaean System of Classification

The classification system created by Linnaeus was universally accepted and is the basis of the system we use today. However, as discoveries in nature and advances in science are made, Linnaeus's system is always being modified. The Linnaean system of classification is solely based on an organism's form and structure. New organisms are always being discovered, even to this day. This classification is always used to identify organisms when found. As new methods of classifying organisms are developed, the classification system is adjusted.

Linnaeus originally had three broad categories to begin his classification system: kingdom animal, kingdom vegetable, and kingdom mineral. Since the time of Linnaeus, many new groups and levels have been added to his classification system. The current classification system we use today, which is based off the Linnaean system, has a total of 8 categories or levels, ranging from the broadest (including the most organisms) to the most specific (including only one organism). The levels of classification are called taxa (singular, taxon). The eight levels in order are domain, kingdom, phylum, class, order, family, genus, species.

Table 35-1 includes all 8 levels of classification used today. **Table 35-1** also has an analogy with the levels to help you understand the concept of how the taxa levels work. Domain is the broadest level including the most of whatever it is that you are classifying. As you make your way down the levels in **Table 35-1**, notice how the levels become more and more specific, narrowing down the classification. Recognize when you reach the genus and species levels it is a very specific street number and apartment number which identifies a very specific location of which no one else can have in that city.

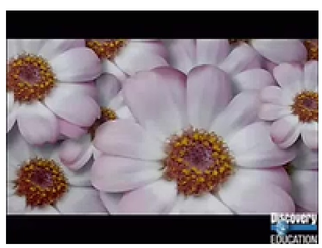


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TABLE 35-1

Levels of Classification	***Analogy***
Domain	Continent

Kingdom	Country
Phylum	State
Class	County
Order	City
Family	Street Name
Genus	Street Number
Species	Apartment Number

Modern Linnaean System of Classification

Remember, organisms are classified according to structure and are grouped according to similar traits at each taxon (level). **Table 35-2** displays the 8 taxa with the human, bobcat, and lion as examples.

The levels begin with Domain. Domain is the broadest category focusing on the different cell types. There are three domains: bacteria, archae, and eukarya. Domain bacteria and archae are both prokaryotic domains (cells without a nucleus) with the main difference between the two being the chemical make-up of their cell walls and different genetic make-up. Domain eukarya is the only eukaryotic domain (cells with a nucleus). Notice in **Table 35-2**, humans, bobcats, and lions all share the same domain, kingdom, phylum, and class. However, as the levels become more specific, the human breaks away from the two cats in classification and continues down into a species. The two cats share the next two levels, then break away from each other into different genera (singular, genus) and species.

TABLE 35-2			
Levels of Classification	***Human***	***Bobcat***	***Lion***
Domain	Eukarya	Eukarya	Eukarya
Kingdom	Animalia	Animalia	Animalia
Phylum	Chordata	Chordata	Chordata
Class	Mammalia	Mammalia	Mammalia
Order	**Primates**	Carnivora	Carnivora
Family	**Hominidae**	Felidae	Felidae
Genus	**Homo**	**Lynx**	**Panthera**
Species	**Sapiens**	**Rufus**	**Leo**

Domains are made up of kingdoms. As of the 1990s, there are 6 kingdoms: *Eubacteria, Archaebacteria, Protists, Fungi, Plantae, Animalia*. Prior to the 1990s, kingdom eubacteria and archaebacteria belonged to the same kingdom named *Monera*. See **Table 35-3** for some of the key differences among the 6 kingdoms.

Table 35-3						
Domain	**Bacteria**	**Archaea**	**Eukarya**			
Kingdom	**Eubacteria**	**Archaebacteria**	**Protista**	**Fungi**	**Plantae**	**Animalia**
Cell Type	Prokaryotic		Eukaryotic			
Cell Walls	With peptidoglycan	With special lipids	Some species have cell walls	With chitin	With cellulose	No cell walls
Number of Cells	unicellular		Unicellular or multicellular	Mostly multicellular	Mostly multicellular	Multicellular

Nutrition	Autotroph or heterotroph	Heterotroph	autotroph	heterotroph

Kingdoms are made up of phyla (singular, phylum) or divisions. Most sources use the term phylum to represent this level of classification, however, some sources still use division to name this classification level for kingdom plantae.

Phyla are made up of classes, classes are made up of orders, orders are made up of families, and families are made up of genera (singular, genus).

From the genus level, a species name is reached for each living thing found on Earth. The genus and the species name together make up the scientific name of an organism. There is only one scientific name for every living thing on Earth.

