Chapter 01: The Study of Life

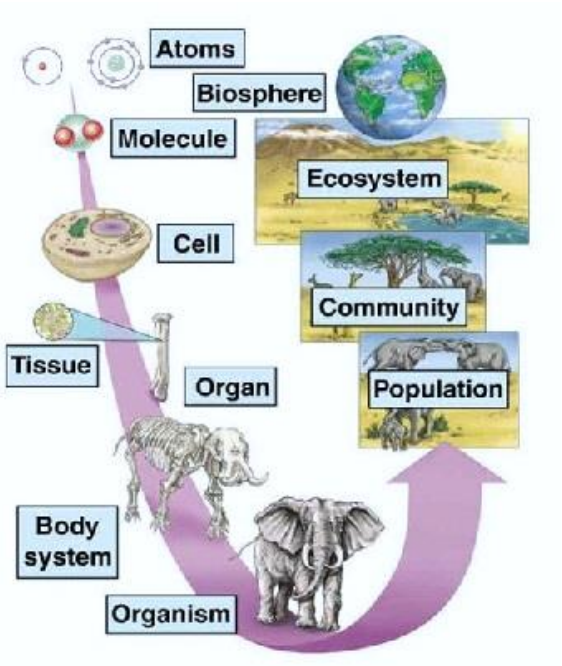
Lesson 01:

The Study of Life, Part 1

Reading Assignment:

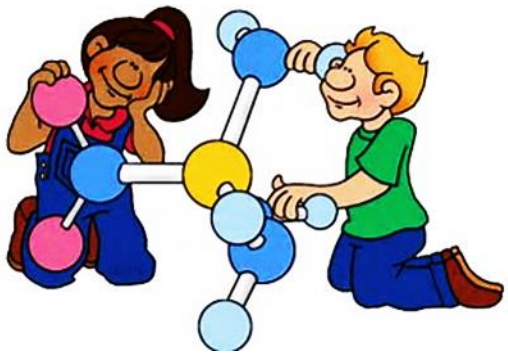
Whether you have studied biology or not, you already have an intuitive understanding of life on Earth because you are part of it. Every one of your experiences with the natural world - from the warmth of the sun on your skin to the love of your pet - contributes to that understanding.

Biologists study life. What, exactly, is "life"? We may never actually come up with a concise definition, because living things are too diverse, and they consist of the same basic components as nonliving things. When we try to define life, we end up with a long list of properties that differentiate living from nonliving things. These properties often emerge from the interactions of basic components. An example is a complex behavior called swarming. When honeybees swarm, they fly en masse to establish a hive in a new location. Each bee is autonomous, but the new hive's location is decided collectively based on an integration of signals from hivemates. The swarm's collective intelligence is the emergent property in this example. A characteristic of a system (a colony of bees swarming, for example) that does not appear in any of the system's components (individual bees) is called an **emergent property**. The idea that structures or systems with emergent properties can be assembled from the same components is a recurring theme in our world—and in biology.



Emergent property - A characteristic of a system that does not appear in any of the system's component parts.

Biologists view life as having nested levels of organization; interactions among the components of each level give rise to emergent properties

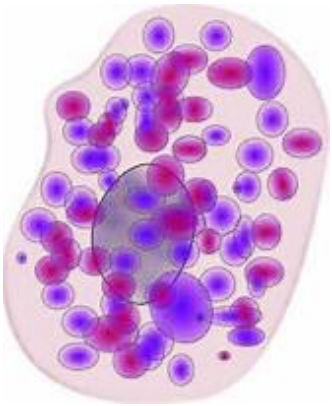


This organization begins with atoms. **Atoms** are the smallest units of a substance; they and the fundamental particles that compose them are the building blocks of all matter. Atoms bond together to form **molecules**. There are no atoms unique to living things, but there are unique molecules. A **cell**, which is the smallest unit of life, consists of many of these "molecules of life."

Atom - Smallest unit of a substance; consists of subatomic particles.

Molecule - Two or more atoms bonded together.

Cell - Smallest unit of life.



Some cells live and reproduce independently. Others do so as part of a **multicelled organism**. An **organism** is an individual that consists of one or more cells. In most multicelled organisms, cells are organized as tissues. A **tissue** consists of specific types of cells in an arrangement that allows the cells to collectively perform some function— protection from injury (dermal tissue) or movement (muscle tissue), for example. An **organ** is a structure composed of tissues that collectively carry out a task or set of tasks. For example, a flower is an organ of reproduction in plants; a heart, an organ that pumps blood in animals. An **organ system** is a set of interacting organs and tissues that fulfill one or more body functions. Examples of organ systems include the aboveground parts of a plant (the shoot system), and the heart and blood vessels of an animal (the circulatory system).

Multicelled organism - Individual that consists of more than one cell. Cells of this California poppy plant make up its shoot system and root system.

Organism - An individual that consists of one or more cells.

Tissue - Specialized cells organized in a pattern that allows them to perform a collective function.

Organ - A structure that consists of tissues engaged in a collective task.

Organ system - A set of interacting organs that carry out a body function.

Unique types of organisms - California poppies, for example - are called **species**. A **population** is a group of interbreeding individuals of the same species living in each area. For example, all

California poppies growing in California's Antelope Valley Poppy Reserve form a population. A **community** consists of all populations of all species in each area. The Antelope Valley Reserve community includes California poppies and all other plants, as well as animals, microorganisms, and so on . Communities may be large or small, depending on the area defined. The next level of organization is the **ecosystem**, which is a community interacting with its physical and chemical environment. Earth's largest ecosystem is the **biosphere**, and it encompasses all regions of the planet's crust, waters, and atmosphere in which organisms live.

