

Unit 2. Characteristics and Classification of Organisms

Content	Learning competences
2.1. Characteristics of living things 2.2. Taxonomy of living things 2.2.1. Principles of classification 2.2.2. Taxonomic hierarchies in biological classification 2.3. Relevance of classification 2.4. Linnaean system of nomenclature 2.5. Common Ethiopian animals and plants 2.6. The five-kingdom system of classification 2.7. Renowned taxonomists in Ethiopia	• State the characteristics of living things • Classify living things based on taxonomic principles • Argue for or against the importance of classification • Describe the system of Linnaean nomenclature • Classify common Ethiopian animals and plants based on the taxonomic categories. • List the characteristic features of the five kingdoms • Appreciate the works of renowned taxonomists in Ethiopia

2.1 Characteristics of living things

Objectives

At the end of this section, the student will be able to:

- *state the characteristics of living things.*

Living things have variety of shapes and forms. Thus, biologists study life in many different ways. Biologists often live with wildlife, collect fossils, or listen to whales. For example, they count how many times a hummingbird's wings beat per second. What makes something "alive"? Anyone could deduce that a galloping horse is alive and a car is not, but why? We cannot say, "If it moves, it's alive" because a car can move, and gelatin can wiggle in a bowl. They certainly are not alive. Although we cannot define life with a single sentence, we can come up with a series of characteristics shared by living systems.

Activity 2.1: Reflective Discussion

If somebody places an object in front of you and asks you whether it is alive, what would you do?

Would you poke it to see if it reacts?

Would you watch it closely to see if it moves or breathes?

Would you dissect it to look at its parts?

Activity 2.2: Field Observation

Discuss what makes living things different from non-living. Go outside your village or your school compound and sort the things you observe into living and non-living. Based on your observations, write a short report and present to your classmates.

What are the characteristics of living things?

Some of the properties that are shared by all living things are listed below:

All living things are made up of one or more cells: Those made up of one cell, such as bacteria are termed 'unicellular' and those made up of more than one cell, such as plants are termed 'multi-cellular'.

All living things require energy: All organisms use a source of energy for their metabolic activities. For example, every muscle in your body is powered by the energy you obtain from your diet. Some organisms use energy from the sunlight to make their foods through the process of photosynthesis. Such organisms, for example plants, are known as **producers or autotrophs**. Other organisms cannot make their own food but consume others. Such organisms are known as consumers or heterotrophs.

All living organisms respond to stimuli: organisms can detect or sense stimuli (change) in the internal or external environment and make appropriate responses.

All living things can grow: Growth is a permanent increase in size and mass due to an increase in cell number or cell size or both. Even bacteria and single-celled creatures show an increase in size. Multicellular organisms which increase the number of cells in their bodies become more complicated and change their shape and size.

All living things can reproduce: Reproduction is the process that makes more of the same kind of organism. Single-celled organisms may simply keep dividing into two. However, multicellular plants and animals may reproduce sexually or asexually.

All living things can excrete: Excretion is the removal of the metabolic wastes produced in cells as a result of chemical reactions (**metabolism**). For example, respiration and other chemical reactions in the cells produce waste products such as carbon dioxide. Living organisms expel such substances from their bodies in various ways.

All living things display ordered complexity: All living things are both complex and highly ordered. The levels of organization in biological systems begin with atoms and molecules and increase in

complexity. Your body is composed of many different kinds of cells each containing many complex molecular structures. Many nonliving things may also be complex, but they do not exhibit this degree of ordered complexity.

Most living things maintain homeostasis: Most organisms maintain relatively constant internal conditions that are different from their environment. Homeostasis is the regulation of an organism's internal conditions to maintain stability. For example, your body temperature remains stable despite changes in outside temperatures.

All living things possess adaptations that evolve overtime: All organisms interact with other organisms and their environment in ways that influence their survival, and as a result, organisms evolve adaptations to their environments (Fig.2.1).

Figure 2.1. Characteristics of life

Self Assessment

1. Is it possible to define life in a simple sentence? If your answer is no, why not? Give a hort explanation.
2. How are living things different from the non-living things?

2.2 Taxonomy of living things

2.2.1 Principles of classification

Objectives

At the end of this section, the student will be able to:

- *classify living things based on taxonomic principles,*

Why do biologists classify living things?

Organizing items not only makes them easier to find but can also make them easier to understand. One tool biologists use to organize and understand living organisms is classification. Classification is the process of grouping things based on their similarities. The science of naming, identifying and classifying organisms is known as taxonomy. Scientists who study taxonomy are called taxonomists. Biologists classify organisms into different categories mostly by judging the degrees of their apparent similarities and differences. These include the external and internal structures of the organism as well as where the organism lives. Taxonomists also consider the genetic makeup of organisms to reveal their evolutionary relationships to other organisms. The assumption is that the greater the degree of physical

Activity 2.3: Reflective Discussion

This section explains how biologists have organized the study of living things. This organization makes it easy to tell which organisms share characteristics and which are related to each other.

1. How organized are you?
2. Do you organize your clothes or books in some way?
3. Discuss the advantages of being organized.

Key Terms

Identification: identifying organisms using characteristic feature

Nomenclature: Aspect of taxonomy that deals specifically with the naming of organisms

Taxonomy: The science of naming and classifying species.

similarity between them, the closer their biological relationship is. They try to identify and classify organisms based on a number of features (e.g., morphological, physiological, molecular, behavioural, and/or ecological characters).

2.2.2. Taxonomic hierarchies in biological classification

Objectives

At the end of this section, the student will be able to:

- *At the end of this section, the student will be able to:*
- *describe taxonomic hierarchies*

Activity 2.4: Problem solving

Read a book or search in the internet on biological classification. Why do biologists need to organize living things in hierarchies?

Thousands of years ago, the Greek philosopher **Aristotle** (384-322 BC) developed the first widely accepted biological classification systems. He used simple morphological characters to classify plants into trees, shrubs and herbs. He also divided animals into two groups -those which had red blood and those that did not have. Though it was useful for a while, Aristotle grouped some organisms that had very little in common. For example, he grouped birds, bats, and flying insects because they could fly. Later on in the 1700s, a Swedish Botanist **Carolus Linnaeus** (1707–1778), who is also known as the father of taxonomy, introduced a taxonomic hierarchy of classification. He was the first person to propose an orderly system for classifying organisms.

Taxonomic hierarchy is the process of arranging various organisms into successive levels of the biological classification either in a decreasing or an increasing order. In the Linnaean classification system, all organisms are placed in a ranked hierarchy. The kingdom is ranked the highest followed by Phylum (division), class, order, family, genus, and species (Fig. 2.2). Each rank in a taxonomic hierarchy is termed taxon (plural, taxa). Linnaeus' developed a two Kingdom system of classification. He classified all living organisms under kingdoms Plantae and Animalia that included all plants and animals, respectively. This system did not distinguish between the eukaryotes and prokaryotes, unicellular and multicellular organisms; and photosynthetic (green algae) and non-photosynthetic (fungi) organisms.

On the broadest level, biologists divide the diversity of life into three domains: Bacteria, Archaea, and Eukarya. Every organism on Earth belongs to one of these three domains. The first two domains, Bacteria and Archaea, identify two very different groups of organisms that have prokaryotic cells, relatively small and simple cells that lack a nucleus or other compartments bounded by internal membranes. Eukaryotes

have relatively large and complex cells that contain a nucleus and other membrane-enclosed compartments. They are grouped into the domain Eukarya. The domaineukarya includes groups such protists, fungi, plants and animals. Domain is the rank above kingdom.

Domain ➡ Kingdom ➡ Phylum ➡ Class ➡ Order ➡ Family ➡ Genus ➡ Species

Eukarya ➡ Animalia ➡ Chordata ➡ Mammalia ➡ Pimate ➡ Hominidae ➡ Homo ➡ Homo sapiens

Key Terms

Archaea: is a group of single-celled organisms that lack a nucleus but are more closely related to eukaryotes than to bacteria.

Bacteria: is the most diverse and well-known group of single-celled organisms that lack a nucleus.

Classes: is a taxon of similar orders.