Scientific Name

As was already stated, a scientific name identifies one specific type of organism and is made up of the genus and species for that organism. A scientific name, along with the other taxa, use Latin or Latin-like terms so that the names are understood world-wide. The Latin terms used for classification are descriptive of the organism, named after someone, or created with humor.

Scientific Names		
		
Ursus arctos (brown bear)	*Ursus americanus* (black bear)	*Ursus maritimus* (polar bear)

Ursus arctos (brown bear), *Ursus americanus* (black bear), and *Ursus maritimus* (polar bear) are some scientific names. The **scientific name** of an organism is made up of the *genus* of the organism and a *species identifier*, which is usually the species taxon and is descriptive of the organism. There are some rules to writing a scientific name. The first name of the scientific name (the genus) must be capitalized, the second name (the species identifier) is lowercase. The entire name should be italicized or underlined. Scientific names may be abbreviated, but only if it has been used once fully. To abbreviate a scientific name, the genus is abbreviated by the first letter of the genus being capitalized and the species identifier fully written out as lowercase, such as *Ursus arctos* into *U. arctos*.

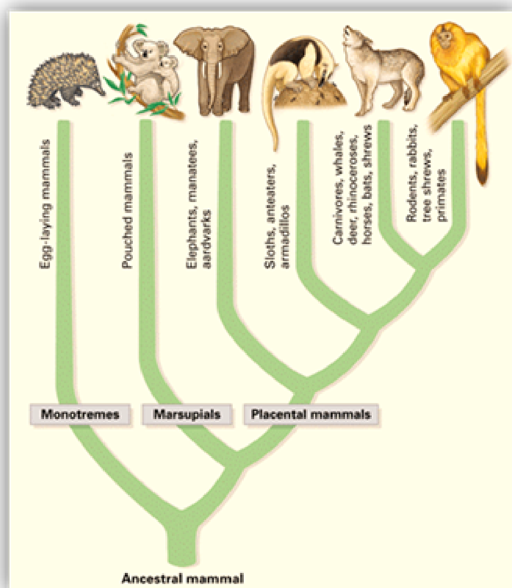
Notice how the three bear scientific names all have the same first name of Ursus. That means they all have the same classification from Domain all the way down to Genus. The next and last level, which is species, is where they all branch off into the specific type of bear they are.

Sometimes, an organism can be classified beyond the species level. There are some species which have slight variations within their species. Generally if these slight variations are noticed with plants the term **variety** is used. If the variation is found among animal species then the term **subspecies** is used. A variety or subspecies name will be written following the species identifier as in *Ursus arctos horribilis* (grizzly bear). Notice the similarity in name between the brown bear and the grizzly bear.

Ursus arctos horribilis (grizzly bear)

Systematics

Systematics organizes the diversity of living organisms in terms of evolution. Linnaeus based his classification system solely on organism's morphology (structure). Since the time of Linnaeus, we have developed new technologies to study chromosomes, DNA/RNA, proteins, and embryos. Using all of this new information about organisms, along with their morphology, we can now improve Linnaeus's original system of classifying. We can now even go a step further and relate the idea of evolution of these organisms. Using all of this data, modern taxonomists can now study the evolutionary history of an organism, or **phylogeny**. Scientists use a phylogenetic tree to study and demonstrate the evolutionary history of an organism. A **phylogenetic tree** is a diagram showing the evolutionary relationship hypothesized to exist among a group of organisms. As new evidence and information is found, phylogenies change.



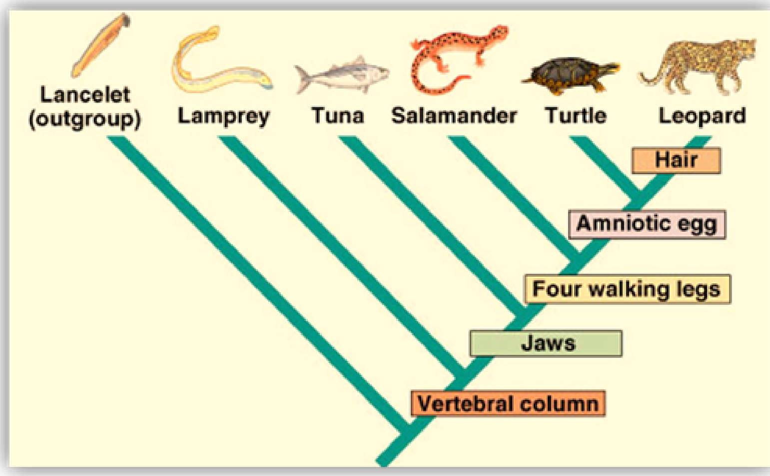
It would seem that all we would need to look at to determine if something is related, with regard to evolution, is structure or morphology. That is not the case. When looking at a group of potentially related organisms, two types of structures arise, homologous and analogous. **Homologous structures** are structures between different organisms that are the same because they were inherited from a common ancestor. **Analogous structures** are structures that appear to be the same, however, the structures were not inherited by the same ancestor. Analogous characteristics usually arise from convergent evolution, when two organisms adapt to similar environments and become more and more similar. Only homologous structures can be used as evidence for an evolutionary relationship, since those structures were inherited from a common ancestor.