Species – A unique type of organism.

Population – A group of interbreeding individuals of the same species living in a defined area.

Community - All populations of all species in a defined area.

Ecosystem - A community interacting with its environment.

Biosphere - All regions of Earth where organisms live.

Comprehension Check

01.01. T or F: Atoms are the smallest unit of a substance, consisting of subatomic particles. _____

01.02. Which of the following indicates "an individual that consists of one or more cells?"

a. organism
b. community
c. molecule
d. population
e. species

01.03. What is the term for "all regions of Earth where organisms live." _____

01.04. A _____ is the smallest unit of life.

01.05. T or F: A species is a group of interbreeding individuals of the same species living in a defined area. _____

01.06. Which of the following indicates "specialized cells organized in a pattern that allows them to perform a collective function?"

a. an atom
b. an organ
c. a molecule
d. a tissue
e. none of the above

01.07. What is the term for "a characteristic of a system that does not appear in any of the system's component parts?" _____ _____

01.08. In multicelled organisms, a/an _____ _____ is the set of interacting organs that carry out a body function.

01.09. T or F: Molecules are two or more protons bonded together. _____

01.10. Which of the following indicates "unique type of organism?"

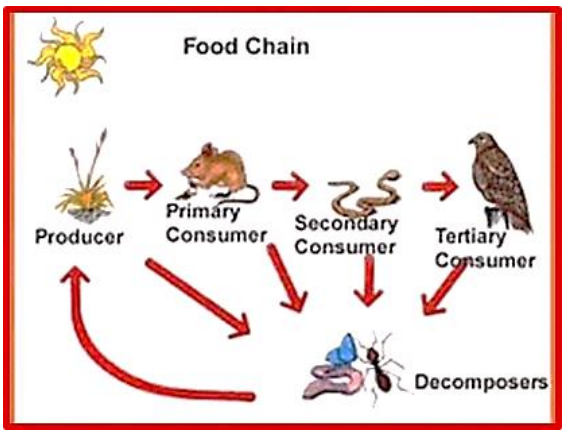
a. organism
b. community
c. molecule
d. population
e. species

Comprehension Check answers can be found in the Parent Test Manual. They are provided to help self-test your learning. The questions on your future Chapter Tests and Semester Exams will be similar to these.

All living things share a set of key features. You already know one of these features: Because the cell is the smallest unit of life, all organisms consist of at least one cell. For now, we introduce three more: All living things require ongoing inputs of energy and raw materials; all sense and respond to change; and all use DNA as the carrier of genetic information.

- all organisms consist of at least one cell.
- All living things require ongoing inputs of energy and raw materials
- all sense and respond to change
- all use DNA as the carrier of genetic information

Not all living things eat, but all require nutrients on an ongoing basis. A **nutrient** is a substance that an organism acquires from the environment to support growth and survival. Both nutrients and energy are essential to maintain the organization of life, so



organisms spend a lot of time acquiring them. However, the source of energy and the type of nutrients required differ among organisms. These differences allow us to classify all living things into two categories: producers and consumers. A **producer** makes its own food using energy and simple raw materials it obtains from nonbiological sources. Plants are producers. By a process called **photosynthesis**, plants can use the energy of sunlight to make sugars from carbon dioxide (a gas in air) and water. **Consumers**, by contrast, cannot make their own food. A consumer obtains energy and nutrients by feeding on other organisms. Animals are consumers. So are **decomposers**, which feed on the wastes or remains of other organisms. Leftovers from consumers' meals end up in the environment, where they serve as nutrients for producers. Said another way, nutrients cycle between producers and consumers.

Nutrient - Substance that an organism acquires from the environment to support growth and survival.

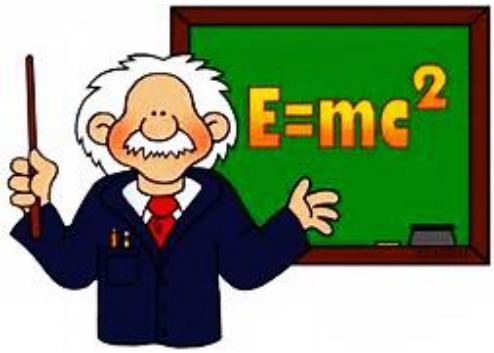
Producer - Organism that makes its own food using energy and nonbiological raw materials from the environment.

Photosynthesis - Process by which producers use light energy to make sugars from carbon dioxide and water.

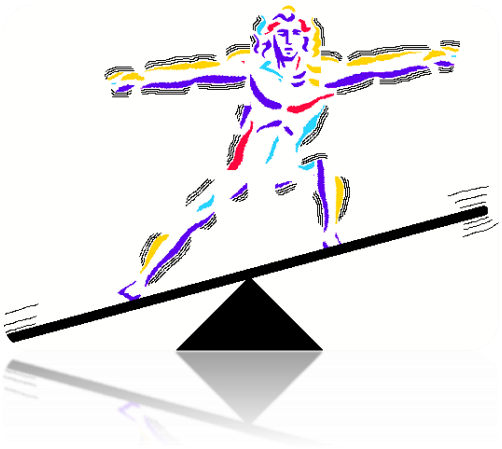
Consumer - Organism that gets energy and nutrients by feeding on tissues, wastes, or remains of other organisms.