Eukaryotic cells: are single-celled organisms with a nucleus.

Family: is a taxon of similar genera.

Genera: is a taxon of similar species.

Kingdoms: is a taxon of similar phyla (plural for phylum).

Orders: is a taxon of similar families.

Phylum: is a taxon of similar classes. (Plant taxonomists use the taxon division instead of phylum).

Prokaryotic cells: are unicellular organisms without a separate nucleus.

Species: unique type of organism

Taxon: is a group of organisms that share a unique setof traits.

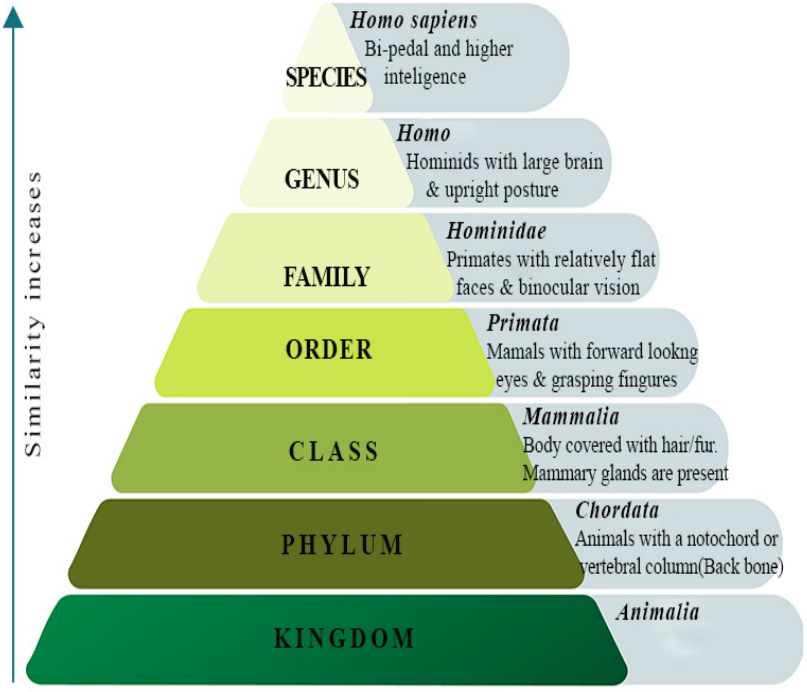


Figure 2.2. Taxonomic hierarchy

Self Assessment

1. What is taxonomic hierarchy?
2. List some of the taxonomic hierarchies that you know.

Did You Know?

Have you ever asked yourself what a species is? What are the characteristic features of a species? The smallest natural group of organisms is the species. A species can be defined as a group of organisms that can reproduce to produce fertile offspring. Members of a species also often resemble each other very closely in appearance, unless humans have taken a hand in the breeding programs. All cats belong to the same species but there are wide variations in the appearance of different breeds. There are many other definitions of species; for example, phylogenetic species, morphological species, evolutionary species, systematic species, recognition species etc. However, for a biological species, members could reproduce to produce fertile offspring. Members of a species also often resemble each other very closely in appearance.

2.3 Relevance of classification

Activity 2.5: Investigating

1. Why and how do human beings classify organisms?
2. Visit a library in your school or public library in your village, and write on the importance of biological classification and present your results to your classmates.

Objectives

At the end of this section, the student will be able to:

- *describe the relevance of classification*

What is the relevance of biological classification?

Classification gives biologists a framework that allows them to study the relationships between living (extant) and extinct organisms. For example, this framework allows biologists to study the relationship between birds and dinosaurs. Biologists have found that the bones of some dinosaurs have large internal spaces. So do the bones of birds. Because of these findings, some biologists believe that dinosaurs are more closely related to birds than to reptiles.

Taxonomy can be a useful tool for scientists who work in such areas as agriculture, forestry, and medicine. Taxonomy can also help the economy. For example, taxonomists can discover new sources of lumber, foods, medicines, and energy. For example, a taxonomist might know that a certain species of tree contains chemicals that make good disinfectants (e.g., Shiferaw/Moringa). It is possible that a closely related plant species could have the same useful substances. So instead of having one source of chemicals, there may be two or more sources.

Self Assessment

1. For which of the following purposes could taxonomy be used?
a. to determine whether a plant is safe to be planted in a schoolyard
b. to find a new source for medicine that comes from plants
c. to determine how closely related two species animals
d. all of the above

2.4 Linnaean system of nomenclature

Objectives

At the end of this section, the student will be able to:

- *describe the system of Linnaean nomenclature*
- *explain how organisms are given scientific names.*
- *write scientific names properly and give examples.*

How did Carl Linnaeus classify living organisms?

Linnaeus was a Swedish naturalist who initially graduated in medicine but became interested in plants. He travelled in Scandinavia, England and Eastern Europe, discovering and naming new plant species. In 1735 he published his *Systema Naturae*, in which he accurately described 7700 plant species and classified them. He further grouped species into genera, genera into classes, and classes into orders. He also classified over 4000 animals, but rather less successfully into mammals, birds, insects and worms.

Linnaeus refined and popularized the **binomial system** of naming organisms, in which the first name represents the genus and the second name the specific epithet. This system is still the official starting point for naming or revising the names of organisms.

Binomial nomenclature

Species must be named in such a way that the name is recognized all over the world. For example, maize is named *Bekkolo* in Amharic, *Boqqollo* in Afan Oromo and *Baddela*in Sidamu Affo and corn in American English etc. If you are not aware of these names, it could lead to confusion. If the botanical name, *Zea mays*, is used, however, there is no chance of error. As you all might know our country is endowed with cultural and linguistic diversities and each would have different names for the same species. As a result, it would be difficult for a person to know the names given by the 80 plus ethnolinguistic groups in Ethiopia. Similarly, there are over thousands of languages in the African continent and beyond.

Therefore, the Latin form of the name allows it to be used in all over the world irrespective of language barriers. The similarity in size, shape, behavior and colormakes it difficult to differentiate one species from the other. Again, the use of the scientific name avoids such confusion.

The **binomial system of** naming species **(**introduced by Linnaeus**)** is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species. Binomial means 'two names'; the first name gives the **genus** and the

Activity 2.6: Inquiring and researching

Did you know Carl Linnaeus?

List the contribution of Carl Linnaeus to the Science of taxonomy.

second gives the specific epithet. For example, Enset, false banana, *Ensete ventricosum* and Banana, *Musa acuminate*, belong to the same family (Musaceae).In writing a scientific name, the first letter of name of the genus is a capitalized letter and the specific epithet always starts with a small letter, for example, the scientific name of human beings is *Homo sapiens.* The scientific names are underlined when handwritten or italicized when printed.

Self Assessment

1. What is a binomial nomenclature?
2. Write the scientific names of the following organisms: house fly, mouse, dogs, cat & goat.

2.5 Common Ethiopian animals and plants

Objectives

At the end of this section, the student will be able to:

- *classify common Ethiopian animals and plants based on the taxonomic categories.*
- *write the scientific names of common Ethiopian plant and animals species*
- *use dichotomous keys to identify unknown organism*

Ethiopia is endowed with high biological diversity (biodiversity) due to its geographical location, topographical diversity and diverse climatic features. The country is a hot spot for a diversity of wild plant and animal species with a high degree of endemicity. Furthermore, Ethiopia is a primary centre of diversity for field crops such as noug (*Guizotia abyssinica*), tef (*Eragrostis tef*) and the Ethiopian mustard (*Brassica carinata*). Besides, field crops such as barley, sorghum, durum wheat, finger millet, faba bean, chickpea, lentil, and cowpea have wide diversity in Ethiopia. Also Ethiopia has served as a gateway to domestic animals from Asia to Africa and its diverse ecology favoured diversification of these resources. The scientific and common names of some plants and animals in Ethiopia are presented in table 1.

Activity 2.7:Inquiring and Researching

Read books and/or search in the internet for the scientific and the local names common Ethiopian plants and animals species. Present your report to your classmates.