Cladistics

Two types of characters exist in organisms, ancestral and derived. An **ancestral character** is a character, or characteristic, that has evolved in a common ancestor of two groups of organisms in question. A **derived character** is a character that evolves in one group of organisms and not in another. An example for ancestral and derived characters could be bird feathers. Most animals do not have feathers, therefore, it is safe to assume that birds evolved with feathers at some point in time while other animals did not. Feathers would then be a derived character. **Cladistics** is a method of systematics which determines phylogenies by comparing both ancestral and derived characteristics.

A **cladogram** is a diagram of the evolutionary history of a group of organisms focusing on derived characters. Some sources use phylogenetic trees and cladograms interchangeably. Carefully look at **Table 35-4** for an example of a cladogram and how to interpret a cladogram.

Table 35-4: Cladogram



Animals	Vertebral Column	Jaws	Four Walking Legs	Amniotic Egg	Hair
Lancelet	No	No	No	No	No
Lamprey	Yes	No	No	No	No
Tuna	Yes	Yes	No	No	No
Salamander	Yes	Yes	Yes	No	No
Turtle	Yes	Yes	Yes	Yes	No
Leopard	Yes	Yes	Yes	Yes	Yes

Dichotomous Key

A method of classifying organisms in the field when an unknown organism is found is by using a dichotomous key. A **dichotomous key** is an identification key used to determine the name of an unknown organism, by going through a sequence of choices requiring the analysis of characteristics. Look at the dichotomous key example in **Table 35-5** as you read the following explanation.

We will first classify a dog. With a dichotomous key always start at #1! #1 asks us if the organism we are classifying is an animal or not. A dog is an animal. To the right of that choice it says "go to 2". We then go to #2.

#2 asks does it have wings or not have wings. A dog does not have wings, and to the right of that choice it says "go to 6". We go to #6, where it asks, lives in water or lives on land. A dog lives on land. That choice says "go to 7". #7 asks does it have fluffy fur or not. A dog has fluffy fur, and to the right of that choice it says "go to 8". #8 asks if it is a common pet or not. A dog is a common pet, and to the right of that it doesn't say to go to another numbered step. Instead, it has a name. The name to the right is the scientific name for the dog, *Canis familiaris*.

We'll try one more. We will classify a canary. Start at step 1, a canary is an animal, so go to #2. A canary has wings, so go to #3. A canary has feathers, so go to #4. A canary flies high, so go to #5. A canary is often yellow, so the name of the canary is *Serinus canaria*.

Dichotomous Key for Question #20	
1. animal not an animal	go to 2 go to 11
2. has wings no wings	go to 3 go to 6
3. has feathers no feathers	go to 4 Ochloerotatus taeniorhynchus
4. flies high does not fly high	go to 5 Meleagris gallopavo
5. often yellow not yellow	*Serinus canaria* *Haliaeetus leucocephalus*
6. lives in water lives on land	go to 9 go to 7
7. has fluffy fur no fluffy fur	go to 8 *Bos taurus*
8. common pet not a common pet	*Canis familiaris* *Mephitis mephitis*
9. has fins no fins	go to 10 *Haematopus ostralegus*
10. razor sharp teeth pegged, pointy teeth	*Carcharodon carcharias* *Tursiops truncates*
11. green not green	go to 12 go to 13
12. grows tall does not grow tall	*Pinus ponderosa* *Rhus toxicodendron*
13. can be poisonous not poisonous	*Boletus edulis* *Rosa sylvestris*

Unit 35 Worksheet Taxonomy

Unit 35 Taxonomy Answer Key

UNIT VOCABULARY REVIEW

The evolutionary history of an

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