Decomposers - An organism, usually a bacterium or fungus, that breaks down the cells of dead plants and animals into simpler substances.

Unlike nutrients, energy is not cycled. It flows in one direction: from the environment, through organisms, and back to the environment. This flow maintains the organization of every living cell and body, and it also influences how individuals interact with one another and their environment. The energy flow is one-way, because with each transfer, some energy escapes as heat, and cells cannot use heat as an energy source. Thus, energy that enters the world of life eventually leaves it.



An organism cannot survive for very long unless it can respond appropriately to specific stimuli inside and outside of itself. For example, humans and some other animals normally perspire



(sweat) when the body's internal temperature rises above a certain set point. The moisture cools the skin, which in turn helps cool the body. All the internal fluids that bathe the cells in your body are collectively called your internal environment. Temperature and many other conditions in that environment must be kept within certain ranges, or your cells will die (and so will you). By sensing and adjusting to change, all organisms keep conditions in their internal environment within ranges that favor cell survival. **Homeostasis** is the name for this process, and it is one of the defining features of life.

Homeostasis - Process in which organisms keep their internal conditions within tolerable ranges by sensing and responding appropriately to change.

With little variation, the same types of molecules perform the same basic functions in every organism. For example, information in an organism's **DNA** (deoxyribonucleic acid) guides ongoing cellular activities that sustain the individual through its lifetime. Such functions include **development**: the process by which the first cell of a new individual gives rise to a multicelled adult; **growth**: increases in cell number, size, and volume; and **reproduction**: processes by which organisms produce offspring. **Inheritance**, the transmission of DNA to offspring, occurs during reproduction. All organisms inherit their DNA from one or more parents.

DNA - Deoxyribonucleic acid; molecule that carries hereditary information; guides development and other activities.

Development - Process by which the first cell of a multicelled organism gives rise to a multicelled adult.

Reproduction - Processes by which organisms produce offspring.

Inheritance - Transmission of DNA to offspring.

Individuals of every natural population are alike in most aspects of body form and behavior because their DNA is very similar: Humans look and act like humans and not like poppy plants because they inherited human DNA, which differs from poppy plant DNA in the information it carries. Individuals of almost every natural population also vary—just a bit—from one another: One human has blue eyes, the next has brown eyes, and so on. Such variation arises from small differences in the details of DNA

molecules, and herein lies the source of life's diversity. As you will see in later chapters, differences among individuals of a species are the raw material of evolutionary processes.

Comprehension Check

01.11. What is the term for "an organism that gets energy and nutrients by feeding on tissues, wastes, or remains of other organisms?" _____

01.12. _____ is the process by which the first cell of a multicelled organism gives rise to a multicelled adult.

01.13. T or F: Deoxyribonucleic acid (DNA) is a molecule that carries hereditary information, guides development, and other cellular activities. _____

01.14. In multicelled species, which of the following indicates an increase in the number, size, and volume of cells?

a. development
b. homeostasis
c. growth
d. reproduction

01.15. What is the term for an "organism that makes its own food using energy and nonbiological raw materials from the environment?" _____

01.16. Inheritance is the _____ of DNA to offspring.

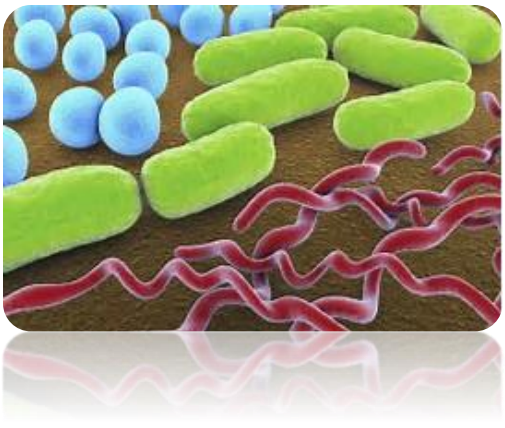
01.17. T or F: Chemosynthesis is the process by which producers use light energy to make sugars from carbon dioxide and water. _____

01.18. Which of the following is the process in which organisms keep their internal conditions within tolerable ranges by sensing and responding appropriately to change?

a. development
b. homeostasis
c. growth
d. reproduction

01.19. What is the term for the "processes by which organisms produce offspring?" _____

01.20. A nutrient is a substance that an organism acquires from the _____ to support growth and survival.



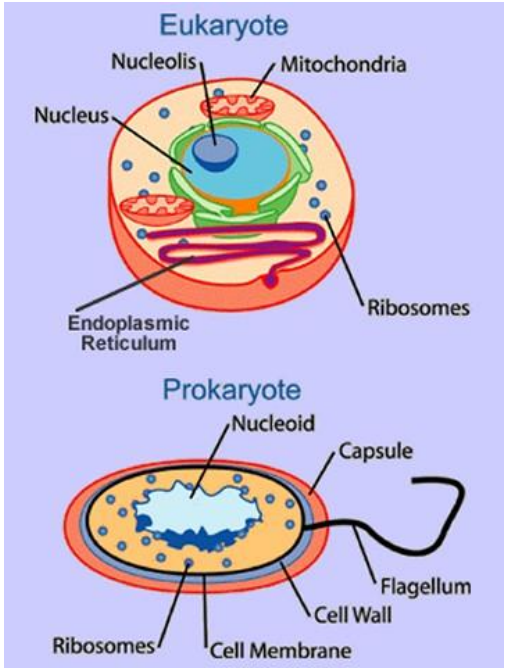
Differences in the details of DNA molecules are the basis of a tremendous range of differences among types of organisms. Various classification schemes help us organize what we understand about the scope of this variation, which is an important aspect of Earth's **biodiversity**. For example, organisms can be grouped based on whether they have a nucleus, which is a saclike structure containing a cell's DNA. **Bacteria** (singular, bacterium) and **archaea** (singular, archaeon) are organisms whose DNA is not contained within a nucleus. All bacteria and archaea are single celled, which means each organism consists of one cell. Collectively, these organisms are the most diverse representatives of life. Different kinds are producers or consumers in nearly all regions of Earth. Some inhabit such extreme environments as frozen desert rocks, boiling sulfurous lakes, and nuclear reactor waste. The first cells of Creation may have faced similarly hostile conditions.