Table 1: Scientific names of some common plants and animals in Ethiopia

Common name	Taxon						
	Kingdom	Phylum/ Division	Class	Order	Family	Genus	Species
Elephant	Animalia	Chordate	Mammalia	Proboscidea	Elephanti-dae	Loxodonta	Loxodonta africana
Ethiopian Wolf	Animalia	Chordate	Mammalia	Carivora	Canidae	Canis	Canissimen-sis
Gelada	Animalia	Chordate	Mammalia	Primate	Cercopith-ecidae	Thero-pithecus	Theropithe-cus gelada
Lion	Animalia	Chordate	Mammalia	Carivora	Felidae	Panthera	Panthera leo
Walia	Animalia	Chordate	Mammalia	Artiodactyla	Bovida	Capra	Capra walie
Ostrich	Animalia	Chordate	Ave	Struthioni-formes	Struthion-idae	Struthio	Struthio camelus
Watled Ibis	Animalia	Chordate	Ave	Pelecani-formes	Threskior-nithidae	Bostrychia	Bostrychia carunculata
Enset	Plantae	Angio-spermata	Monocy-lodoneae	Zingiberales	Mussaseae	Ensete	Ensete ven-tricosum
Maize	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Zea	Zea mays
Noug	Plantae	Angio-spermata	Eudicots	Asterales	Asteraceae	Guizotia	Guizotia abyssinica
Tef	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Eragrotes	Eragrstos tef
Wheat	Plantae	Angio-spermata	Lilospida	Cyperales	Poacea	Triticum	Triticum aestivum

Dichotomous keys

Dichotomous keysare used to identify unfamiliar organisms. They simplify the process of identification. Each key is made up of pairs of contrasting features (dichotomous means two branches), starting with quite general characteristics and progressing to more specific ones. By following the key and making appropriate choices it is possible to identify the organism correctly. Figure 2.3 shows an example of a dichotomous key that could be used to place an unknown vertebrate and unknown invertebrate in the correct class. Item 1 gives you a choice between two alternatives. If the animal is **poikilothermic (cold-blooded),** you move to item 2 and make a further choice. If it is a **homoiothermic (warm-blooded),** you move to item 4 for your next choice. The same technique may be used for assigning an organism to its class, genus or species. However, the important features may not always be easy to see and you have to make use of less fundamental characteristics.

Activity 2.8: Inquiring and Researching

You may have come across organisms that you did not recognize and could not classify. How do you solve this problem?

1	Poikilothermic	2
	Homoiothermic	4
2	Has fins but no limbs	Fish
	Has four limbs	3
3	Has no scales on body	Amphibian
	Has four limbs	Reptile
4	Has feathers	Bird
	Has fur	Mammal

1	Has Legs	2
	No les	5
2	More than six legs	3
	Six legs	4
3	Short, flattened gray body	Woodlouse
	Long brown/yellow body	Reptile
4	Pincers on last segment	Earwig
	Hard wing covers	Beetle
5	Body segmented	Earthworm
	Body not segmented	6
6	Has a shell	Snail
	No shell	Slug

Figure 2.3. Vertebrate (left) and invertebrate(right) keys

2.6 The five-kingdom system of classification

Self Assessment

1. Make a field visit in your village and or your school compound and ask the names of twenty common Ethiopian animals and plants. Write their scientific names along with their local names.

Objectives

At the end of this section, the student will be able to:

- *list the characteristic feature of the five kingdoms,*
- *describe the kingdoms of the Monera, Protista and Fungi and give examples of organisms from each one.*
- *describe the kingdom Plantae and explain its major taxa, giving examples.*
- *discuss features the kingdom Animalia and explain its major taxa, giving examples.roup animals into vertebrates and invertebrates and explain the differences between them.*

Why did we come up with the five kingdoms?

Classification of organisms into plants and animals was easily done and understood, but a large number of organisms did not fall into either category. Hence the two kingdom classification used for a long time was found inadequate. Besides, gross morphology a need was also felt for including other characteristics like cell structure, nature of cell wall, mode of nutrition, habitat, methods of reproduction, evolutionary relationships, etc.

Activity 2.9: Cooperative Learning

What is the largest group of organisms recognized by biologists? How many such groups should there be? Most biologists used to favor the adoption of two groups. What are these two groups?

Whittaker (1969) proposed a five kingdom classification to solve the pitfalls of the two kingdom system of classification. The main criteria for classification used by him include cell structure, body organization, mode of nutrition, reproduction and phylogenetic relationships. Whittaker's five-kingdom scheme consists of animals, plants, fungi, monera and protists(Fig.2.4). It is still not easy to fit all

organisms into the five-kingdom scheme. For example, many protista with chlorophyll (the protophyta) show important resemblances to some members of the algae, but the algae are classified into the plant kingdom.

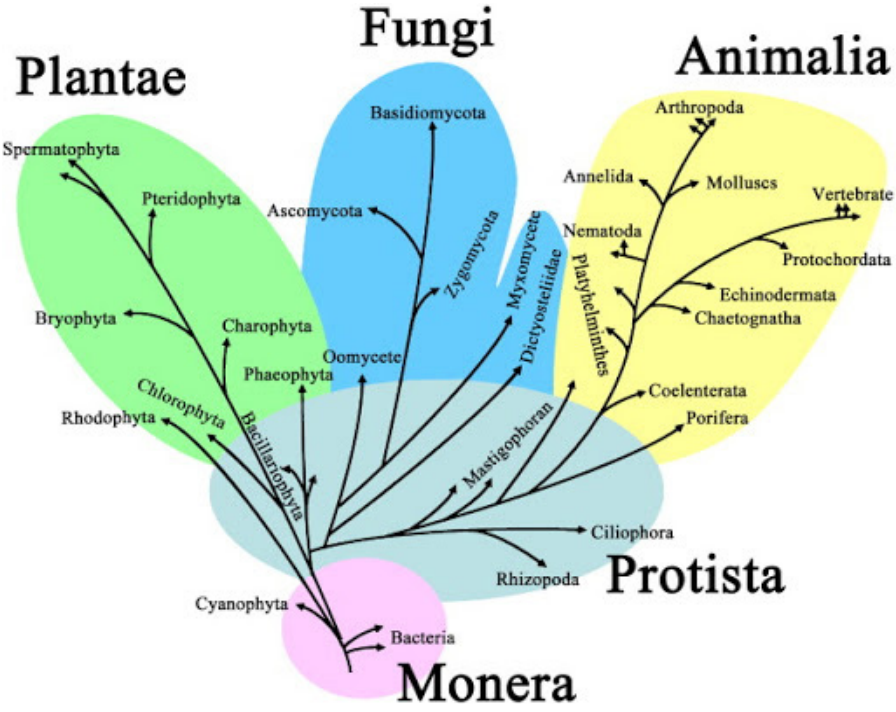


Figure 2. 4. The five kingdoms of life

Self Assessment

1. Do you agree or disagree with the classification of algae as a plant? Explain.
2. Do you suggest an alternative category or group for organisms' such as algae and the likes?

Did You Know?

Viruses are not included in any kingdom – they are not considered to be living organisms because they lack key characteristics of living things. Viruses are particles that are not alive. They cause diseases and infections. Viruses are made up of nucleic acids, either DNA or RNA, surrounded by a protein coat. They are smaller than the tiniest bacterium. Most biologists agree that viruses are not alive because they don't grow, develop, or carry out respiration. All viruses replicate, or make copies of themselves. However, viruses need the help of living cells to copy themselves. In order to copy itself, a virus must enter a living cell. The cell in which a virus replicates is called the host cell.

Activity 2.10: Debate

Debate on why it is difficult for biologists to develop a rigid classification scheme? Do you think the Whittaker's five-kingdom scheme has solved the classification problems biologists are trying to answer for generations?

Procedure:

1. Divide members of your classmates into three groups.
2. Members of group 1 support the idea that Whittaker's five-kingdom scheme has solved the classification problems.
3. Members of group 2 are against the idea that Whittaker's five-kingdom scheme has solved the classification problems.
4. The third group will be the audience.
5. Let members of group 1 and 2 present their position each in five minutes, and
6. Let students from group three ask questions both groups.