Biodiversity - The variety of life in the world or in a habitat or in an ecosystem.

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

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

Traditionally, organisms without a nucleus have been classified as **prokaryotes**, but the designation is now used only informally. This is because bacteria and archaea are less related to one another than we once thought, despite their similar appearance. Archaea turned out to be more closely related to **eukaryotes**, which are organisms whose DNA is contained within a nucleus. Some eukaryotes live as individual cells; others are multicelled. Eukaryotic cells are typically larger and more complex than bacteria or archaea.



Prokaryote - Single-celled organism without a nucleus.

Eukaryote - Organism whose cells characteristically have a nucleus.

There are five main groups of eukaryotes: protists, chromists, fungi, plants, and animals. **Protist** is the common term for a collection of eukaryote groups that are not plants, animals, or fungi. Collectively, they vary

dramatically, from single-celled consumers to giant, multicelled producers. **Chromist** is the term used for all algae whose chloroplasts contain chlorophylls a and c, as well as various colorless forms that are closely related to them. The organism's chloroplasts are surrounded by four membranes, which are believed to have been acquired from some red algae. **Fungi** (singular, fungus) are eukaryotic consumers that secrete substances to break down food externally, then absorb nutrients released by this process. Many fungi are decomposers. Most fungi, including those that form mushrooms, are multicellular. Fungi that live as single cells are called yeasts. **Plants** are multicelled eukaryotes, and the clear majority of them are photosynthetic producers that live on land. Besides feeding themselves, plants also serve as food for most other land-based organisms. **Animals** are multicelled consumers that ingest other organisms or components of them. Unlike fungi, animals break down food inside their body. They also develop through a series of stages that lead to the adult form. All animals actively move about during at least part of their lives.

Protist - Common term for a eukaryote that is not a chromist, plant, animal, or fungus.

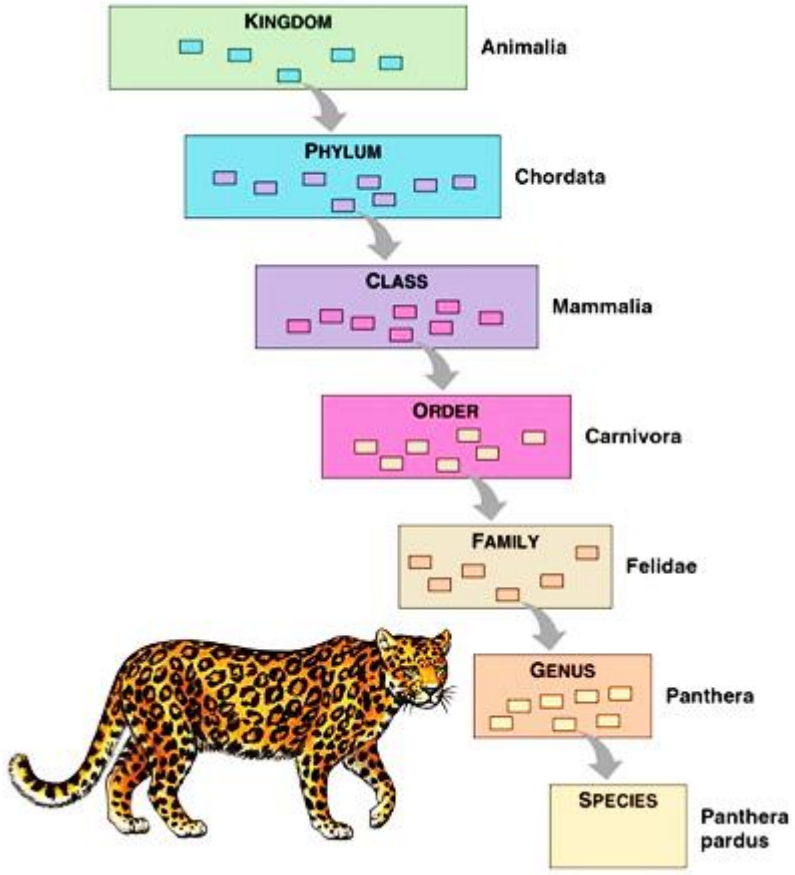
Chromist - Algae whose chloroplasts contain chlorophylls a and c, as well as various colorless forms.

Fungi - Single-celled or multicelled eukaryotic consumers that breaks down material outside themselves, then absorbs nutrients released from the breakdown.

Plant - A multicelled, typically photosynthetic producer.

Animal - Multicelled consumer that breaks down food inside its body, develops through a series of stages, and moves about during part or all its life.

Each time we discover a new species, we name and classify it, a practice called **taxonomy**. Taxonomy began thousands of years ago, but naming species in a consistent way did not become a priority until the eighteenth century. At the time, European explorers who were just discovering the scope of life's diversity started having more and more trouble communicating with one another because species often had multiple names. For example, the dog rose (a plant native to Europe, Africa, and Asia) was alternately known as briar rose, witch's briar, herb patience, sweet briar, wild briar, dog briar, dog berry, briar hip, eglantine gall, hep tree, hip fruit, hip rose, hip tree, hop fruit, and hogseed - and those are only the English names! Species often



had multiple scientific names too, in Latin that was descriptive but often cumbersome. The scientific name of the dog rose was *Rosa sylvestris inodora seu canina* (odorless woodland dog rose), and also *Rosa sylvestris alba cum rubore, folio glabro* (pinkish white woodland rose with smooth leaves).

Taxonomy - Naming and classifying species in a systematic way.

An eighteenth-century naturalist, Carolus Linnaeus, (see vignette at end of lesson) standardized a naming system that we still use. By the Linnaean system, each species is given a unique two-part scientific name. The first part of a scientific name is the **genus** (plural, genera), which is defined as a group of species that share a unique set of features. Combined with the second part of the name (the "specific epithet"), it designates one species. Thus, the dog rose now has one official name, Rosa canina, that is recognized worldwide.

Genus - A group of species that share a unique set of traits.

The genus name is always capitalized, and the specific epithet is not. Both are always italicized. Consider *Panthera*, a genus of big cats. Lions belong to the species *Panthera leo*. Tigers belong to a different species in the same genus (*Panthera tigris*), and so do leopards (*P. pardus*). Note how the genus name may be abbreviated after it has been spelled out.

The individuals of a species share a unique set of traits. For example, giraffes normally have very long necks, brown spots on white coats, and so on. These are morphological (structural) traits. Individuals of a species also share biochemical traits (they make and use the same molecules) and behavioral traits (they respond the same way to certain stimuli, as when hungry giraffes feed on tree leaves). We can rank a species into ever more inclusive categories based on some subset of traits it shares with other species. Each rank, or **taxon** (plural, taxa), is a group of organisms that share a unique set of inherited traits. Each category above species - genus, family, order, class, phylum (plural, phyla), kingdom, and domain - consists of a group of the next lower taxon.

Using this system, we can sort all life into a few categories. Later chapters return to details of these and other classification systems.

Taxon - A rank of organisms that share a unique set of traits.

It is easy to tell that humans and dog roses are different species because they appear very different. Distinguishing other species that are more closely related may be much more challenging. In addition, traits shared by members of a species often vary a bit among individuals. Performing the following biological key experiment should help solidify these classification concepts.

Experiment 01
Biological Classification

Objective**:**

Identify ten living things using the biological key provided below. Keys vary in their style and content. An excellent library activity would be to check other keys and see how they are used.

Supplies:

- Photographs from the Internet
- Biological key provided below
- Notebook and pencil

Procedure:

Below is the biological key you should use for this exercise:

1. a. flying (go to 2)
   b. Not flying (go to 6)

2. a. Feathered (go to 3)
   b. Not feathered …… *Myotis lucifugus*

3. a. Web footed, water living ……. *Anas platyrhynchos*
   b. Not web footed, not water living (go to 4)

4. a. Hovering flight, very small …… *Archilochus colubris*
   b. Not hovering flight (go to 5)

5. a. Mouse eater, nocturnal ……. *Bubo virginianus*
   b. Insect eater, diurnal ……..... *Turdus migratorius*

6. a. Hairy or furred (mammalian) (go to 8)
   b. Not furred, (not mammalian) (go to 7)

7. a. Legs present …… *Rana pipiens*
   b. Legs absent …….. *Thamnophis sirtalis parietalis*

8. a. Aquatic mammal …….. *Phoco vitulina*
   b. Terrestrial mammal (go to 9)

9. a. Hopping or jumping locomotion (go to 10)
   b. No hopping or Jumping locomotion (go to 11)

10. a. Large with large tail used for balance …….. *Macropus rufus*
    b. Small with small bobbed tail ……. *Lepus townsendii*

11. a. Large, flat, leathery tail ……... *Castor Canadensis*
    b. Tail not leathery and flat (go to 12)

12. a. Hoofed, vegetation eating (go to 13)
    b. Not hoofed, carnivorous or omnivorous (go to 17)

13. a. Spotted or striped coat (go to 14)
    b. No spots or stripes on coat (go to 15)

14. a. Spotted coat, long neck …… *Giraffa camelopardalis*
    b. Striped black and white, horse-like ……. *Equus burchelli*

15. a. Can be domesticated ……. *Ovis aries*
    b. Not usually domesticated (go to 16)

16. a. Lives primarily in marshes and forested areas …… *Alces alces*
    b. Once numerous on the prairies ……... *Bison bison*

17. a. Long ringed tail ……... *Procyon lotor*
    b. Shorter, bobbed tail (go to 18)

18. a. Cat-like ……... *Lynx lynx*
    b. Not cat-like (go to 19)

19. a. Eats eucalyptus leaves, often found in trees ……... *Phascolarartos cinereus*
    b. Not eucalyptus leaf eating (go on to 20)

20. a. White coat, northern dwelling …… *Ursus maritimus*
    b. Brown coat, can be found in southern areas ……. *Ursus arctos*

The chart below gives you an example of how to identify a grizzly bear using the biological key. Once you understand how the chart is filled in, search for a picture of each creature listed online. DO NOT use Wikipedia or any other source to look up the classification. You may use online resources for additional information about the creature, however.