Activity 2.11: Collaborative Learning

What do you think about when you hear the word bacteria? You probably think about germs or something that is bad for you. Did you know that some bacteria are actually helpful? For example, some bacteria help with human digestion, while other bacteria help produce cheese, yogurt, and sourdough bread. However, other bacteria cause diseases in humans, for example Mycobacterium tuberculosis, causes tuberculosis, and Haemophilus ducreyi, chancroid. Discuss the major distinguishing features of kingdom Monera

Key Terms

Archaebacteria: methanogen, thermophiles, acidophilic bacteria

Chemosynthetic: synthesis food using chemical reaction.

Eubacteria: true bacteria

Kingdom Monera

Objectives

At the end of this section, the student will be able to:

- *describe the kingdom Monera and give example of organisms*
- *describe importance of Monera*

What are Monera?

Monera includes eubacteria and archaebacteria. Eubacteria (bacteria) have strong cell walls. They exist in various shapes and forms (Figs 2.5 and2.6). Some eubacteria are heterotrophs; otherscan make their (autotrophs). Some autotrophic bacteria make their own food the way plants do; they are photosynthetic. Others make energy by chemical reactions; chemosynthetic. The eubacteria live in most habitats, except the most extreme. Some eubacteria cause diseases, like strep throat and pneumonia. Most eubacteria, however, are harmless and helpful.

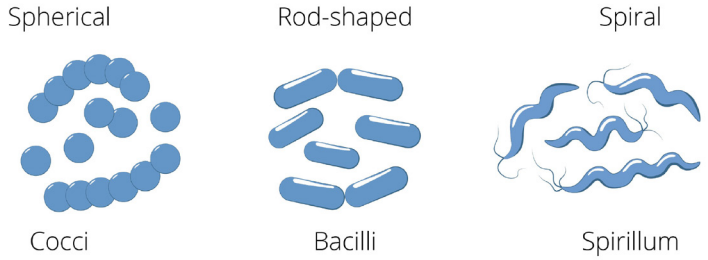


Figure 2.5. Examples major groups of Monera

Archaebacteria (Archaea) have very different cell walls than bacteria,ut like bacteria, archaebacteria make their own food. They are chemosynthetic and photosynthetic. Archaebacteria live in extreme environments. They live in such places as swamps, deep-ocean hot-water vents and seawater evaporating ponds. The environments in which the archaebacteria live often have no oxygen (Fig 2.5).

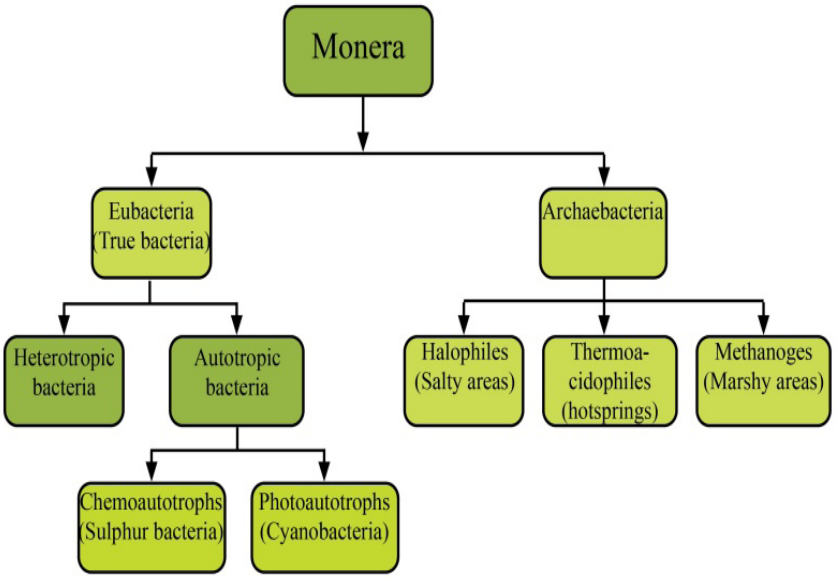


Figure 2.6. Some representative of taxa of kingdom monera

Did You Know?

Most people tend to think of bacteria in terms of illness and disease. However, there are actually only a few disease-causing bacteria compared to the number of harmless and beneficial bacteria. In fact, we could not survive without bacteria. Bacteria cause diseases in plants, animals, and humans. Disease causing bacteria enter the human body through openings such as the mouth. Bacteria are carried in air, food, and water. Sometimes bacteria enter the body through skin wounds. There are two ways bacterial diseases harm people. First, the growth of bacteria can interfere with the normal function of body tissues. Second, the bacteria can release a toxin that directly attacks the host.

Activity 2.12: Collaborative Learning

Classify the following statements into useful versus harmful relating to the importance of bacteria: endospores germinate in human lungs, cause infection in humans, provide nitrogen in a usable form for plants, flavor food, oxygen is a byproduct of making food and Create toxins.

Self Assessment

If someone tells you that bacteria are bad, how would you respond?

Kingdom Protista

Objectives

At the end of this section, the student will be able to:

- *describe the kingdom Protista and give examples of organisms*
- *describe importance of Protista*

Activity 2.12: Collaborative Learning

You have learned that all life is organized into five kingdoms. Without using your notes, name all five kingdoms. Some of the organisms you will learn about in this section are plantlike, and some are animal-like. Still others have characteristics like fungi. Some of them were placed in different kingdoms before they were finally classified as Kingdom Protista. As you read this sub-section keep in mind how much variety there is in the world of Protista.

What are protists?

There is no such thing as a typical protist. Kingdom protista contains the most diverse organisms of all the kingdoms (Figs. 2.7 and 2.8). There are single-celled (unicellular) protists as well as many-celled (multicellular) protists. Some are microscopic, others are very large. Some can make their own food, some cannot. Protists have only one thing in common—they are all eukaryotes. That means most of their metabolic processes (chemical reactions) take place inside their membrane-bound organelles. Other than that, organisms classified as protists are quite different from each other. Some protists, called protozoans, seem to be like animals except that they only have one cell. Others, called **algae,** seem to be like plants except they do not have roots, stems, or leaves. Algae are photosynthetic and autotrophic. Unicellular algae are the basis of aquatic food chains and produce much of the oxygen in Earth's atmosphere. Still, other protists seem to be like fungi except that they do not have the same kind of cell walls that fungi have.

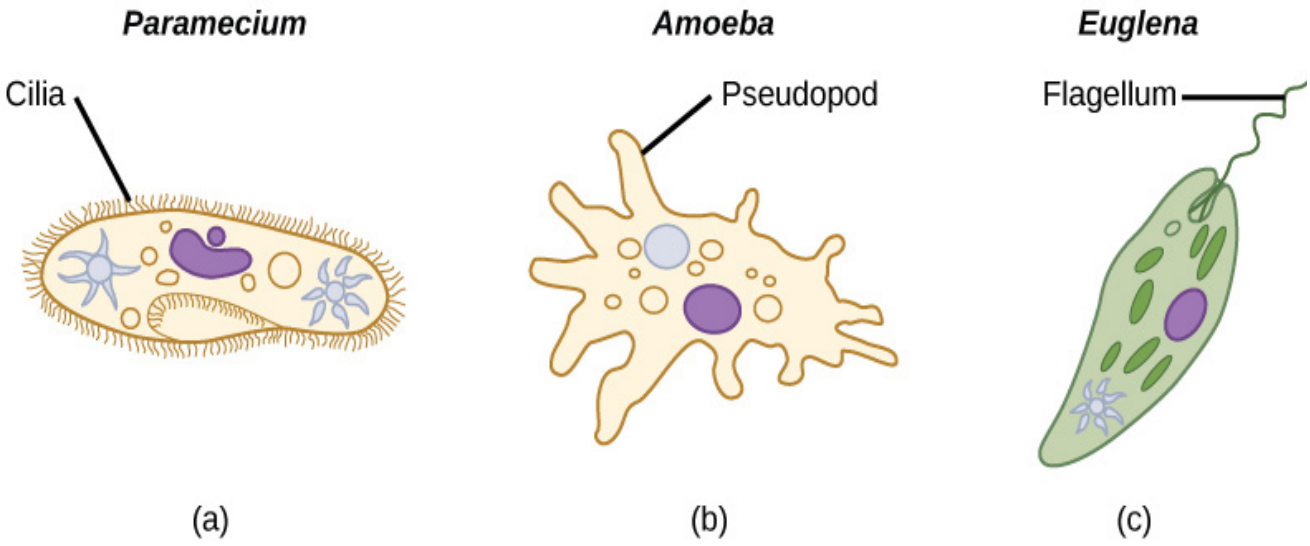


Figure 2.7. Examples major groups of protists

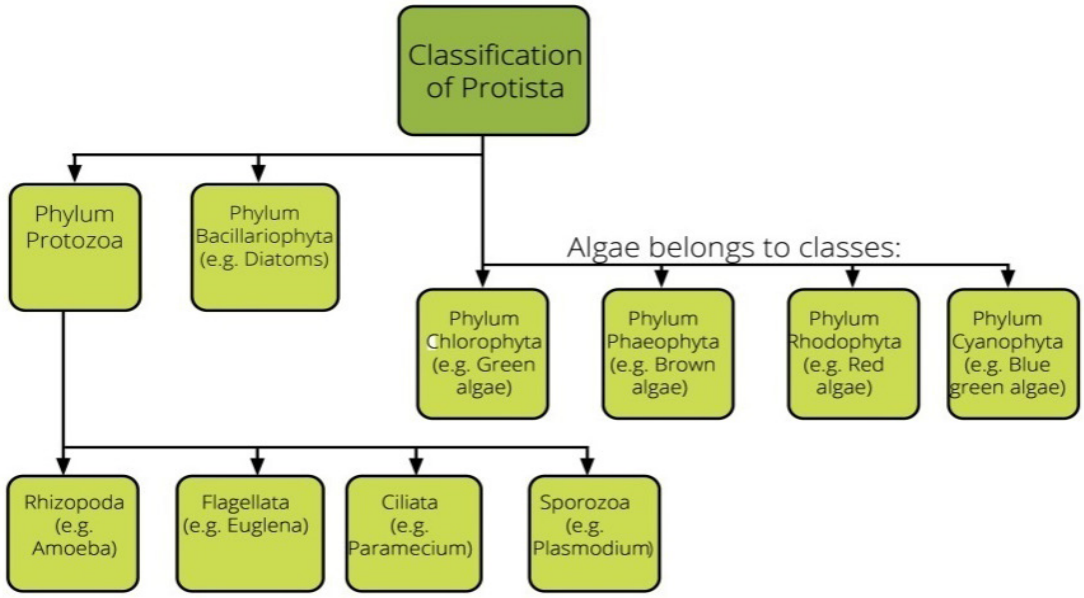


Figure 2.8. Some representative taxa of kingdom Protista

Self Assessment

1. What are the characteristic features of protists?
2. Write the single common feature to all protists.

Activity 2.14: Reflective discussion

You probably come into contact with algae every day. Diatoms are a type of algae whose remains become a powdery, porous rock called diatomite. Diatomite is highly absorbent. It is used in pet litter and to clean up chemical spills. It also is used as an abrasive in household cleaners. It is even added to paint to add sparkle. Now that you know that diatomite is absorbent, sparkling, and abrasive, see if you can imagine some additional uses for it. Discuss the additional application and present to your classmate.

Kingdom Fungi

Objectives

At the end of this section, the student will be able to:

- *describe the kingdom fungi and give example of organisms*
- *describe the importance of fungi*

What are fungi?

Fungi are eukaryotic organisms that include microorganisms such as yeasts, moulds and mushrooms.

Except for unicellular yeasts, fungi are filamentous multicellular organisms.

Their bodies consist of long, slender thread-like structures called hyphae. Hyphae play an important role in how they obtain food.

Fungi possess a cell wall that is made up of chitin and polysaccharides.

Like animals, fungi are heterotrophic in nutrition. But unlike animals, fungi do not ingest (eat) their food. Instead, a fungus absorbs nutrients from the environment outside of its body. Many fungi accomplish this task by secreting powerful enzymes into their surroundings, digest compounds from a wide range of sources, living or dead. These enzymes break down complex molecules into smaller organic compounds that the fungi can absorb into their bodies and use (Figs 2.9 and 2.10).

Figure 2.9. Examples of fungi

Most fungi absorb soluble organic matter from dead substrates and hence are called saprophytes (decomposers). Decomposer fungi break down and absorb nutrients from nonliving organic material, such as fallen logs, animal corpses, and the wastes of living organisms.

Activity 2.15: Peer conferencing

So far, you have studied bacteria, and protists. In this section, you will learn about the kingdom Fungi. Fungus is the singular of fungi. Mushrooms are types of fungi. Think about places you have seen mushrooms growing. What do those places have in common? Were they hot, dry, cool, or damp? Did the mushrooms appear suddenly or grow slowly over time?

Key Terms

Mutualism: symbiotic relationship in which both species benefit.

Parasitism: symbiotic relationship in which one organism benefits at the expense of another.

Symbiosis: permanent, close association between two or more organisms of different species.

Fungi cannot make their own food. They are heterotrophs. Fungi use a process called extracellular digestion to obtain nutrients. This means food is digested outside a fungus's cells and then the digested food is absorbed. For example, some hyphae of a fungus will grow into an orange. They release digestive enzymes into the orange that break down the large organic molecules into smaller molecules. These small molecules are absorbed into the hyphae and move into the flowing cytoplasm.

Fungi can also live with different living as parasites or mutualists. Parasitic fungi absorb nutrients from the cells of living hosts. Some parasitic fungi are pathogenic, causing diseases in humans (Example: *Candida albicans* cause rush and *Tinea pedis* cause athlete's foot), animals and plants. Mutualistic fungi also absorb nutrients from a host organism, but they reciprocate with actions that benefit the host. For example, mutualistic fungi that live inside certain termite species use their enzymes to break down wood, making food available for termites. Fungi can also live as symbionts in association with algae as lichens and with roots of higher plants as mycorrhiza.

Did You Know?

Some fungi cause food to spoil, others cause diseases, and some are even poisonous. However, fungi are important and beneficial. Without fungi, the world would be overrun with huge amounts of waste, dead organisms, and dead plants. Thanks to many fungi, some bacteria, and protists, the organic material is broken down and recycled into the raw materials that other living organisms need.

Fungi can reproduce either by vegetative means (fragmentation, fission and budding), asexual reproduction through spores formation and sexually. The various spores are produced in distinct structures called fruiting bodies

Yeast (saccharomyces service) is a very important fungus used for making injera rise and allows us to make alcohol (Tej, Tella, Beer etc).

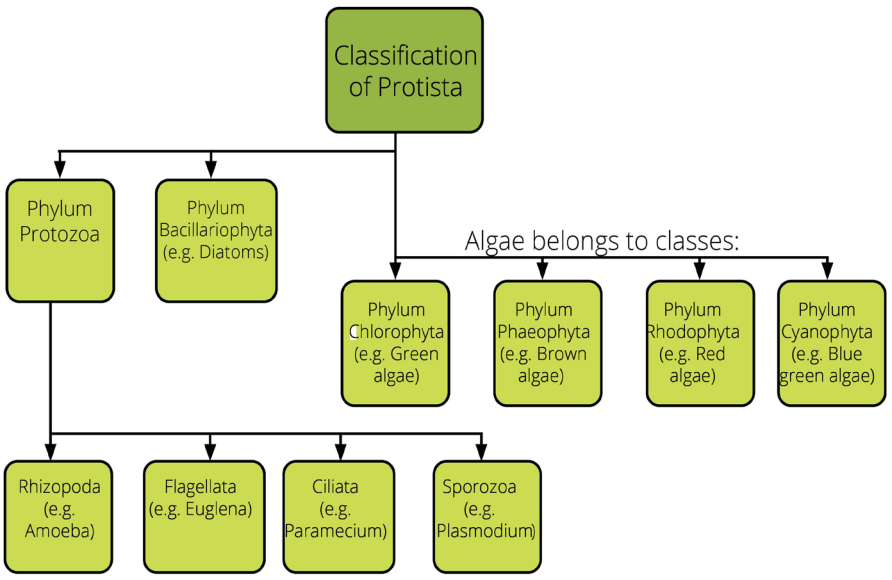


Figure 2.10.Some representative taxa of kingdom fungi

Self Assessment

1. What are the characteristic features of fungi?

Kingdom Plantae

Objectives

At the end of this section, the student will be able to:

- *describe the kingdom Plantae and give example of organisms*
- *describe characteristic features of major divisions of plants*
- *give examples of flowering plants*

What are plants?