Once you have found a picture, identify each creature below by working through the key provided. As you work through the key, make a chart in your laboratory notebook like the one given below. (Note: you do not have to include the picture in your chart. We provide a grizzly bear picture below as an example of what to look for online.)

Number	Specimen	Numbers used from Key	Genus and species
Example	Grizzly Bear 	1b, 6a, 8b, 9b, 11b, 12b, 17b, 19b, 19b, and 20b.	Ursus arctos
01.	Little Brown Bat		
02.	Leopard Frog		
03.	Red Kangaroo		
04.	Giraffe		
05.	Red Sided Garter Snake		
06.	Great Horned Owl		
07.	Mallard Duck		
08.	Harbor Seal		
09.	Koala Bear		
10.	Beaver		

Complete the chart so that you have an entry for each specimen. Please note that you may not be able to answer every question in the biological key based on the picture found alone. You might have to do a little research to classify some of the specimens, but DO NOT look up the classification information. Once you have completed the chart in your laboratory notebook, check the answers that are provided at the end of the Chapter.

How do biologists decide whether similar-looking organisms belong to different species? The short answer to that question is that they rely on whatever information is available. Early naturalists studied anatomy and distribution—essentially the only methods available at the time—so species were named and classified according to what they looked like and where they

lived. Today's biologists can compare traits that the early naturalists did not even know about, including biochemical ones such as DNA molecules.

Consider that the information in a molecule of DNA changes a bit each time it passes from parents to offspring, and it has done so since life began. Over long periods of time, these tiny changes have added up to big differences between species such as humans and dog roses. Thus, differences in DNA are one way to measure relative relatedness: The fewer differences between species, the closer the relationship. For example, we know that the DNA of humans is more similar to chimpanzee DNA than it is to cat DNA, so we can assume that chimpanzees and humans are closer relatives than cats and humans. Every living species known has DNA in common with every other species, so every living species is related to one extent or another. Unraveling these relationships has become a major focus of biology.

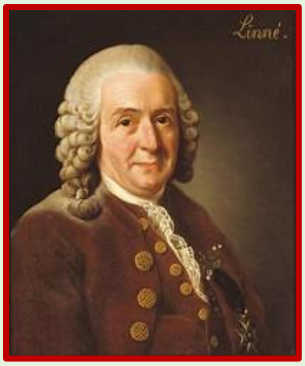
The discovery of new information sometimes changes the way we distinguish a particular species or how we group it with others. For example, Linnaeus grouped plants by the number and arrangement of reproductive parts, a scheme that resulted in odd pairings such as castor-oil plants with pine trees. Having more information today, we place these plants in separate phyla.

Evolutionary biologist Ernst Mayr defined a **species** as one or more groups of individuals that potentially can interbreed, produce fertile offspring, and do not interbreed with other groups. This "biological species concept" is useful but not universally applicable. For example, we may never know whether populations of some species could interbreed because impassable geographical barriers keep them separated. As another example, populations often continue to interbreed even as they diverge, so the exact moment at which two populations become two species is often impossible to pinpoint. We return to speciation and how it occurs in a later Chapter, but for now it is important to remember that a "species" is a convenient but artificial construct of the human mind.

Species - One or more groups of individuals that potentially can interbreed, produce fertile offspring, and do not interbreed with other groups.

Most of us assume that we do our own thinking, but do we, really? You might be surprised to find out how often we let others think for us. Consider how a school's job (which is to impart as much information to students as quickly as possible) meshes perfectly with a student's job (which is to acquire as much knowledge as quickly as possible). In this rapid-fire exchange of information, it can be very easy to forget about the merit of what is being exchanged. Any time you accept information without evaluating it, you let someone else think for you.

Carolus Linnaeus



(1707–1778), Swedish botanist and zoologist, laid the foundations for the biological binomial nomenclature system still used today. As the father of modern taxonomy and ecology, he is known as the "most famous botanist of all time." He was also "a creationist and thus an enemy of evolution." Dr. Henry Morris wrote:

[Linnaeus] was a man of great piety and respect for the Scriptures. One of his main goals in systematizing the tremendous varieties of living creatures was to attempt to delineate the original Genesis "kinds." He…[believed] that variation could occur within the kind, but not from one kind to another kind.

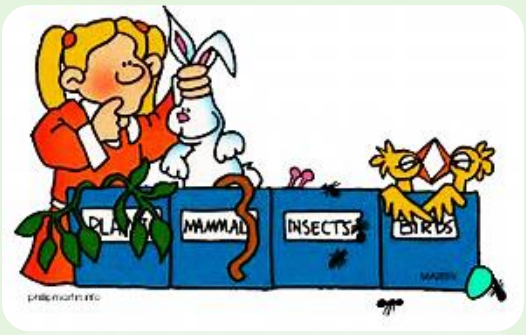
Born in southern Sweden, Linnaeus spent much of his spare time searching for new plant specimens and collecting flowers. First educated at Lund University, he later transferred to Uppsala University to study botany. There he soon realized the current taxonomy system used to name plants was severely lacking.