Kingdom Plantae includes all eukaryotic, and multicellular autotrophic organisms.

Plants make their own food through the process of photosynthesis. Plants have chloroplast and chlorophyll pigment, which is required for photosynthesis. Photosynthesis also provides oxygen in the atmosphere.

They do not move from place to place; they are stationary.

Their cells contain a rigid cell wall made up of cellulose.

They reproduce asexually by vegetative propagation or sexually.

There are over 250 000 species of plants. These include flowering plants, mosses, ferns, and coniferous plants (see figs2.11 and 2.12).

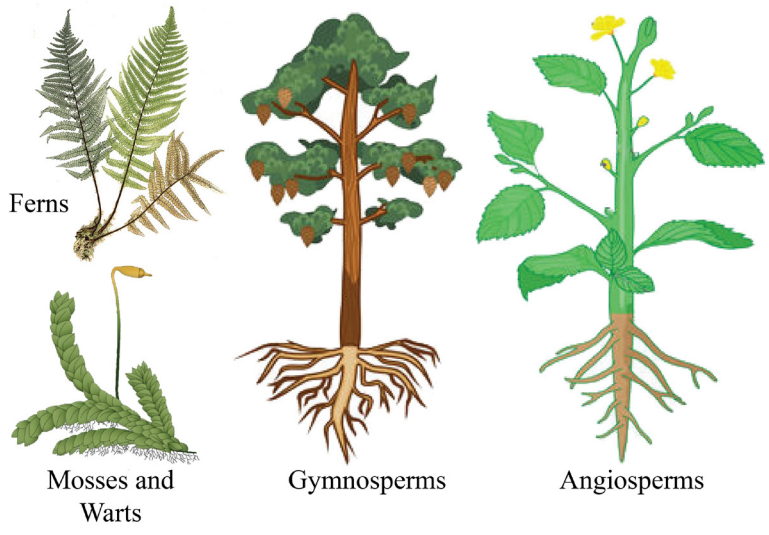


Figure2.11. Examples major groups of plants

Activity 2.16: Reflective Discussion

Think of all the things that plants provide for us. They are an important source of food. They also provide oxygen through photosynthesis. Some plants are valuable sources of medicine. What are some other things that plants provide?

Activity 2.17: Inquiring and Researching

Name or think of at least five different plants. You might think of flowers, bushes, shrubs, ferns, trees, and grasses to name a few. They are all plants, yet they look different from each other. As in the other kingdoms you have studied, the plant kingdom has divisions based on shared characteristics. If you were to place plants in divisions, what characteristics would you use? Hint: Look at figure 2.12 to find useful features to classify plants.

Self Assessment

1. What are the characteristic features of plants?

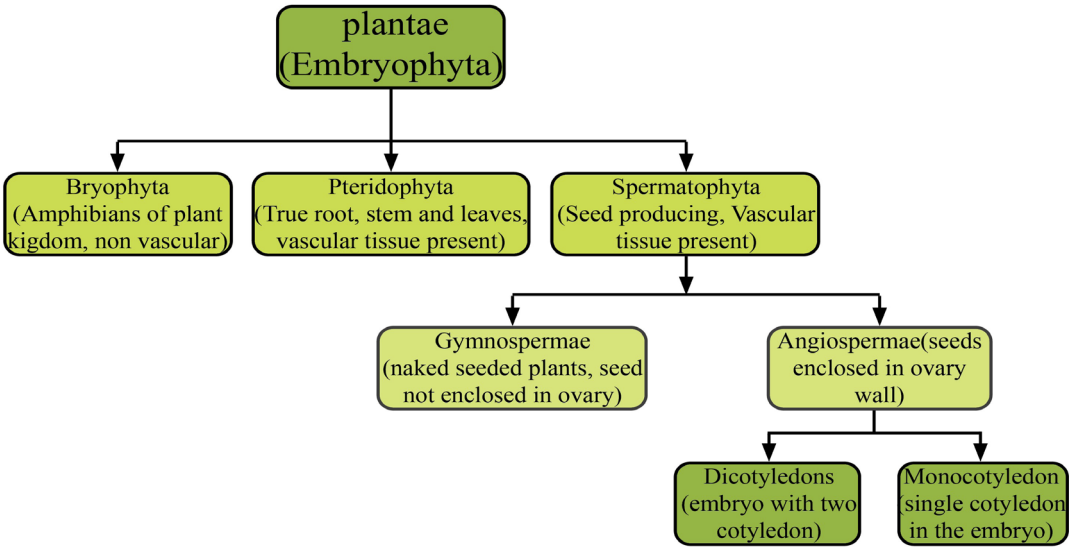


Figure 2.12. Classification of the plant kingdom

Activity 2.18: Interviewing

Ask a botanist about the economic, medicinal and ecological uses of plants (e.g., food, medicinal, ornamental, horticultural, cultural, spiritual, aesthetic, music and arts etc.).

Key Terms

Angiosperms: Most diverse seed plant group. Only group that makes flowers and fruits.

Bryophyte: is the common name for three lineages of plants: mosses, liverworts, and hornworts.

Dicots: Most diverse groups of angiosperms; members have two seed leaves, branching leaf veins.

Embryophyta: land plants; photosynthetic species that protect and nourish the embryo on the parental body

Gymnosperm: Seed plant that does not make flowers or fruits; for example, a conifer.

Monocots: Highly diverse angiosperm group; includes plants such as grasses that have one seed leaf and parallel veins.

Seed plant (spermatophyte): Plant that produces seeds and pollen; an angiosperm or gymnosperm.

Vascular plant: Plant having specialized tissues (xylem and phloem) that transport water and sugar within the plant body.

Kingdom Animalia

Activity 2.19: Investigating

Think about all the animals you are familiar with. They may be pets, animals in nature, or captive animals such as in a circus or zoo. This section explains what all animals have in common. List the characteristics you know about that all animals share.

Objectives

At the end of this section, the student will be able to:

- *list the characteristic feature of the animal kingdom,*
- *describe characteristic features of invertebrates and vertebrates*
- *list the common class of animals*

What is an Animal?

Kingdom Animalia includes all multicellular, heterotrophic, eukaryotic animals. Constructing a good definition of an animal is

not straightforward, as there are exceptions to nearly every criterion for distinguishing animals from other life forms. However, several characteristics of animals, when taken together, sufficiently define them.

Animals differ from both plants and fungi in their mode of nutrition. Unlike plants, animals are not photosynthetic. Animals consume food obtained from other organisms (i.e. they are heterotrophs). But unlike fungi, most animals do not feed by absorption; instead, animals ingest their food and then use enzymes to digest it within their bodies.

In contrast to plants and fungi, however, animals lack the structural support of cell walls. Instead, animal cells are held together by structural proteins, the most abundant being collagen, which is found only in animals.

Many animals have two types of specialized cells not seen in other multicellular organisms: muscle cells and nerve cells. In most animals, these cells are organized into muscle tissue and nervous tissue, respectively, and are responsible for moving the body and conducting nerve impulses.

The ability to move and conduct nerve impulses underlies many of the adaptations that differentiate animals from plants and fungi, making muscle and nerve cells central to what it means to be an animal.

Most animals reproduce sexually.

Animals are very diverse. They are generally classified into two groups based on the presence or absence of backbone as invertebrates (animals with no backbone) and vertebrates (animals with a backbone(Fig. 2.13 -2.15).