Before Linnaeus' generation, most people lived in a simple and geographically small world and were exposed to so few organisms that it was fairly easy to achieve a taxonomic order that made good sense. In Linnaeus' day these simple times had rapidly come to an end. At the start of the eighteenth century, hundreds of European ships left port with adventurers and missionaries eager to explore the world opening up to them. Cartographers, mineralogists, and naturalists scoured the globe for new life forms to sell to European exotica collectors.

Scientists "in different countries, speaking different languages, reading different texts, quickly began to find it difficult to know, in any particular case, whether any two naturalists were even talking about the same animal or plant or something entirely different." For example, the many names for buffalo included bubalus, buffle, urus, catoblepas, bubalas, theur, and the Scottish bison.

This abundance of names caused confusion for scholars—a problem Linnaeus set out to solve. Linnaeus was actually said to be "obsessed with order in general, a quality that helped him keep his head in the growing botanical and zoological chaos. He…and any who followed his mandates" would be able to achieve order in the natural world.

At only 23, Linnaeus began to develop a new system to reorganize the entire plant kingdom. In the end, it was his "organization, his spit and polish rules, that have been among Linnaeus's most lasting gifts to science and part of what helped to rescue natural history from disarray." Writing in his autobiography that Almighty God gave him insight "into His myriad forms [of life] unchanged since the day of creation," Linnaeus believed "he did indeed have a special



ability that set him apart…his talents and powers [are] a clue to that difference." His entire taxonomy system was based on his belief "that God could be approached through the study of Nature," and he felt it was his Christian obligation to learn about God by studying "the wonders of the created universe."

Over the next several years Linnaeus originated the two-word binomial classification system that uses the genus and species designation. He published the first edition of the taxonomy bible Systema Naturae (The System of Nature) in 1735 at the age of 28. Linnaeus achieved this feat by "laying out not only a vast compendium of rules for the ordering and naming of life, but an ordering of the entire living world." This book eventually grew to multiple volumes, naming some 7,700 species of plants and 4,400 species of animals "for the glory of God."

This elegant work far surpassed other existing schemes due to its all-encompassing nature, clarity, and "simple good sense—seeming so inexplicably right to so many—that they and he would take the world by storm."18 This and his other books were very popular and sold well.

In the 1740s, he made several journeys throughout Sweden to discover and classify new plants and animals. He continued to collect and classify animals, plants, and even minerals for his entire life, continually publishing new volumes of his Systema Naturae.1 His tenth edition is now "recognized by scientists around the world as the official starting point for all zoological nomenclature, the ordering and naming of all animals," and his work Species Plantarum (The Species of Plants) would be internationally recognized as the basis for all botanical nomenclature.

Philosopher Jean-Jacques Rousseau wrote of Linnaeus, "I know no greater man on earth." German writer Johann Wolfgang von Goethe opined, "With the exception of Shakespeare and Spinoza, I know no one among the no longer living who has influenced me more strongly." Professor Å. Gustafsson of the University of Lund concluded that "Linnaeus is regarded in the history of biology as the brilliant classifier of nature's diversity. God created the world, Linnaeus put it in order.'

Linnaeus was knighted in 1753 by the king of Sweden. Today he is revered "as a national hero in Sweden, depicted in countless biographies, [and] spoken of with glowing admiration in textbook after textbook. He captured and validated our world." Linnaeus eventually became professor of medicine and botany at Uppsala.

Although a dedicated and popular professor, he found time to write many books, such as Flowers of Lapland, and he even penned a

Manual on classifying minerals. From 1749 to 1769 he published 170 papers and several books on topics ranging from woodpeckers to the cause of epilepsy. His life documents what a man of God can attain by applying Genesis to science.

Comprehension Check

01.21. T or F: Bioecology is the variety of life in the world or in a habitat or in an ecosystem. _____

01.22. Which of the following characteristically have a nucleus?

a. bacteria
b. prokaryotes
c. fungi
d. archaea
e. none of the above

01.23. What is the term for a "multicelled consumer that breaks down food inside its body, develops through a series of stages, and moves about during part or all its life?" _____

01.24. _____ is the term for "naming and classifying species in a systematic way."

01.25. T or F: A class is a group of species that share a unique set of traits. _____

01.26. Using the biological classification key provided in Experiment 01, which of the following would be classified based on being a non-flying, hairy, marine-loving organism?

a. *Phoco vitulina*
b. *Archilochus colubris*
c. *Castor Canadensis*
d. *Bison bison*
e. *Ursus maritimus*

01.27. What is the term for "a rank of organisms that share a unique set of traits?" _____

01.28. When the differences in _____ are few between species, their ancestral relationship becomes closer.

01.29. T or F: Species are one or more groups of individuals that potentially can interbreed,

produce fertile offspring, and do not interbreed with other groups. _____

01.30. Who believed that that variation could occur with the kind of species, but not that species could change into another kind?

a. Louis Pasteur
b. Charles Darwin
c. Gregor Mendel
d. Albert Einstein
e. Carolus Linnaeus

Lesson 01:

The Study of Life, Part 1

Video Link & Notes:

Reading Assignment: Lesson 01, pp. 33 - 38

Lesson Video: Play Lesson 01 from the Video File. (Print off notes below before playing.)

Lesson Starts: 7:00 (Fast forward to this point for lecture.)