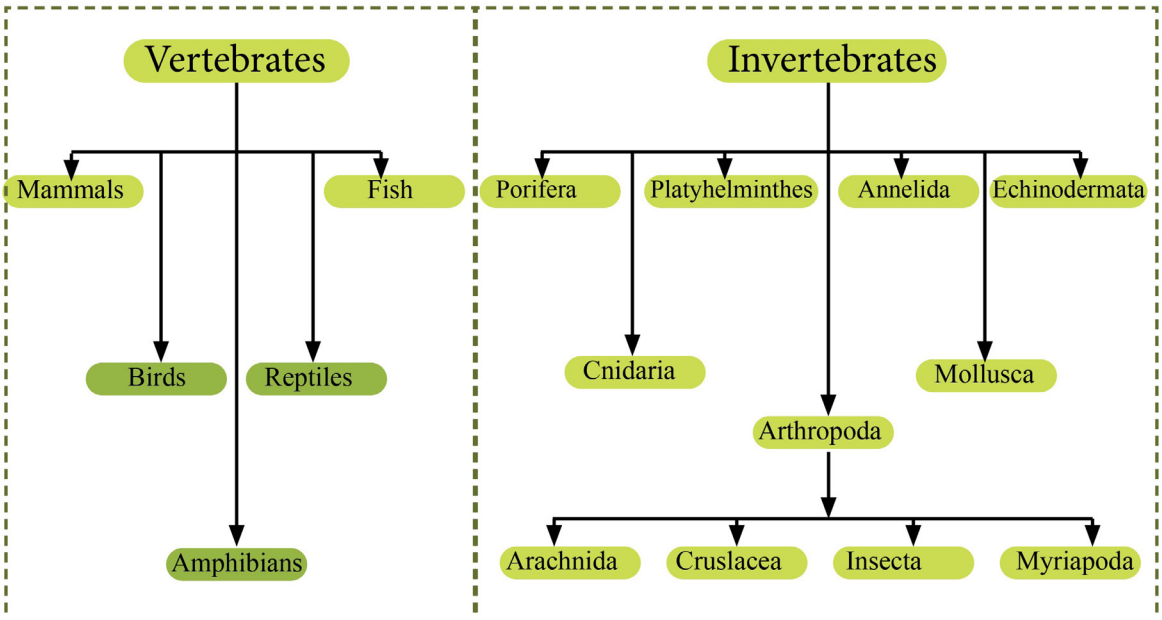


Figure 2.13. Major groups of animals

Self Assessment

1. What are the characteristic features of animals?
2. What are the differences between invertebrate and vertebrates?

Activity 2.20: Collaborative Learning Groups

What are the two largest groups of animals recognized by biologists/ zoologists? Make a field visit in your school compound or village and try to classify the animals you see/know into invertebrates or vertebrates. (Hint: you could use a dichotomous key)

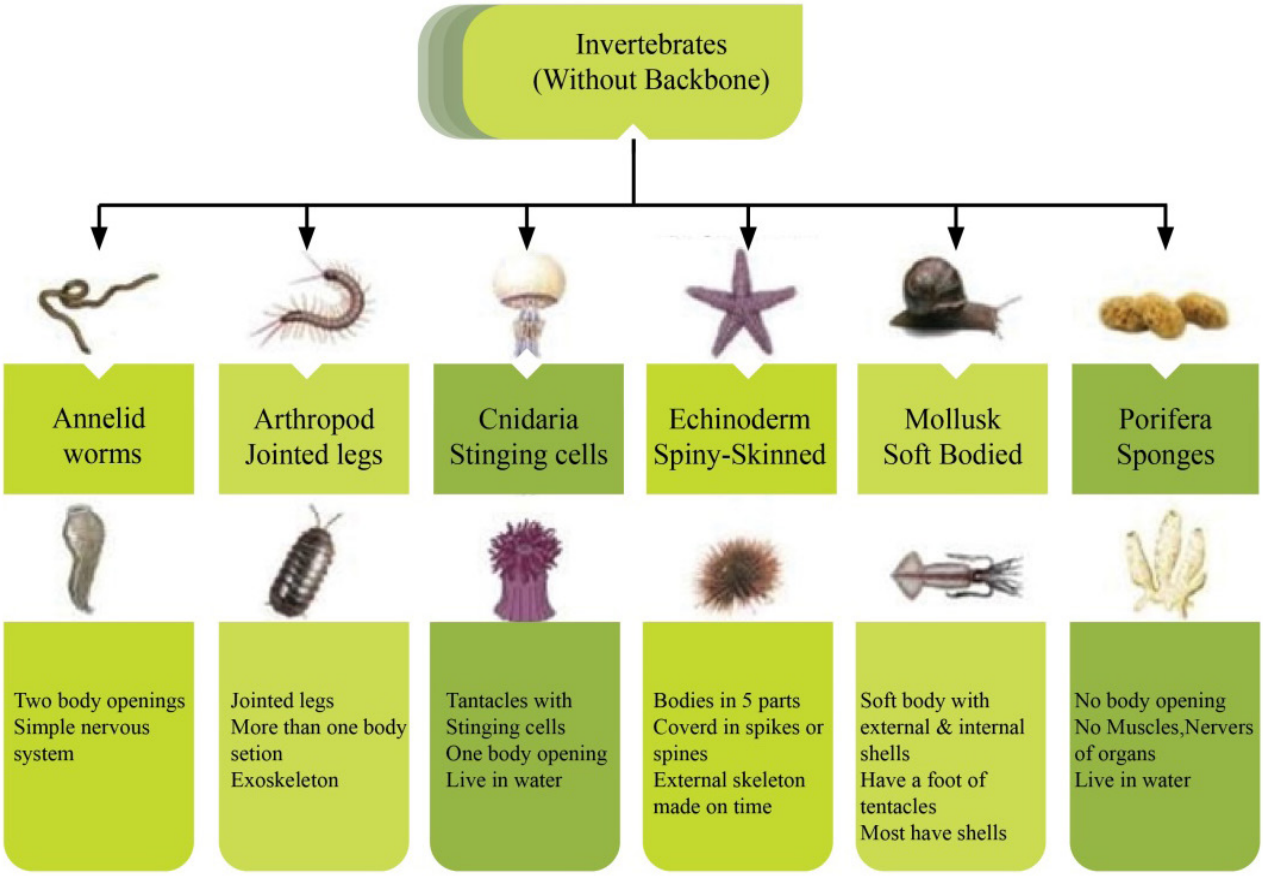


Figure 2.14. Major groups of invertebrates

Key Terms

Anatomy: the study of internal structure, as revealed by dissection.

Invertebrates: are animals without a backbone.

Morphology: is the study of the form or outward appearance of organisms.

Vertebrates: are animals with a backbone.

Activity 2.21: Interviewing

Make internet search or ask a biologist about medically or agriculturally important insects (e.g., grasshopper, tsetse fly, mosquito, honey bee etc.) and list their importance (Hint: economic, pollination, pest, aesthetic; music and arts, cultural, spiritual, vector etc.).

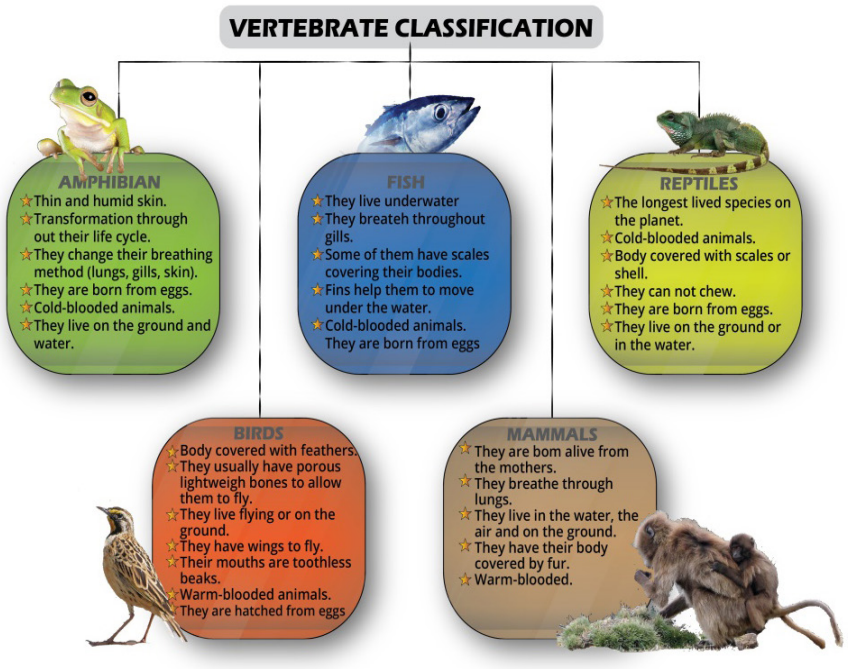


Figure 2.15. Major groups of vertebrates

Activity 2.22: Collaborative Learning

Read a book or search on internet about important fish species, mammals, and birds. Then list their economic, medicinal, aesthetic, cultural, spiritual, and/or ecological importance.

2.7 Renowned Taxonomists in Ethiopia

Objectives

At the end of this section, the student will be able to:

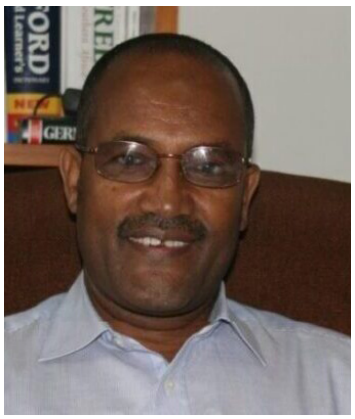
- *Appreciate the works of renowned taxonomists in Ethiopia.*

Activity 2.23: Collaborative Learning

Do you know any renowned Ethiopian taxonomist? If you know one, please write the name and the contribution of the renowned Ethiopian taxonomist.

As stated in section 2.5 of this textbook, Ethiopia is known for high degree speciesdiversity and endemcity. However, only few studies have been done to identify, name and classify the biodiversity at different levels (e.g., gene, species, and ecosystem).. Among the factors that led to inadequate level of studies done in Ethiopia in the field of biodiversity could be due to the few number of scientists educated and trained in taxonomy despite the country's rich biodiversity.

Yet, as the result of efforts made over the past six decades, our country has trained and educated a couple of renowned taxonomists that contributed the publication of volumes of books on the Flora of Ethiopia, for example. Among these scientists are Dr. Mesfin Taddese, Professor Sebsebe Demissew, Professor Ensermu Kelbessa and Professor Silesh Nemomissa to mention a few of them. In addition, there are few other zoologists like Professor Abebe Getahun; who contributed to the field of animal taxonomy. Below, we will discuss briefly the contributions made by some distinguished Ethiopian taxonomists to the scientific community in general and Ethiopian society in particular.



Professor Sebsebe Demissew

Professor Sebsebe Demissew has participated in several successful research projects universities in Europe and Africa. He has published books and articles on the vegetation and plants of Ethiopia and Africa. He is a member of national and international professional organizations and has served as Chair of the Biological Society of Ethiopia, Secretary-General of the Association for the Taxonomic Study of the Flora Tropical Africa (AETFAT) in addition to being a Council member of the International Association for Plant Taxonomy. He has also served as a director of Flora of Ethiopia and Gulelle botanical Garden.

Unit review

- The characteristics of living things are movement, respiration, sensitivity, growth, reproduction, excretion, nutrition, etc.
- Classification is a way of sorting organisms into a meaningful order, traditionally using morphology and anatomy, but recently also using DNA (molecular).
- The science of naming, identifying and classifying organisms is known as **taxonomy**.
- **Carolus Linnaeus** (1707–1778), who is also known as the father of taxonomy, introduced a taxonomic hierarchy of classification.
- The taxonomic hierarchies are domains, kingdom, Phylum (division), class, order, family, genus, and species
- The three domains are archaea, bacteria and eukarya (i.e. protists, fungi, plants and animals)
- Classification gives biologists a framework that allows them to study the relationships between living and extinct organisms.
- Taxonomy can be a useful tool for scientists who work in such areas as agriculture, forestry, and medicine.
- The binomial system is an internationally agreed system in which the scientific name of an organism is made up of twoparts showing the genus and the specific epithet.
- In writing a scientific name, the first letter of name of the genus is a capitalized letter and the specific name always starts with a small letter, for example, the scientific name of human beings is *Homo sapiens*. The scientific names are underlined when handwritten or italicized when printed.

- Ethiopia is endowed with high biological diversity (biodiversity) due to its geographical location, topographical diversity and diverse climatic features. The country is a hot spot for a diversity of wild plant and animal species with a high degree of endemicity
- Dichotomous keys are used to identifying unfamiliar organisms.Dichotomous means two branches, so the user is given achoice of two possibilities at each stage.
- Whittaker's five-kingdom scheme consists of animals, plants, fungi, monera and protoctista
- Monera(bacteria and archaea): do not typically have a nucleus or endomembrane system,and they do not reproduce sexually. Members of both groupstypically have cell walls.
- Protists do not have a specific defining trait; they are a collection of many eukaryotic groups. Most protists are single-celled, but there are multicelled and colonial species. Life cycles vary like nutrition; some species are autotrophs, others are heterotrophs.
- Fungi are heterotrophs that secrete digestive enzymesto break down organic material, then absorb the releasednutrients. Some live as single cells; others grow as amulticelled mycelium. All have cell walls with chitin.
- Bryophytes: have no vascular tissues, seedless,
- Gymnosperms: Vascular tissue present, "naked" seeds
- Angiosperms: Vascular tissue present, Seeds form in a floral ovary that becomes a fruit and monocots, dicots, and relatives
- Animals are very diverse. They are generally classified into two groups based on the presence or absence of backbone as invertebrates (animals with no backbone) and vertebrates (animals with a backbone).
- The invertebrates includes: sponges, flat worms, round worms, annelida, Mollusca, Arthropoda (e.g.,Insects, Arachnids, Crustacea&Myriapods).
- The invertebrates includes: fish, amphibians, reptiles, birds, & mammals.
- Dr. Mesfin Taddese, Professor Sebsebe Demissew, Professor Ensermu Kelbessa, Professor Abebe Getahun and Professor Silesh Nemomissa are few of the renowned Ethiopia taxonomists.

Review Questions

Part One (True or False items): Say true if the statement is correct false if the statement is wrong

1. Archaea have very different cell walls from bacteria.
2. Classification is the process of grouping things based on their similarities.
3. Ethiopia is a primary center for *Eragrostis tef* and *Guizotia abyssinica*.
4. Gymnosperm are seed plant that does not make flowers or fruits
5. Linnaeus' developed a four Kingdom system of classification.
6. Some autotrophic bacteria make their own food the way plants do and they are chemosynthetic.
7. The Greek philosopher Aristotle (384-322 BC) developed the first widely accepted biological classification systems.
8. Fungi can reproduce either by vegetative, asexual reproduction through spores formation and sexually.
9. Many animals have two types of specialized cells not seen in other multicellular organisms.
10. Unicellular algae are the basis of aquatic food chains and produce much of the oxygen in Earth's atmosphere.

Part Two (Multiple Choices items): Choose the best answer among the give alternatives.

1. A process by which an organism produces offspring is called.....
   A. reproduction B. homeostasis C. development D. inheritance
2. Bacteria that serve as decomposers are
   A. photoautotrophs B. chemoautotrophs. C. photoheterotrophs D. chemoheterotrophs
3. All fungi.....
   A. are multicelled B. are heterotrophs C. form flagellated spores D. all of the above
4. Most fungi obtain nutrients from .....
   A. nonliving organic matter B. living animals C. living plants D. photosynthesis
5. Fungal infections are most common in .....
   A. plants B. mammals C. insects D. birds
6. ..... is the transmission of DNA to offspring.
   A. reproduction B. homeostasis C. development D. inheritance
7. Bacteria, Archaea, and Eukarya are three .....
   A. famalies B. kigdom C. classes D. domain

8. Organisms require..... and .....to maintain themselves, grow, and reproduce.

A. DNA; energy B. nutrients; energy C. food; sunlight D. DNA; cells

Part Three: Critical thinking questions

1. How do viruses affect human health?
2. What are the major groups of vertebrates?
3. What ecological roles do bacteria play?
4. What ecological roles do fungi play?
5. Write the ecological and economic importance of insects
6. What structural and functional features do bacteria and archaea share?
7. How are plants important?