Please watch this video before class starts or the session video is viewed:

http://www.youtube.com/watch?v=CBeCxKzYiIA

(Parents: Please be advised that these are You-Tube videos. We have no control over the ads that are presented. We do our best to screen the presentations, but ads change daily. Please preview the video environment before your student views the links. We feel that Google Chrome is the best browser for students to watch videos. It screens content very well.)

https://www.google.com/chrome/browser/

The four criteria for life are as follows:

a. All life forms contain deoxyribonucleic acid, which is called _____.

b. All life forms have a method by which they extract _____ from the surroundings and convert it into energy that sustains them.

c. All life forms can sense _____ in their surroundings and respond to those _____.

d. All life forms _____.

1. According to scientific research, all live forms contain what? _____

2. A mule is a cross between a male ass (a jackass) and a female horse (a mare). It is usually sterile. This means it cannot produce offspring. Is the mule alive? _____

3. A virus is composed of genetic material (sometimes DNA, sometimes RNA). It invades a cell, hijacks the cell's reproductive machinery and makes the cell start reproducing viruses. The cell eventually explodes due to the huge number of viruses inside. Is a virus alive? _____

4. A Euglena has an eyespot which allows it to sense light and respond to the light. Is the Euglena living? Why?
_____

5. The process by which a living organism takes energy from its surroundings and uses it to sustain itself, develop, and grow is called what? _____

a. _____ is the sum total of all processes in an organism which use energy and simple chemical building blocks to produce large chemicals and structures necessary for life

b. _____ is the sum total of all processes in an organism which break down chemicals to produce energy and simple chemical building blocks

6. Where does the process of metabolism begin?

It begins with the _____.

7. The process by which a plant uses energy of sunlight and certain chemicals to produce its own food is called what?

_____

8. There are two words given in your text that signify an organism that makes its own food. What are they?

_____ or _____

9. Heterotrophs are organisms that depend on other organisms for food. What are the two kinds mentioned in your book?

_____ and _____

10. There are three kinds of consumers listed in your book. What are they and what do they eat?

_____ are organisms that eat plants exclusively.

_____ are organisms that eat only organisms OTHER than plants.

_____ are organisms that eat both plants and other organisms

11. Plants are autotrophs. Are they carnivores or omnivores? Are they producers or consumers?

Plants are _____; therefore, the words _____ or _____ do not apply.

12. I have an article about a lion that WILL NOT eat meat. This animal would literally starve to death before it would eat meat. It only eats oats, grain, etc. Is it an omnivore, carnivore, or herbivore?

_____ Because this animal has been bred to only eat grains and will never eat meat, it is a herbivore.

13. Can you name some omnivores other than humans?

14. A fungus is a decomposer. Would you classify it as an omnivore or carnivore?
_____

15. Are decomposers autotrophs or heterotrophs?

a. They are _____.

b. They are also called _____.

16. Are there any living organisms that have no receptors? _____

17. Do humans asexually reproduce? On a cellular level, _____, they do.

18. In asexual reproduction, there is no need for a _____; hence, no chance for genetic disorders being passed. What is in the parent will be in the offspring.

A disadvantage is that there is no _____; hence, no exchange of genetic material. If the parent has a mutation, the mutation will be in the offspring. There is no chance of getting a bad trait out in asexual reproduction.

19. An advantage in sexual reproduction is that there is a partner; hence, _____ of genetic material. If one parent has a genetic defect, there is a chance of getting a bad trait out of the gene pool in sexual reproduction.

In sexual reproduction, there is a need for a partner; hence, there is a chance for genetic _____ to be passed. For example, if both parents have the trait for sickle cell anemia, there is 50-50 chance that the off-spring will have the disease. If one parent was able to asexually reproduce, then all the offspring would have the trait, but never have the disease.

20. Scientists have successfully cloned several organisms. Is this creating life?

Cloning _____ creating life.

21. Is Dolly an exact replica of her "mother?" _____

22. The discovery of Neptune is excellent example of the scientific method in use. Scientists had noticed that the planet Uranus did not orbit around the sun exactly as Newton's Universal Law of Gravitation predicted. French scientist Urbain Jean Joseph Leverrier assumed that this was because a previously undiscovered planet was interfering with Uranus' movement. He made some calculations using Newton's Universal Law of Gravitation and determined where this undiscovered planet had to be in order for Uranus's motion to be consistent with Newton's law. German scientist Johann Gottfried Galle used a telescope to look in the sky at the position that Leverrier predicted, and he saw the planet on the very first night of the search! The planet was named Neptune.

a. What was the observation that started the use of the scientific method in this instance?
Scientists had noticed that the planet Uranus did not _____ around the sun exactly as Newton's Universal Law of Gravitation predicted.

b. What was the hypothesis?

French scientist Urbain Jean Joseph Leverrier assumed that this was because a previously undiscovered _____ was interfering with Uranus' movement. He made some calculations using Newton's Universal Law of Gravitation and determined where this undiscovered planet had to be in order for Uranus's motion to be consistent with Newton's law.

c. What was the experiment to confirm the hypothesis?

German scientist Johann _____ Galle used a telescope to look in the sky at the position that Leverrier predicted, and he saw the planet on the very first night of the search!

d. At the end of the story as written here, was the presence of Neptune in space a scientific law or a theory? _____

23. In terms of the scientific method, where is the idea of evolution?

Evolution is still a _____ because its assumption of macroevolution as fact has not been proven.

24. What lessons can we draw from the story of spontaneous generation?

a. Even though a scientific law seems to be supported by hundreds of years of experiments, it might very well still be _____ because the original experiments might be flawed.

b. Scientific laws are not _____ reliable.

25. Does the current version of spontaneous generation have experimental evidence? _____

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